Report

NL Seafood Value Chain Infrastructure Benchmarking Assessment

Submitted to:

Mr. Carey Bonnell, Executive Lead, Fisheries Investment Fund

Department of Fisheries and Aquaculture
Government of Newfoundland and Labrador
30 Strawberry Marsh Road
P.O. Box 8700
St. John's, NL
A1B 4J6

Submitted by:

Pisces Consulting Limited
(902) 482-0984 (o)
(902) 497-4134 (c)
Contact: Peter Norsworthy
pisces@ns.sympatico.ca
www.PiscesConsult.ca

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EXECUTIVE SUMMARY

Project background and objectives: The Comprehensive Economic and Trade Agreement (CETA) between Canada and the European Union (EU) was agreed to in principle on October 18, 2013 and should be ratified sometime in 2016. One of the principal benefits of the CETA agreement will be the removal of prohibitive tariffs from seafood products entering the EU from Canada. With the implementation of CETA, significant opportunities will exist for the Newfoundland and Labrador (NL) seafood industry to increase sales activity into the lucrative EU market.

A second benefit for the province's seafood industry resulting from CETA is a tentative agreement between the federal and provincial governments on the establishment of a $400 million Fisheries Investment Fund to support industry enhancements. The program is to be cost shared on a 70-30 basis and will support harvesters and processors in the delivery of high quality products to world markets. The fund is to provide investment in several areas including research and development, new marketing initiatives, fisheries science, as well as infrastructure enhancements to improve overall efficiency in the industry.

Recognizing the need for significant technological investment and best practice improvements in operation efficiency, quality enhancement, and other value chain improvements, the Department of Fisheries and Aquaculture (DFA) issued a request for proposals for a benchmarking assessment of the operational infrastructure in the aquaculture, harvesting, processing and transportation sectors. The purpose of the project is to conduct a comprehensive scan of key technological based infrastructure requirements to improve the operational efficiency of the seafood value chain in NL. This includes assessing the current state of technologies and practices in NL, and contrasting to those in similar jurisdictions.

The outcome of this assessment will guide DFA in identifying key areas where future investment in infrastructure can best support improving overall efficiency, product quality, and advances in the seafood value chain for the province.

Industry sectors and challenges: The seafood industry in NL is comprised of a traditional wild fishery, a diverse processing sector and a growing aquaculture sector. The harvesting sector is made of an inshore fleet of 3,251 inshore enterprises, with 77% in the < 40' category and 23% in the > 40' nearshore fleet. This sector harvests a range of species led predominately by snow crab, shrimp, groundfish and pelagics. Additionally, there are approximately 14 offshore vessels >100' participating in the shrimp and groundfish fisheries.

In 2013, there were 86 active processing plants. This represents 70 primary processing, two secondary processing, and three aquaculture operations. There were also 11 operations classed as retail. These operations are located in coastal areas throughout the province processing a range of species with the predominant species being snow crab, shrimp, groundfish and pelagics.

The aquaculture sector has shown significant growth since mid 2000's, growing fivefold between 2004 and 2013. The majority of the production is comprised of salmonids at 22,196 mt while blue mussels represents the remainder at 4,354 mt. Salmonid growing operations are located on the south coast of the island while blue mussels are grown primarily on the northeast coast.

The seafood industry in NL is faced with a number of challenges that include, but is not limited to, the following:

- **Changing fisheries** - Declining shellfish stocks and an increasing abundance of groundfish stocks.
- **Supply capacity ratio** - Both harvesting and processing capacities exceed available raw material supply.
- **Workforce** - Aging workforce and recruitment challenges.
- **Seasonality –** The limited seasons when most species are harvested results in challenges to attract labour, maximize quality and supply markets at optimal times.
- **Trends in sophisticated markets –** The consumers in most markets serviced by NL have very high expectations regarding product quality, safety, traceability, sustainability and convenience.
- **Regulation –** The seafood sector operates in a highly regulated environment, which impacts both short and long term business decisions.
- **Environmentally responsible fisheries –** Through both federal regulation and actions by environmental non-governmental organizations there is a requirement to demonstrate sustainable harvesting and processing practices, and secure third party certifications of these practices.
- **Aquatic health** - The aquaculture sector continues to face aquatic health challenges.
- **Logistics** - Given our location, the logistics of getting product, particularly fresh product, to the market continues to be challenging.

Current state of the industry: The following summarizes the current technological state of each sector of the industry.

Harvesting: Overall, vessels in the inshore sector average 15 years or older and most enterprises are licensed and harvest multiple species. Almost all vessels utilize some form of electronic fish finding technology, few use fuel flow monitoring, only larger vessels have shelter decks and there is limited use of Refrigerated Sea Water Systems (RSW). Bulk holding was indicated as the most common form of holding.

Harvesters demonstrated a clear understanding of what technologies are needed to improve their operations; however, many stated the limited resource access, and resulting cash flow, reduce their ability to invest. Survey participants also indicated that investment in technology was curtailed due to lack of knowledge or understanding regarding funding programs.

- **Snow Crab:** The crab fishery operates in the spring and early summer utilizing a range of vessel sizes up to 65'. Onboard handling has evolved and improved over the years. Product is generally stored in bulk pens or pans using flake ice, with very limited use of RSW systems. The most recent harvest innovations are biodegradable twine, and increases in mesh size in pots.

- **Shrimp:** The inshore sector operates from spring to fall in >40' vessels utilizing bottom trawl. Product is landed onboard where it is bagged in poly woven mesh bags, then stored below deck on shelves with flake ice used for cooling. Due to vessel configuration and capacity issues, few vessels use pans for holding. A number of innovative initiatives have taken place over the past few years in terms of energy efficiency and environmental impacts; however, there has been limited uptake in the inshore harvesting sector.

The offshore shrimp fleet is comprised of larger freezer processing vessels >100' that fish year round. These vessels land in-shell product in a frozen state, ready for market or subsequent processing. Most vessels are equipped with the most modern electronic technology, and continue to adopt innovations to bottom gear, twine and cable types, and trawl design in an effort to improve catch performance and reduce fuel consumption.

- **Groundfish:** The groundfish fishery is comprised of many species, with turbot, flounders and cod being the most predominant in the past few years. In the inshore sector, most vessels fish multiple species and employ more than one gear type, with gillnet the most common followed by hook and line (non automated). Survey information indicated that there is limited use of dedicated bleed tanks. Cooling is completed primarily with flake ice or an ice/water slurry mixture. Product is generally held in bulk below deck in pens.

  The offshore sector utilizes trawling technology. Most have factory processing decks, and are designed with dedicated bleed systems and ice slurry is used on wet fish trips. A significant amount of groundfish is frozen at sea, either destined for final market or on shore processing. There is regular investment to assess alternative harvest methods improve trawling performance and onboard handling methods.

- **Pelagics:** The pelagic fishery is comprised of three species, capelin, herring, and mackerel. The fishery is primarily a day fishery prosecuted by inshore vessels of all sizes, which harvest using gillnet, trap and seines. Efforts are made to hold product in a buoyant medium to eliminate crushing and permit pumping. Some vessels store in a bulk fashion, delivering product to shore as soon as possible. The tuck seine has been broadly adopted in recent years for herring and capelin, which has increased catch rates, reduced costs and provides superior landed quality.

  The offshore sector has limited participation in this fishery, however, efforts to improve technologies are ongoing in this sector.

Processing: Most of the respondents have processing licenses for numerous species. The majority of respondents indicated they had made investments in research and development (R&D) and/or new technology in the past five years. Over half the respondents indicated they had received funding for these investments. Discussions with processors indicated that varying levels of technology exists, depending on species processed.

- **Snow Crab:** There have been significant improvements in snow crab processing technologies, providing higher throughputs, reduced demand for labour, improved quality and better yield recovery. NL is a world leader in snow crab section production, and many technological innovations conceived in NL have been adapted elsewhere. Recent innovations such as automated butchering and steam cooking has received considerable interest locally. Opportunities continue to exist for improved handling methods and whole frozen crab processing.

- **Shrimp:** Onshore shrimp processing operations in state-of-the-art, utilizing highly automated processing and materials handling systems. Stock declines in northeast coast shrimp stocks pose significant risk to these cooked and peeled shrimp operations.

  Offshore shrimp processing vessels are highly automated and comparable to others in this sector, though areas of improvement have been identified. Due to the fact the processing factories are in the mid deck of the vessels, equipment upgrades and process retrofits are both time consuming and costly. Fleet size reductions have occurred in response to declining stocks available to the offshore shrimp sector

- **Groundfish:** There are 45 licensed groundfish production facilities in the province. Each facility may process up to 20 species of various size and quality, making the adoption of technology challenging. The primary species processed include turbot, cod, flounder and redfish. With the exception of a couple of plants, most groundfish plants in the province rely on manual processing methods with limited, and out-dated, automated technologies. With the likely resurgence of northern cod, considerable investment would be required in order to compete in the international market.

  Offshore groundfish vessels require a high degree of flexibility to process various sizes and species. As a result, a higher level of innovation is required to improve operations and adapt to the market.

- **Pelagics:** There are 43 licenses pelagic plants processing primarily capelin, herring and mackerel into a whole round state. The processing methods used for production of whole pelagics have improved in some plants, but for the most part the process is not highly mechanized. Some limited value adding in fillets or chunks also occurs, using dated technologies.

Aquaculture: The aquaculture industry is poised for continued growth and diversification over the next few years. While there are a number of sector challenges, industry, with the support of governments, continue to invest in research and development initiatives such as sea lice control, waste management, mussel culture, processing and marketing. Other initiatives, such as the establishment of Bay Management Area and biosecurity are seen as critical. Technology in both the growing and processing segments are in line with that in other areas; however, opportunities for new product development and value adding do exist.

Opportunities for improvement: In reviewing the status of technologies used in other jurisdictions, and outcomes of discussions with technology providers, research bodies and industry stakeholders, a number of opportunities were identified.

- **Snow Crab:** In the harvesting sector, opportunities exit to optimize fishing efforts through the use Olex or WASSP multi beam sonar system to provide detailed bottom maps, therefore providing better information to harvesters.

The development of a suitable sorting table for all vessels and the use of refrigerated or chilled seawater holding systems significant quality benefits.

Improvements to offloading through the use of onboard net bags has been demonstrated to reduce labour for unloading, reduce worker fatigue and improve quality through reduced handling.

In processing, consideration should be given to the use of live tank holding systems, particularly to extend the holding time of less lively crab. Additionally, the latest advances in auto butchering and steam cooking provide the opportunity to reduce labour and improve quality and yield. Automated size grading can reduce labour content, and improve compliance to pack specifications. Automation of materials handling systems on the front and back end of the production process can also reduce labour requirements and reduce worker fatigue.

- **Shrimp:** The inshore shrimp harvesting sector could benefit from several available technologies including bottom mapping, and improved trawling technologies such as lighter/stronger rope and twine, rolling rock hopper gear, pelagic doors, and net monitoring technology. Onboard handling methods could be improved through adoption of a bycatch separation system and automated bagging of shrimp. A longer term initiative should include moving to storing shrimp in small insulated boxes, as vessels are replaced or refitted.

  While the processing sector is considered state-of-the-art, opportunities exist in unloading, bag cutting, and automation in the packaging and mastering areas. Should the processing of frozen shrimp supplies be adopted on a broader basis, an auto controlled defrosting system and materials handling system modifications would be required.

  In the offshore sector, adoption of cool steam cooking would reduce energy demand, while improving product quality and yield. Further, an optical sorting system to separate less desirable colours of whole shrimp from higher quality packs would reduce improve throughputs and maximize values of finished product.

- **Groundfish:** Inshore groundfish enterprises would benefit from mapping technologies, adopting automated jigging and longlining technologies, and utilizing improvements in trawling technologies such as lighter/stronger rope and twine, rolling rock hopper hear, pelagic doors, and net monitoring technology must be considered.

  Many practices currently in place in Iceland should be considered including recovery of liver and roe in order to maximize value of the resource. Further, there have been many quality improvements realized through advances in bleeding methods and chilling systems.

  The most significant improvement that could be realized by the inshore sector would be reducing the reliance on gillnet harvesting in favour of jigging and longlining. The benefits of this change have been demonstrated in Icelandic fishing, resulting in significant improvements in landed quality and finished product sales values.

Similar to the harvesting sector, considerable technological advances are available for processing, particularly in relation to cod. Improved technologies exist for heading, filleting and skinning from a number of suppliers. The use of Super Chill technology to improve fillet quality and allow for improved skinning and trimming provides significant quality and value opportunities.

There have been significant advances in fillet processing with automated removal of pin bones and fillet portioning which incorporates X-ray imaging and water jet cutting robotics. Other technologies such as ice dosing, automated grading, and automated plate freezers also offer significant labour and quality benefits.

Salt fish processing can benefit from new automated splitting and curing injection technologies.

While current volumes do not permit widespread adoption of these technologies (harvesting and processing) in the mid term, efforts to bring them into the current business model must be considered if the value of production is to meet harvesting income requirements.

- **Pelagics:** Pelagics is a high volume, low margin business. Competing nations such as Norway and Iceland have significant volumes of raw material that justify the investment in highly efficient harvesting and processing technologies. Opportunities exist in the NL harvesting sector for the use of RSW/CSW systems to better enhance quality and reduce handling requirements. Potential also exists in the offshore sector to improve operations through the use of larger, advanced vessels with European technologies such as trawling. These larger vessels can harvest in rougher weather and fish at deeper levels.

  In the processing sector, chilled holding in tanks versus tubs will reduce handling and demand for labour. Further, enhancements to automate the weighing, packing, freezing, and mastering processing would benefit mid and large volume whole processing operations. In the filleting/portioning processes there have been significant advances in auto feeding, filleting, portioning and roe extraction technologies. While volumes will impact the overall opportunity to invest, there is likely justification for adopting some of these individual technologies on a limited basis.

- **Salmon:** The adoption of automated stunning/bleeding and live well holding vessels will become more economical as volumes continue to increase.

  In salmonids processing, the use of temperature controlled tank trucks as opposed to insulated containers would reduce handling. Adoption of mechanical gutting would also benefit the sector through reduced labour demand. In value added, the use of the latest filleting and robotic trimming technology offers the opportunity to improve finished product value, while not adding significant labour demands. Further, adopting technologies such as automated grading, packing, modified atmosphere packaging (MAP), and materials handling systems will be required if the sector continues to grow.

- **Mussels:** On the harvest side, the ability to harvest through the ice must be addressed to ensure continuity of supply to markets. Additionally, adopting predator dispersion technologies must be further examined.

  In processing, a move to tanks with chilled seawater as opposed to tubs would reduce handling labour. The use of auto weighing / bagging systems will also improve productivity and the use of slurry ice will better enhance quality and shelf life. For value added products, opportunities exist for adoption of MAP, auto mixing and dispensing units for sauce, and auto bagging.

In both the harvesting and processing sectors for all species, opportunities exist to integrate and improve the management information systems as well as traceability systems to allow for more accurate timely information management.

Logistics: Iceland faces similar logistics challenges as NL; both are major seafood producing north Atlantic island jurisdictions. Iceland has adopted an integrated value chain approach. Vessels fish at the time of year when quality is best, market demand and timing of fresh deliveries dictate fishing plans, and all processes ensure product quality is maintained to maximize fresh market deliveries. Further, implementing a sea carrier system and reducing reliance on air carriers have reduced the cost of getting fresh product to market. This integrated value chain approach was a collaborative effort between government, industry, research bodies, equipment manufacturers and transport companies.

Infrastructure program: The components of the program should include:

- R&D and fabrication capacity building.
- Broad based implementation of new technologies.
- Value chain improvement.
- Training support.

Both provincial and federal representatives that are well versed in the seafood sector should provide program oversight including establishing basic principles, monitoring program performance against the principles and changing needs of industry.

Program implementation could be completed using existing funding agencies that would have a broader mandate. Both FTNOP and ACOA have the required expertise, and with additional resources for the term of the program could successfully manage and deliver the funds available. Establishing a project funding threshold, $250,000, could be used to delineate the roles of each agency with FTNOP managing projects funded to $250,000 and ACOA managing funding projects >$250,000. Field resources and technical support personnel should be used jointly by both agencies to ensure consistency and reduce the amount of time to build the required expertise.

The program should provide 30%-40% funding support, perhaps scaled to higher levels to encourage participation by smaller enterprises and producers. Support services should be provided by field personnel, particularly for small enterprises and producers which may lack the time or experience to make application, submissions and claims.

Recommendations: The following recommendations are provided for consideration.

- Federal and provincial governments must engage industry stakeholders to develop a comprehensive transitional plan from shellfish to groundfish.
- DFA retain the services of the Marine Institute to summarize available information regarding harvesting and onboard handling methods required to land the highest intrinsic quality product for all key species. The outcome should define the best season, capture and handling method for each species and fleet sector.
- If feasible and desirable, cooked and peeled shrimp producers should move toward a high value product model and diversify supply sources to sustain the sector and realize the best market returns.
- Complete a comprehensive assessment of EU markets for snow crab. Further, it is necessary to determine the impact of Barents Sea snow crab resources on the market.
- Establish a working group comprised of governments and sectoral representatives to develop a strategy that achieves maximum value from renewed groundfish resources within the confines of existing structural challenges.
- The infrastructure program should encourage and support producers to secure internationally recognized food safety certifications.
- Industry, academia and governments should collaborate with the Iceland Ocean Cluster to establish a similar cluster approach in NL.
- DFA should collaborate with educational institutes to define the training needs that will support technicians and groundfish processing workers. These institutes should subsequently improve their capacity in these areas and develop training workshops and courses.
- Establish a working group to develop a strategy to address the anticipated trades people labour shortage.
- The infrastructure program should be multi-faceted and provide 30%-40% funding, scaled higher for small enterprises and producers.

TABLE OF CONTENTS

1.0 BACKGROUND

The Comprehensive Economic and Trade Agreement (CETA) between Canada and the European Union (EU) was agreed to in principle on October 18, 2013. The agreement should be ratified sometime in 2016. One of the principal benefits of the CETA agreement will be the removal of prohibitive tariffs from seafood products entering the EU from Canada. In the past, Canadian producers faced tariffs as high as 20% on products sold into EU markets. With the implementation of CETA, significant opportunities will exist for the Newfoundland and Labrador seafood industry to increase sales activity into the lucrative EU market.

A second benefit for the province's seafood industry resulting from CETA is a tentative agreement between the federal and provincial governments on the establishment of a $400 million Fisheries Investment Fund to support industry enhancements. The program is to be cost shared on a 70-30 basis and will support harvesters and processors in the delivery of high quality products to world markets. The fund is to provide investment in several areas including research and development, new marketing initiatives, fisheries science, as well as infrastructure enhancements to improve overall efficiency in the industry.

It is recognized that the future the seafood industry will require significant technological investment focusing on operation efficiency, quality enhancement, and other value chain improvements. To ensure success in advancing technological and best practice improvements in this area, the Department of Fisheries and Aquaculture (DFA) issued a request for proposals for a benchmarking assessment of the operational infrastructure in the aquaculture, harvesting, processing and transportation sectors.

The purpose of this project is to conduct a comprehensive scan of key technological based infrastructure requirements to improve the operational efficiency of the seafood value chain in Newfoundland and Labrador. This includes assessing the current state of technologies and practices in NL, and contrasting to those in similar jurisdictions.

The outcome of the assessment will guide DFA in identifying key areas where future investment in infrastructure can best support improving overall efficiency, product quality, and technological advances in the seafood value chain for the province.

1.1 Industry Challenges

The NL seafood industry is faced with a number of challenges that will impact the industry as it moves forward, including:

- **Changing Fisheries** - With declines in the current cold water shrimp resource and indications of returning groundfish stocks, industry is faced with many decisions surrounding their current and future investments. For the most part, the industry has not been active in the groundfish sector for more than 20 years, and must improve understanding of markets and determine the best product forms to meet market requirements within the structural constraints of the fishery.

- **Supply to Capacity Ratio** - The current harvesting and processing capacities exceed the supply of resources available from the wild fishery. This mismatch results in short seasons and a highly competitive buying environment, both of which limit investment and financial returns.

- **Aging Workforce** - The current workforce continues to age and each year more people are retiring and leaving the industry. This is creating a labour shortage in the entire seafood industry, thus making it more challenging for enterprise owners and processors to operate. This problem is exacerbated by the fact that rural youth are leaving communities to attend post secondary schools and finding opportunities to utilize their skills in other industries. As a result, these youth are not returning to rural communities to apply acquired skills in the seafood industry.

- **Seasonality –** There are few fisheries that are executed year round, and some fisheries where harvesting is done when resources are at less than optimal condition. This means of prosecuting the fishery result in supply gluts, reducing the value of some species, and hampering capital investment. The seasonal nature of the fishery also results in low direct incomes, further hampering recruitment efforts. Limited seasonal availability of species also has impact in the marketplace, as producers may not be able to provide product to customers that desire year round supply. The seasonality challenge is a significant impediment to maximizing the value of resources available and limiting investment in infrastructure.

- **Trends in Sophisticated Markets** - The market place is becoming more demanding; this includes factors such as where the product is coming from, how it was caught, etc. Customers are demanding safe products of high, consistent quality from sustainable fisheries. Suppliers need to have technology and systems in place to meet these consumer expectations.

- **Regulation** - Both the federal and provincial governments regulate the industry. Often regulations present challenges for enterprise owners and processors that want to adjust their activities and improve operations through investments in the industry.

- **Environmentally Responsible Fisheries** - To protect the fishery for future generations, the industry must be aware of the environment around them and take steps to ensure our resources are harvested in an environmentally sustainable way. Further, to meet consumer demands, these fishery sustainable practices must be demonstrated through third-party verification, such as the Marine Stewardship Council (MSC). MSC certification of products is especially important if NL producers want to gain access to EU markets in Western Europe.

- **Aquatic Health -** The aquaculture sector, as in other jurisdictions, continue to deal with aquatic health issues. Further research and implementation of mitigation strategies must continue, to permit these year round operations to be competitive with other jurisdictions.

- **Logistics** - Consumer demand for fresh seafood is increasing. Coupled with anticipated supply increases in groundfish, salmonids and live shellfish, there will be a need to have either dedicated transport or priority transport services to move these products to distribution hubs in both the US and EU.

1.2 Project Methodology

This project utilized several methods of information gathering, including surveys, direct consultations, and desktop research; each is further described.

Processor Survey: An on line survey was designed and sent to all processors in the province. The survey requested that processors reply on a plant-by-plant basis as a number of companies operate several plants. The survey focused on information such as species processed, certifications, previous investment in research and development, previous investment in innovative technologies, future plans for new technology and factors that influence their decision to invest in new technology. A total of 18 companies representing 25 plants responded. This information was supplemented with numerous interviews of producers and association representatives.

Harvester Survey: An on line survey was prepared and, with assistance from the Fish, Food and Allied Workers (FFAW), sent to enterprise owners in the province. The survey focused on information related to vessel size, species fished, vessel age, fishing methods, technology onboard, and holding and handling methods. Other information gathered related to previous and future investments in technology as well as factors influencing enterprise owner's ability to invest. A total of 147 enterprise owners responded representing 227 separate vessels.

Aquaculture Survey: A survey tool was developed, then emailed and faxed to aquaculture participants listed on the Newfoundland Aquaculture Industry Association (NAIA) website. The survey was prepared to solicit feedback regarding opportunities and challenges associated with ongoing development of the NL aquaculture sector. The response rate to the survey was poor, likely due to the amount of recent survey activity occurring in the sector. Overall, through telephone and email, a total of five responses were received.

Consultations: Discussions were held with a range of industry participants both regionally and internationally. These consultations included industry associations, FFAW, government departments, academic institutes, research and development groups, harvesters, processors, aquaculture companies, technology supply companies, transportation, and logistics companies.

Desktop Research: Desktop research was completed to identify additional information regarding the most current technologies available and technologies under development. These were focused on known seafood development areas, companies known to supply seafood and other food processing technologies, and institutions that conduct seafood related activities in various numerous countries.

2.0 CURRENT PRACTICES

The **seafood industry in Newfoundland and Labrador** is comprised of the traditional wild fishery, a diverse processing sector and a growing aquaculture sector. In 2013, the estimated value of seafood production in the province was $1.1 billion. The seafood industry is the primary employer in most coastal communities and provides employment to over 18,000 individuals in the three sectors.

2.1 Harvesting

There were 3,251 inshore fishing enterprises licensed in NL in 2013, comprised of 2,495 (77%) in the <40' sector with the remaining 756 (23%) in the >40' nearshore sector.[1] These inshore enterprises employed an estimated 9,500 harvesters in 2013.[2] Further, there are an estimated 14 active offshore, >100’, vessels participating in the shrimp and groundfish fisheries and landing in NL.

In 2013, there was a total of 268,646 mt of product landed at an estimated value of $576 m. As illustrated in the following exhibit, the majority of volume and value is provided by seven species.

Exhibit 2.1: NL landings and values - 2013

Category	Species	Landings (MT)		Landed Value ($ 000's)
Shellfish	Snow Crab	50,806	$	209,210
	Shrimp	83,878	$	187,418
	Other	33,699	$	66,519
	Total Shellfish	168,383		463,147
Groundfish	Turbot	10,981	$	52,654
	Flounder	10,001	$	14,074
	Cod	8,066	$	9,061
	Other	6368	$	18,379
	Total Groudfish	35,416		94,168
Pelagics	Herring	29,575	$	9,780
	Capelin	30,070	$	6,628
	Mackerel	5,145	$	2,496
	Other	57	$	484
	Total Pelagic	64,847	$	19,388
	Total All Species	268,646	$	576,703

Source: DFA Seafood Industry Year in Review 2013

[1] DFO
[2] DFA Seafood Industry Year in Review

With the assistance of the FFAW union, an on line survey was distributed to the enterprise owners in the inshore harvesting sector. The objective was to gather general data from industry related to current technologies employed, on-board handling, research and development, ability to invest, etc. Additionally, species-specific harvest and handling information was gathered. A total of 147 enterprise owners responded, representing 227 individual vessels. It is important to note that the information provided through the survey may have some overlap as a result of harvesters operating multiple vessels; however, where possible the responses were refined to reflect specific vessel and fishery combinations. To supplement and quantify survey responses, discussions with fishing area representatives were completed.

Exhibit 2.2: Harvester survey profile

Category	Responses	Vessel Age	Number Crew	% Respondents Licensed Groundfish	Crab	Shrimp	Pelagics
0 - 34'11"	151	15.9	2.3	99%	79%	5%	96%
35' - 64'11"	73	17.6	4.6	85%	84%	45%	56%
65' - 99'11"	2	18.5	6.5	100%	100%	100%	50%
>100'	1	20.0	6.0	100%	100%	0%	100%

Source: Enterprise owner survey

Most vessels are fishing multiple species. In the 0'-34'11' category, groundfish, pelagics and snow crab are the predominant species. In the 35'-64'11" category, the predominant species are groundfish, snow crab, pelagics and shrimp. The 65'-99'11" category fish groundfish, crab and shrimp with some pelagic participants. One respondent indicated they fished groundfish, snow crab and pelagics in a vessel >100'.

The following exhibit reflects the survey responses for three categories of generic technology that may be present on board any harvesting vessels.

Exhibit 2.3: Onboard technology utilized

Category	% Respondents with Technology Fish Finder	Net Sensors	Fuel Monitor
0 - 34'11"	99%	3%	4%
35' - 64'11"	97%	23%	13%
65' - 99'11"	100%	50%	50%
>100'	100%	0%	0%

Source: Enterprise owner survey

Overall, almost all vessels are utilizing some form of electronic fish finding technology. With regard to net sensors, the vessel category with the highest percentage utilizing net sensors is the 65'-99'11 category, which aligns with vessels that employ trawling technology. Similar results were true for fuel monitoring devices.

The configuration of vessels regarding safety, handling and holding systems provide a measure of how owners have addressed issues regarding crew safety and comfort, as well as handling practices onboard that maintain product quality. The following exhibit illustrates responses regarding vessel configuration.

Exhibit 2.4: Vessel configuration

			Cooling Methods				Holding Methods				
Category	Shelter Deck	Auto Hauler	Flake Ice	Slurry	Slurry &/or Flake Ice	RSW	Bulk	Insulated Box	Pans	Refrigeration	Live Tank
0 - 34'11"	22%	84%	28%	42%	30%	0%	33%	29%	30%	2%	6%
35' - 64'11"	45%	75%	54%	28%	17%	1%	55%	12%	21%	6%	6%
65' - 99'11"	50%	100%		50%		50%				100%	
>100'	0%	0%	100%				100%				

Source: Enterprise owner survey

Larger vessels, >34'11", reported a higher percentage with a shelter deck present. In terms of raw material handling, a variety of cooling methods are being employed in all fleet size categories. The survey indicated that Refrigerated Seawater Systems (RSW) is used on very few vessels. Overall, the use of flake ice and/or a combination of flake ice and slurry are the most common means of cooling the catch.

Product holding methods are relatively even split across three methods (Bulk, Insulated Boxes and Pan) in the 0'-34'11" category. In the 35'11"-64' class, bulk holding is the predominant method of stowage with pans being the second most common method.

Investments in R&D and technology have been done regularly, however, not by the majority of operators, as indicated in the following exhibit.

Exhibit 2.5: Investments and intentions to invest in R&D and technology

	Investments in R&D			Investments in Technology			Will You Invest in Technology		
Category	None	Past 2 Years	Past 5 Years	None	Past 2 Years	Past 5 Years	No	Next 2 Years	Next 5 Years
0 - 34'11"	79%	13%	8%	67%	18%	15%	39%	33%	28%
35' - 64'11"	70%	20%	10%	61%	24%	14%	28%	46%	29%
65' - 99'11"		100%			100%			100%	
>100'	100%			100%			100%		

Source: Enterprise owner survey

The majority, 91%, of enterprise owners stated that having funding available for R&D and adoption of technologies would influence their decisions. Those respondents that had made no investment in the past indicated they had not done so for the following reasons:

- Lack of funding available, or lack of knowledge regarding funding available.
- Lack of cash flow from operations, which respondents directly link to lack of quota or boat size limitations imposed by regulation. This regulatory statement aligned with responses from multi-vessel owners.

Most owners indicated they have knowledge regarding the technologies available and that their reasons for investing would be to improve the economics of their enterprise, improve quality of landed product and safety of the crew while at sea. Some of the technologies specifically cited in the categories include:

- Economic viability could be improved through adoption of energy savings technologies including fuel monitoring/pilot system, auto baiting and jigging equipment, monitoring of gear when fishing, and more efficient vessel stability gear.

- Quality improvements could be realized through adopting better holding systems including RSW and liquid ice.

2.1.1 Snow Crab

Snow crab are caught in depths ranging from approximately 50 to 600 meters along the coast of NL as well as in offshore areas on the Grand Banks and continental shelf. The harvest season is generally from April until July and is conducted almost exclusively with vessels that are <65' in length.[3] The Total Allowable Catch (TAC) for NL in 2013, was 52,287 mt with 50,817 mt landed, or 97% utilization of the resource.[4]

The following exhibit summarizes the attributes of the harvesting sector of the snow crab fishery.

Exhibit 2.6: Snow crab harvesting attributes

	< 40'	>40'
Season	April - July	April - July
Catch Method	**Conical Pot**	**Conical Pot**
Holding Method	Pens (ice)	Pens /Pans (ice)/ RSW
Unloading Method	**Pans**	**Pans**
Fishing Duration	1 day	2 - 5 days
Pounds / Trip	**2,500 - 15,000**	**25,000 - 60,000**

Onboard handling practices have evolved to become more effective and efficient since commencement of the fishery. As crab pots are taken onboard, manual sorting occurs on a table or deck with undersize crab, carapace width less than 95 mm, returned to the ocean immediately. The use of sorting tables has become much more commonplace over the past 15 years; however, remains a challenge to install aboard small, <25', vessels due to space limitations. A collapsible table that can be stowed away immediately after sorting has proven to be a good option for this fleet sector.

Handling of crab during sorting and storing is done by the carapace to reduce potential damage. Depending on the vessel, crab are placed in the hold, carapace facing up, in bulk lockers or pens

[3] Snow Crab
[4] Species Quota Report

and covered in layers of ice, or iced in storage pans. Some larger vessels are equipped with RSW that permit for longer trips without compromising product quality.[5]

The DFA monitors landing of snow crab to ensure product temperature and stowage regulations are followed. An industry sponsored dockside grading program has been in place for nearly 20 years, providing feedback to harvesters regarding the quality of the catch each trip, and providing information to buyers to determine the value of the catch.

Training has been provided to harvesters by a variety of means, including workshops, distribution of quality handbooks, and production and distribution of several videos. Most vessel operators and crew are familiar with the best methods employed to ensure quality product is landed to the processor.

Discussions with sector representatives indicate that there has been some innovation in the industry in recent years. These measures all contribute to preservation of the stock and include:

- Voluntary installation of escapement mechanisms.
- Mandatory installation of biodegradable twine
- Voluntary increases in the mesh size in pots.

Results from survey respondents indicate that many harvesters have voluntarily made pot modifications and many have tested artificial bait.

Exhibit 2.7: Technologies implemented or tested

Category	Voluntary Pot Modifications	Tested Artificial Bait
0 - 34'11"	17%	28%
35' - 64'11"	15%	28%
65' - 99'11"	50%	50%
>100'	0%	100%

***Conclusion**: The snow crab harvesting sector would benefit from mandatory use of escape mechanisms, and improvements in holding methods.*

2.1.2 Shrimp

The shrimp fishery in Newfoundland and Labrador consists of two components. The inshore component operates from the spring to fall and is made up of vessels >40' in length. The offshore vessels, >100’, harvest year round with the fishery extending from the Grand Bank to the far north adjacent to Nunavut and Greenland.

[5] Association of Seafood Producers, Quality Seafood, Newfoundland and Labrador Snow Crab Fishery, 2013.

The fishery by vessels >100' lands shell on frozen-at-sea products, cooked and raw, whereas vessels participating in the inshore fishery land product fresh. This fresh shrimp is subsequently sold to cooked and peeled (C&P) processing plants.[6]

The inshore fleet is comprised of ~265 active enterprises and the offshore fleet 12 vessels. The attributes of each fleet are provided in the adjacent exhibit.

Exhibit 2.8: Shrimp fleet profile

	Inshore	Offshore
Vessel Size	>40'	>100'
Season	April -Nov	Jan-Dec
Catch Method	Trawl	Trawl
Holding Method	Bags / Pens (ice)	Frozen
Unloading Method	Tubs	Pallets
Fishing Duration	3 - 5 days	3-6 weeks
Weight Per Trip (MT)	25-30	400-500
Crew Per Trip	4-6	24-28

Inshore Sector - The inshore fishery is undertaken by vessels >40' in length which utilize otter trawl with bottom footgear. The traditional trawl gear is made up of green poly netting, steel cables, bottom rockhopper gear and bottom doors. The trawl is complete with a sorting grate that successfully separates by-catch of large non-target species such as cod or redfish, before they enter the cod end.

The trawl is hauled aboard to the net drum, and the codend suspended and shrimp emptied onto the deck holding area. Sorting of bycatch, which is comprised of small groundfish/pelagics/etc., is done manually on all but one vessel. Shrimp is put in poly mesh bags through drop chutes in the sorting table or use of shovels. Bags with shrimp are either slid down a chute or manually passed through a hatch to the hold area where bags are laid in the hold, or on shelves, and covered in flake ice. Some vessels are storing shrimp in pans rather than bags. Vessel configuration must permit for handling and storage of pans specifically; otherwise the amount of stowage space is compromised. There are clear benefits to panning onboard including reduced handling labour and fewer broken shrimp.

Discussions with harvesting sector representatives and industrial suppliers indicate that a number of initiatives have been taking place in the sector over the past few years. The following table is an overview of these initiatives and their impact.

[6] http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/shrimp-crevette-eng.htm

Exhibit 2.9: Fishing gear technology impact assessment

Technology	Impacts: Energy	Fishing	Environment	Longevity
Pelagic Doors	X	X	X	X
Light Weight Netting	X		X	X
Rope Warps	X		X	X
Dimpled Floats	X		X	X
Roller Footgear	X		X	X
OLEX 3D Charting	X	X	X	X
Net Minding		X		
Fuel Monitoring	X		X	
Species Sorting (On-board)	X	X	X	
Double Trawl	X	X	X	

The specific benefits of some of these technologies are further expanded upon in the following exhibit.

Exhibit 2.10: Fishing gear technology benefits statement

Initiative	Benefit
Pelagic Doors	Trawl spread, Bottom Contact, Energy Efficient
Light Weight Netting	(Dynema/ Spectra) Lighter, Stronger, Fuel Efficient
Warps (Dynex Ropes)	Light weight, Fuel Efficient
Dimpled Floats	Less Drag, Fuel Efficient
Bottom Gear Roller	Less Drag, Fuel Efficient, Less Wear
Double Trawl	Less Tows, Energy Efficient
Olex 3D Charting	Seabed Mapping and Visual. Harvest efficient, Fuel Efficient

While these initiatives have been ongoing, it is important to note that the use of these gear improvements does not appear widespread. The level of participation, based on survey responses, regarding testing or use of some of these important gear initiatives is provided in the following exhibit.

Exhibit 2.11: Shrimp fishing gear tested or in use

Category	Tested Net Modifications	Tested Semi Pelagic Doors
0 - 34'11"	14%	0%
35' - 64'11"	45%	3%
65' - 99'11"	50%	50%
>100'		

Note: Given that a number of harvesters use several vessels, there may have been some overlap, thus suggesting that 0-34'11" vessel were harvesting shrimp.

Onboard handling practices have been documented through a number of media including brochures, handbooks and video. Further, a series of workshops have been provided to industry participants to encourage good handling practices. The DFA has specified requirements for the quality of landed product and industry sponsors a grading program to determine the quality and size of each shrimp on a trip basis. Feedback regarding the quality of shrimp is provided to the vessel operator after each trip.

> ***Conclusion**: Adopting new technologies for inshore shrimp harvesting would reduce energy use, improve landed quality and reduce impact on habitat.*

Offshore sector: In 2013, there were 12 offshore enterprises harvesting shrimp, nine of which use NL ports for unloading and servicing. Like the inshore sector, these vessels fish using trawl gear and are subject to the same regulation related to mesh size, sorting grid, etc. Similar to the discussion above on advances in the inshore sector, the offshore fleet is making similar adjustments related to bottom gear, pelagic doors, lightweight twine and the use of Dynex warps. Many vessels utilize twin trawls, and anecdotal information indicates some are using triple trawls. These trawls increase the swept area per tow and should result in higher catch rates and less habitat impact than fishing a single trawl.

In terms of electronics, these vessels are equipped with modern technologies that will allow for effective identification of suitable fishing habitat including, depth, bottom contour and bottom type (sand/mud/gravel/rock) using software enhanced 2D or 3D sounders. This information can be archived, permitting vessel operators to return to areas of desired depth, and bottom type.

All offshore vessels use net monitoring sensors, Marport or Scanmar, which permit real-time monitoring of net performance including touchdown, net configuration, door spread, wing spread and headline height. Other sensors available; however, not used to a broad degree is the catch monitor which determines the volume of fish in the codend, and flow sensors which monitor the volume of water moving through the net permitting orientation of the net to maximize the volume of water going through the net given tidal and current conditions.

Most vessels are also equipped with data logging features, auto logs such as Trackwell, which utilize GPS technology to track vessel steaming and fishing patterns. This tracking information has a user interface that permits identifying when a fishing set commences, is completed and the operator can enter estimated catch. This permits archiving of catch rates by area, season, bottom type, etc. so effective fishing plans can be developed. These tracking systems also are integrated with satellite communication systems permitting fleet managers on shore to track vessel activity as required.

Most of the vessels have active fuel monitoring systems; however, it is not believed that any vessels have an active fuel pilot system. These active systems permit the most effective fuel management when steaming to a fixed destination with a specified time prescribed. Given sea conditions, time, fuel available, and fuel conservation targets the system controls engine RPM’s during steaming, arriving at the destination on schedule using the least amount of fuel.

> ***Conclusion**: Harvesting of shrimp with offshore vessels uses state of the art technology, and the sector continues to seek innovative technologies to improve fishing and vessel performance.*

2.1.3 Groundfish

In 2013, overall groundfish landings in NL were 35,416 mt, and valued at $94 m. Turbot was the highest volume at 10,981 mt and a value of $53 m. Flounders, yellowtail/plaice, and cod are ranked second and third. Both the inshore and offshore sectors participate in these groundfish fisheries.

Exhibit 2.12: Groundfish landings and landed value (2013)

	MT	Value ($ million)
Turbot	10,981	$ 52,654
Flounder	10,001	$ 14,074
Cod	8,066	$ 9,061
Redfish	2,999	$ 5,510
Hake	278	$ 241
Skate	288	$ 118
Pollock	151	$ 104
Monkfish	53	$ 99
Other	2,599	$ 12,307
Total Groundfish	35,416	$ 94,168

Source: DFA Seafood Industry Year in Review 2013

Exhibit 2.13: Groundfish licenses

Category	Species Fished: Cod Only	Species Fished: Cod & Other
0 - 34'11"	27%	73%
35' - 64'11"	28%	71%
65' - 99'11"	50%	50%
>100'		100%

Survey respondents indicate that the majority of vessels fishing groundfish are licensed to fish more than one species. However, many vessels are licensed to fish cod exclusively.

Many vessels fish more than one gear type, changing gear seasonally based upon quota availability, fish location and fish behaviour. The following exhibit illustrates the type of gear used in all inshore ground fishing trips (19,015) in 2013. As illustrated, there continues to be significant reliance on gillnet fishing in the smaller vessel fleets.

Exhibit 2.14: Fishing gear used by fleet sector

Category	Gear Used					
	Gillnet	Hook & Line	Otter Trawl	Handline	Pot	Trap
0 - 34'11"	67.8%	13.6%	0.0%	18.3%	0.2%	0.1%
35' - 64'11"	75.7%	14.5%	0.6%	9.2%	0.0%	0.0%
> 65'	25.8%	0.0%	74.2%	0.0%	0.0%	0.0%

Source: DFO 2013 data

The following table outlines the key groundfish species and the gear technology utilized in harvesting.

Exhibit 2.15: Groundfish gear technology

	Inshore			Offshore		
	Cod	Turbot	Flounder	Cod	Turbot	Flounder
Gillnet	X	X	X			
Longline	X			X		
Trawl	X			X	X	X
Hook and Line	X					
Pots	X					
Trap	X					

Notes: 1) One offshore company has tested longline for cod in recent years.
2) Pots have been tested in the past few years in the Notre Dame and Placentia Bays.

Respondents were asked to state whether they used a bleeding tank to soak groundfish prior to stowing in the hold. Indications are that only 15%, 23%, 50% and 0% for the <35', 35-65', 65-100', and >100' respectively use bleeding tanks. This may indicate a lack of knowledge on behalf of harvesters regarding the benefit, whiter fillet, of properly bleeding fish. Ideally bleeding would occur in chilled water, which has been demonstrated to extensive the fresh shelf live.

Gillnetting - Depending on the size of the vessel, various means of handling onboard are employed. Smaller vessels conducting day fisheries usually haul their nets using onboard haulers. These inshore day vessels usually bleed and gut and allow the product to bleed, normally in fish pans, prior to icing with flake ice in a storage locker. On occasion, weather conditions and sea state may impact a harvester's ability to tend nets on a daily basis.

On larger vessels, fish are brought onboard and are gutted. It is more common to place the fish in a tank or tub containing a mix of ice and water to permit bleeding and the fish to chill. Once completed, the fish is placed either in tubs of water /ice mix or in flake ice. Others store in pens with flake ice.

Trawl - Trawling is used by both the inshore and offshore when harvesting cod. These larger vessels usually go to sea for several days. Bleeding and gutting occurs and fish are placed in a bleed tank. Once bleeding is completed, fish are removed and placed in the hold of the vessel where it is stored in 70 liter pans (ice water slurry or flake ice) or in pens with ice.

Offshore trawlers conduct their fishery in a similar fashion. The factory deck is designed with a specific area to accommodate bleeding and gutting. Fish are conveyed to bleeding tank, immersed in seawater and ice and held for a prescribed time to permit adequate bleeding and chilling of the fish. The fish is conveyed from the bleed tank to the hold where it is placed in insulated tubs containing either ice or ice slurry, or in shelved pens with flake ice.

In the yellowtail trawl fishery, recent changes to harvesting has permitted increased catch rates by utilizing a wider door spread. The wider door spread and adjoining sweep lines have successfully herded more flatfish toward the trawl. Further, catch rates in relation to habitat, spatial and temporal factors has permitted focused seasonal efforts on certain grounds when the likelihood of yellowtail concentrations are higher.

Long Lining - Smaller vessels that conduct day fisheries usually fish using manual longline systems. Hooks are baited onshore the previous day and coiled in tubs and kept refrigerated until they are transferred aboard. Once fish is hauled on board, product is handled similar to that described above.

It is reported that some larger longliners use an automated baiting, deployment and hauling mechanism such as Mustad Autoline . These, and other similar systems, are custom designed depending upon the habitat being fished and vessel. The most advanced technology provides automatic feeding of hooks to be baited, deployment of gear, hauling of gear, cleaning of hooks and coiling of the longline back into the tub.

Onboard handling of the fish is done in much the same fashion as other methods previously described.

Handline – Though no longer a common practice in NL, hand lining is done more regularly now in other areas due to the fact fish can be harvested live, without damage or risk of predation. New auto jig systems, such as the Belitronic jigger, permit one operator aboard a vessel to operate numerous lines at one time. Handling methods aboard can provide a superior quality product if done effectively as all fish landed are very lively and can be bled effectively providing white fillets with no bruising or blood spots.

Traps and pots – Traps and pots offer the same advantages as handline caught fish by permitting very lively fish to be brought aboard for subsequent handling. The further advantage of traps is that a fixed quantity of fish can be harvested each trip, to meet supply needs onshore, or the fish can be kept in traps for an extended period of time to permit harvest when fresh markets are short.

> ***Conclusion**: Onboard handling methods to improve quality can be improved. Further, there is opportunity to automate hook and line methods, reducing labour needs onboard while providing higher catch rates per trip.*

2.1.4 Pelagics

In 2013, there was 64,847 mt of pelagics landed at a value of $19.4m. The pelagic fishery is comprised of three species including capelin, herring, and mackerel. With an average landed value of $0.13 per pound, pelagics must be harvested in high quantity and handled at the lowest cost possible, indicating handling methods should be highly automated.

The following exhibit provides a harvesting profile of the fishery by vessel size.

Exhibit 2.16: Pelagic harvesting profile

	Capelin		Herring		Mackerel	
Vessel Size	**< 40'**	**>40'**	**< 40'**	**>40'**	**< 40'**	**>40'**
Catch Method	Gillnet/ Trap /Seine	Gillnet/ Trap /Seine	Gillnet/ Trap / Seine	Gillnet/ Trap /Seine	Gillnet/ Trap/Seine/Handl	Gillnet/ Trap/Seine/Handl
Holding Method	**Bulk (some ice/water slush)**	**Bulk/ RSW**	**Bulk (some ice/water slush)**	**Bulk/ RSW**	**Bulk (some ice/water slush)**	**Bulk/ RSW**
Unloading Method	Net /Pump	Pump	Pump	Pump	Pump	Pump
Fishing Duration	**1 day**	**1 - 2 day**	**1 day**	**1 -2 day**	**1 day**	**1 -2 day**

As indicated, the fishery is primarily a day fishery, executed using gillnets, traps, and seines. The only exception being some mackerel, which is fished using handline. For the most part, vessel operators try and maintain pelagics in a neutrally buoyant medium, RSW or ice/water mix, to eliminate any crushing and permit pumping of the product using Transvac or Canavac pumping systems. Some of the smaller inshore boats store the pelagics in bulk on the open deck or below deck, but deliver the product to shore as quickly as possible to maintain product quality. These bulk stowed pelagics can be either dipped out using a brail or can be pumped.

Exhibit 2.17: Species fished and gear used by survey respondents

	Species			Gear Used				
Category	**All**	**Capelin Only**	**Herring Only**	**Gillnet**	**Trap**	**Tuck**	**Purse**	**Bar**
0 - 34'11"	**54%**	**15%**	**5%**	**38%**	**30%**	**23%**		**10%**
35' - 64'11"	58%	24%	5%	20%	22%	41%	5%	12%
65' - 99'11"						**100%**		
>100'		100%			100%			

Data from the survey indicates that over 50% of those involved in the pelagic fishery fish all three pelagic species. Outside of those in that category, 15% of the <34'11" category fish capelin only while 24% in the 35' - 64'11" fish capelin as the sole pelagic species. In either vessel category, only 5% fish herring as the sole species.

The survey indicates that in the <34'11" vessel category, gillnet is the most common harvest method followed closely by seine (Tuck and Bar) and trap. In the 35'-64'11" category, seine (Tuck, Bar and Purse) is the most common harvest method followed by trap and gillnet. The tuck seine has been adopted much more broadly in recent years for the herring and capelin fisheries, providing higher catch rates and a superior quality fish versus gillnet.

Exhibit 2.18: Pelagic fishing gear used

	Inshore			Offshore		
	Capelin	Herring	Mackeral	Capelin	Herring	Mackeral
Seine	X	X	X	X	X	X
Trap	X	X	X			
Gillnet	X	X	X			
Hook and Line			X			

The capelin and herring fisheries are executed for the most part using traps, purse seines, and, tuck seines. The use of tuck seines or traps has varied from location to location. The majority of the inshore landings in recent years comes from purse seines and tuck seines[7]. A range of vessel sizes is utilized in the harvesting of capelin. Mackerel fisheries utilize the same harvest technologies; however, many small vessels also handline for mackerel using several hooks on one line. Larger vessel categories utilize purse seines exclusively for all species.

***Conclusion**: Pelagic fisheries use a number of gear types with tuck seines being used more recently on smaller vessels.*

2.2 Processing

In 2013, there were 86 active processing facilities in the province. This represents 70 primary processing, two secondary processing and three aquaculture operations. There are also 11 operations classed as retail.[8]

An on line survey was distributed to all provincially licensed processors to gather general data from industry regarding their views on research and development, technology investments, certifications, investment plans for the future, etc. A total of 18 responses were received, representing 25 processing facilities. Many of the respondents had numerous species processing licenses, covering the spectrum of species produced in NL, as indicated by the following exhibit.

Exhibit 2.19: Species processed by respondents

Number of Respondents Processing Species								
Groundfish	Crab	Shrimp	Pelagics	Whelk	Mussels	Sea Cucumber	Lobster	Clam
18	15	5	18	6	6	3	3	2

In addition to the survey, discussions were held with plant operators to gather additional information regarding current technologies employed in processing each species, and their views regarding support systems required to modernize the industry.

[7] http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2013/2013_011-eng.pdf
[8] http://www.fishaq.gov.nl.ca/publications/SYIR_2013.pdf

The following exhibit indicates whether survey respondents have invested in research and development (R&D), adopted new processing technologies or intend to invest in new technologies in the future. As indicated, the majority of producers have made investments and will continue to invest in new technology.

Exhibit 2.20: Investment and intention to invest

	Investments in R&D	Adopted New Technology	Will You Invest in Technology	
Past 2 Yeasrs	36%	44%	Next 2 Years	76%
Past 5 Years	20%	27%	Next 5 Years	24%
None	44%	29%	No	0%

Of the producers that have invested, 56% received funding; however, 95% of respondents stated that having a cost shared program in place will influence their decision to invest, or the amount of investment they would make, in new technologies or R&D.

Some common themes expressed by producers regarding funding programs included:

- Aging population of workers poses many challenges and automation of manual processes is essential in order to maintain capacity in face of a declining number of available workers. Given the labour shortages anticipated in the next five years, funding programs that support further automation would be beneficial.

- Funding programs are essential both for conducting research to determine the feasibility of innovative technologies and to support modernization of the industry so the sector can remain internationally competitive.

- Energy costs continue to increase and have become a major portion of operating costs over the past 10 years. Support for implementing energy reduction measures and technologies that reduce energy consumption is environmentally responsible and makes the processing sector more competitive.

- There are many innovative technologies that may be suitable for processing species available in NL. However, in some cases these technologies may not be adaptable to specific sector needs. Therefore, support for investigative trips to other countries would be beneficial in order to quantify the suitability of some new technologies.

2.2.1 Snow Crab

In 2013, there was 50,806 mt of snow crab landed at a value of $209 m and production value of more than $350 m. The snow crab sector is the most economically important species in the NL seafood industry. Snow crab landings have remained relatively static over the past 15 years, and though abundance varies year to year in different areas, the stock abundance remains strong in most fishing areas. The change in environmental regime seen in recent years may impact the amount of suitable habitat for snow crab in coming years if water temperatures continue to rise and predator abundance increases.

There are 27 licensed snow crab facilities in NL, which operate on a seasonal basis, April through July. Some of these facilities are purpose built for snow crab and produce no other species; however, the majority of plants are either housed in the same structure as other processing facilities or are multi-disciplined to permit changeover to groundfish and pelagic species.

Snow crab is relatively consistent in size, ranging from 0.6-1.5 pounds, and is produced almost exclusively into shell-on sections. The consistency of size and limited scope of product forms has permitted high levels of automation for snow crab processing. There have been significant improvements in processing methods since the early 1990's that provide higher throughputs with less demand for labour, improvements in product quality and yield recovery. NL is positioned as a world leader in snow crab section production, and many technological developments from NL have been, or are being, adopted elsewhere.

Recent developments in snow crab processing include:

- Laitram Cool Steam Crab cooking. Utilizing a two pan high and two pan wide process, this cooker fits within the footprint of most existing immersion cookers. A similar steam cooking method has been developed by ABCO; however, the operating concept is different in that it is a heat and hold system rather than a continuous steam cooking system.

Laitram Steam Cooker

In 2014, Laitram introduced a low temperature, forced convection cooker for use in snow crab processing. Initial trials were conducted at the Marine Institute (MI) in 2011 using a demonstration unit. The results of the initial trial indicated that there was no significant difference in quality and suggested that the new cooker could provide an increase in yield. Due to these positive results, in 2012, a single stack prototype unit was installed at Allen's Fisheries. The results proved positive in terms of product quality, and it was noted that oil consumption for the boiler was reduced significantly.

In 2014, Green Seafoods installed Laitram's commercial unit. Processing protocols were established with assistance from the MI. Anecdotal information indicates there was significantly less oil consumption versus immersion system and the pre-cooked pack weight was successfully reduced resulting in yield gains.

Sources: Evaluate Laitram Crab Cooker - Project Summary (2012); Laitram FC Crab Cooker Verification (2013); Green Seafood's Ltd. Steam Cooker Evaluation (2014)

- The Baader 2801 butchering machine. This second generation butchering machine, based on the Flohr machine, was introduced in 2014. A similar system, developed by Ryco, also based on the Flohr design from the 1990's, was also introduced in 2014. Both technologies have the same operating concept; however, the Ryco machine is reported to operate at higher throughput speeds.

Automated Crab Butchering

In response to labour challenges and to improve overall snow crab processing, Baader Food Processing Machinery modified and introduced their new crab butchering machine. In 2014, an independent assessment, conducted Hardy Fish Co. Ltd., was completed. The scope of this assessment was to review the unit in terms of productivity, yield, quality, and maintenance.

The Baader BA 2801 is capable of processing a size range of 95-130mm crab at a rate of 18-30 crab per minute with two feeders. Specialized software allows for automatic adjustment to the size of the crab. The unit works on a combination of mechanical and pressurized water systems.

A number of benefits were identified including minimal operator training, consistent speed, consistent output quality if fed properly, cleaner sections versus manual butchering, and a slightly higher yield compared to manual butchering.

Source: A Summary Report on the Evaluation of the Baader BA2801 Automated Crab Butchering Machine (2014)

Both these technologies have received considerable interest from NL processors as the results from demonstration programs have indicated positive outcomes.

Snow crab meat production is quite limited, with much of the production for high-end Japanese and French markets being completed in China. Canadian snow crab producers, due to tariff barriers, have not exploited European markets to a high degree. However, anecdotal information suggests that consumers in northwest Europe have a preference for meat products and shell-on product is more acceptable in southern European markets. Expansion of markets within the most wealthy nations of the EU will require delivery of more convenient pack formats than sections, whether this is extracted meat, exposed meat, or convenient snap and eat products is uncertain. However, if NL producers wish to service this part of the EU market using NL based processing capacity, there will be a need to incorporate innovate processing technologies to add more value to the product.

The following flow charts illustrate the current processes employed for handling and processing snow crab in NL.

Exhibit 2.21: Snow crab unloading and transport

Unload	•Bulk - Manually remove crab and place in pans, move 1-3 pans to shore. •Pans - Slide pans from pens, move 1-3 pans to shore.
Weigh	•Bulk - Make weight, ice crab, stack on pallet. •Pans - De-ice, make weight, ice and stack on pallet or send direct to production.
Transport	•Pans - Refrigerated reefer truck.

Exhibit 2.22: Snow crab raw processing

Storage	•Pans - Stored in reefer or in refrigerated plant holding area. • Ice added manually.
Input	•Pans manually dumped to process line. •Pans dumped to process line with aid of auto dumper. •Pans direct to butchering operation.
Butcher	•Pans - Direct to individual butchers (Manual butchering). •Whole crab on continuous belt to individual butchers (Manual buthering).
Grade	•Crab sections to individual grades. •Manual grading / sorting for size / quality.
Packing	•Adjust size grade as required. •Remove defects as required. •Pack sections by grade in pan.

Exhibit 2.23: Snow crab cooked processing

Cook
- Pans - Manually placed into cage, lift system into batch cooker.
- Pans - Slide into cage system of gondola style, auto cooking system.
- Pans - Manual lift into continuous cook system.
- Pans - Manually placed in Laitram Steam Cooker.

Chill
- Cage - Manually removed from cooker using lift system, place in chill tank /tub.
- Pans automatically exit cooker and enter chiller or manually placed in chiller
- Pans automatically exit Laitram Steam cooker and enter chiller.

Weigh
- Pans manually removed from cage, may be manually weighed.
- Pans automatically exit chiller, may be manually weighed.
- Pans manually exit chiller, may be manually weighed.

Freeze
- Pans - Manually placed into cage, lift system into batch style brine freezer.
- Pans - Automatic or manually slide pans into cage system of gondola style, auto brine freezer.
- Pans - Manually placed in blast freezer.

Glaze
- Cage - Manually removed from cooker using lift system, into glaze tank or tub and remove.
- Pans automatically exit gondola brine freezer, direct on belt through glazer.
- Pan manually removed from blast freezer, manully dipped in glaze tub.

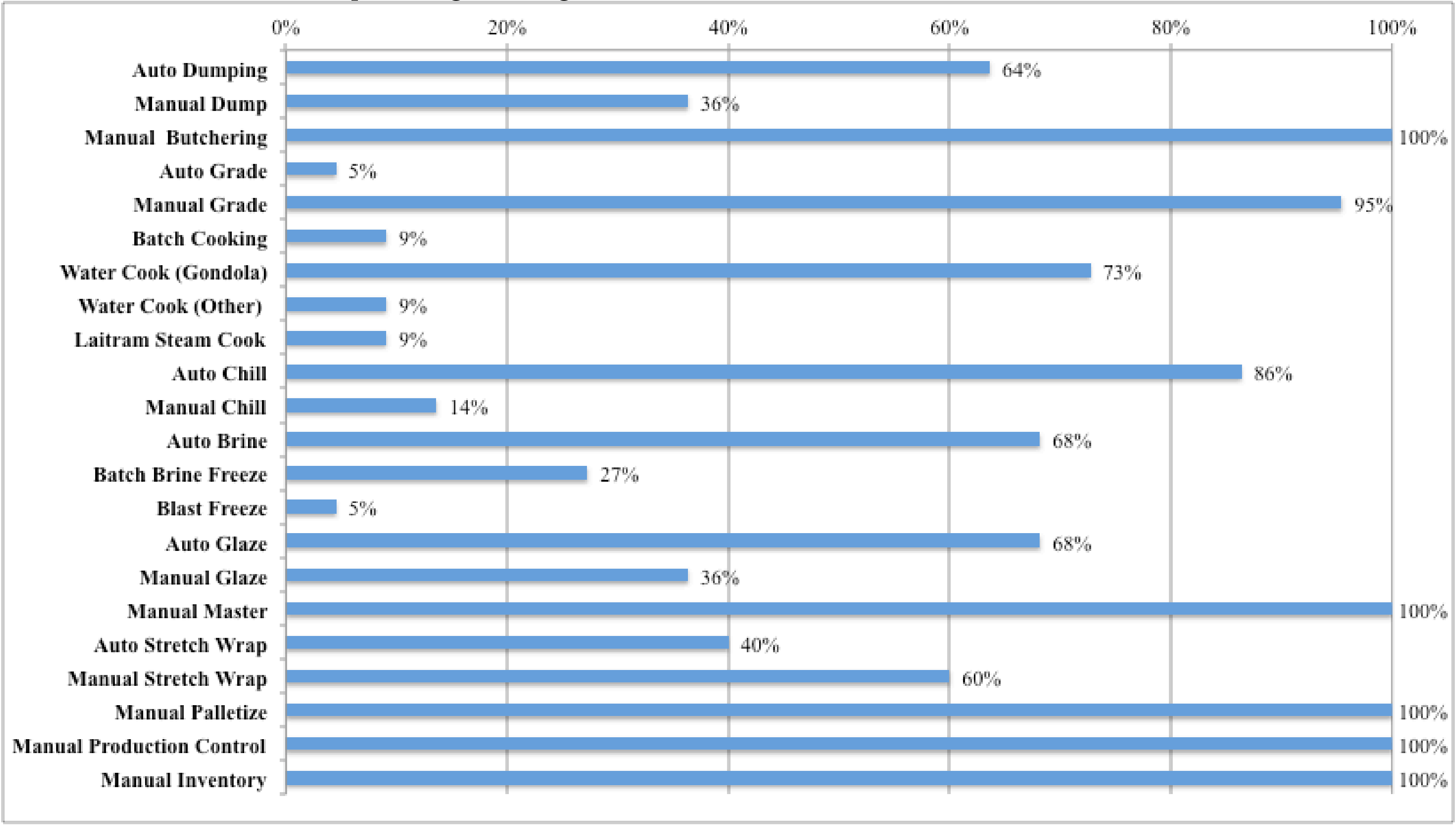
Master Storage
- Pans dumped into master, tape machine, manual paleltize, auto or manual stretch wrap.
- Pans automatically emptied into master, tape machine , manual palletize, auto or manual stretch wrap
- Pallets to cold store or shipment via forklift.

The above process flow outlines the options employed for various activities when processing snow crab sections. The flow indicated that there is further opportunity to automate the overall process, in particular butchering, size grading and the material handling systems. Additionally, there are opportunities for upgrade to some operations; however, smaller producers indicate a low return on investment due to limited supplies.

The processing of raw snow crab takes on a similar process as outlined above, however product is not cooked. In most circumstances, legs are removed and packed. This is a relatively manual process that entails individuals removing legs using circular saws. Raw product is then frozen, usually in a separate brine freezer. Overall, raw production is considered to be much more manual than the cooked process and offers opportunity for improvement.

The following exhibit documents responses from crab processing survey respondents (15) regarding the frequency of process methods currently used for production of snow crab sections. A review of the responses from crab producers indicates most large and several of the smaller producers have high levels of automation for cooking, cooling and freezing operations. Further, most plants have incorporated either flow lines or moving oval surfaces to deliver materials to butchers and packers. Recent innovations in low temperature steam cooking and automated butchering have received much interest and will be given consideration by operators in capital plans in coming years. Much of the front end and back end systems automation have not been adopted and in many instances not considered due to the limited payback or technological risk.

Exhibit 2.24: Current snow crab processing technologies



Source: Survey responses

> ***Conclusion****: Snow crab section production is more advanced than in other jurisdictions and regions; however, further improvements to existing systems and adoption of new technologies can benefit the sector through yield gains and labour reduction.*

2.2.2 Shrimp

In 2013, there was 83,878 mt of shrimp landed at a value of $187 m and export value of more than $225 m. The shrimp sector is the second most economically important species in the NL seafood industry. Inshore shrimp supplies are destined for processing at cooked and peeled (C&P) plants, whereas offshore vessels land shrimp in finished product form.

Shrimp abundance began to decline in recent years in waters adjacent to NL. Harvest from the Grand Banks will be closed in 2015 and stock abundance on the northeast coast has declined with further reductions anticipated in coming years. These reductions have had and will continue to have a dramatic impact on supply to onshore C&P processing plants.

Currently, there are 10 active, and 11 licensed, inshore C&P processing facilities. These facilities are world leaders in wild coldwater shrimp production, with state-of-the-art processing technologies used in peeling, inspection and product handling for most operations. Supply volumes is the most significant risk posed to these operations, resulting in higher manufacturing and fixed costs on a per pound basis. Private capital investment in this sector, without significant reduction in number of active plants, is unlikely given the current supply situation.

Offshore vessels have different challenges in adopting new technologies due to the significant cost to retrofit a plant aboard a vessel, downtime and access to the factory deck. This may have resulted in newer process technologies not being employed. Similar to the inshore sector, this sector is also subject to supply risks.

The following flow charts illustrate the current process flow in C&P processing operations.

Exhibit 2.25: Inshore shrimp unloading and transport

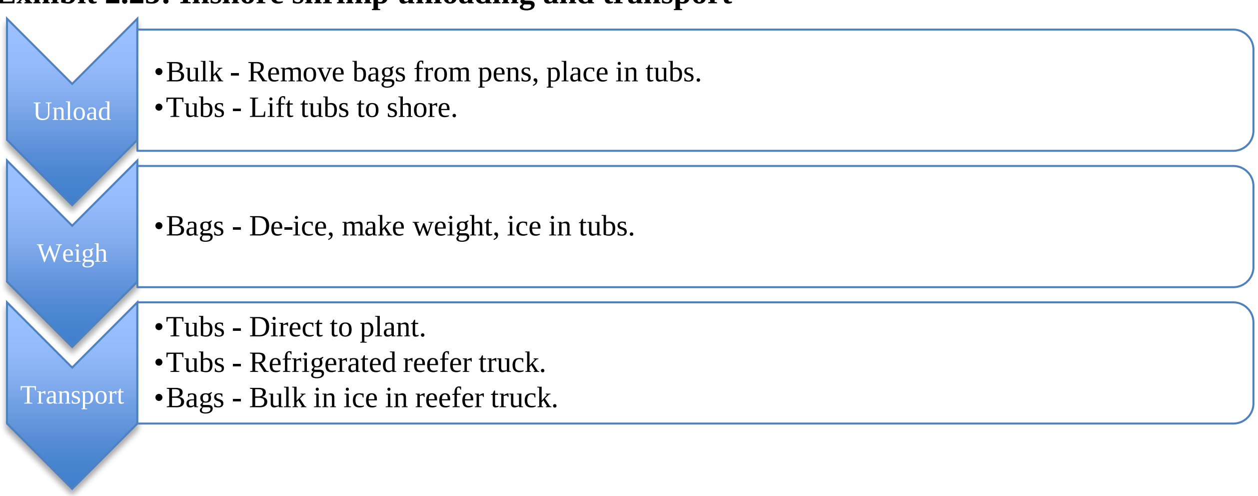
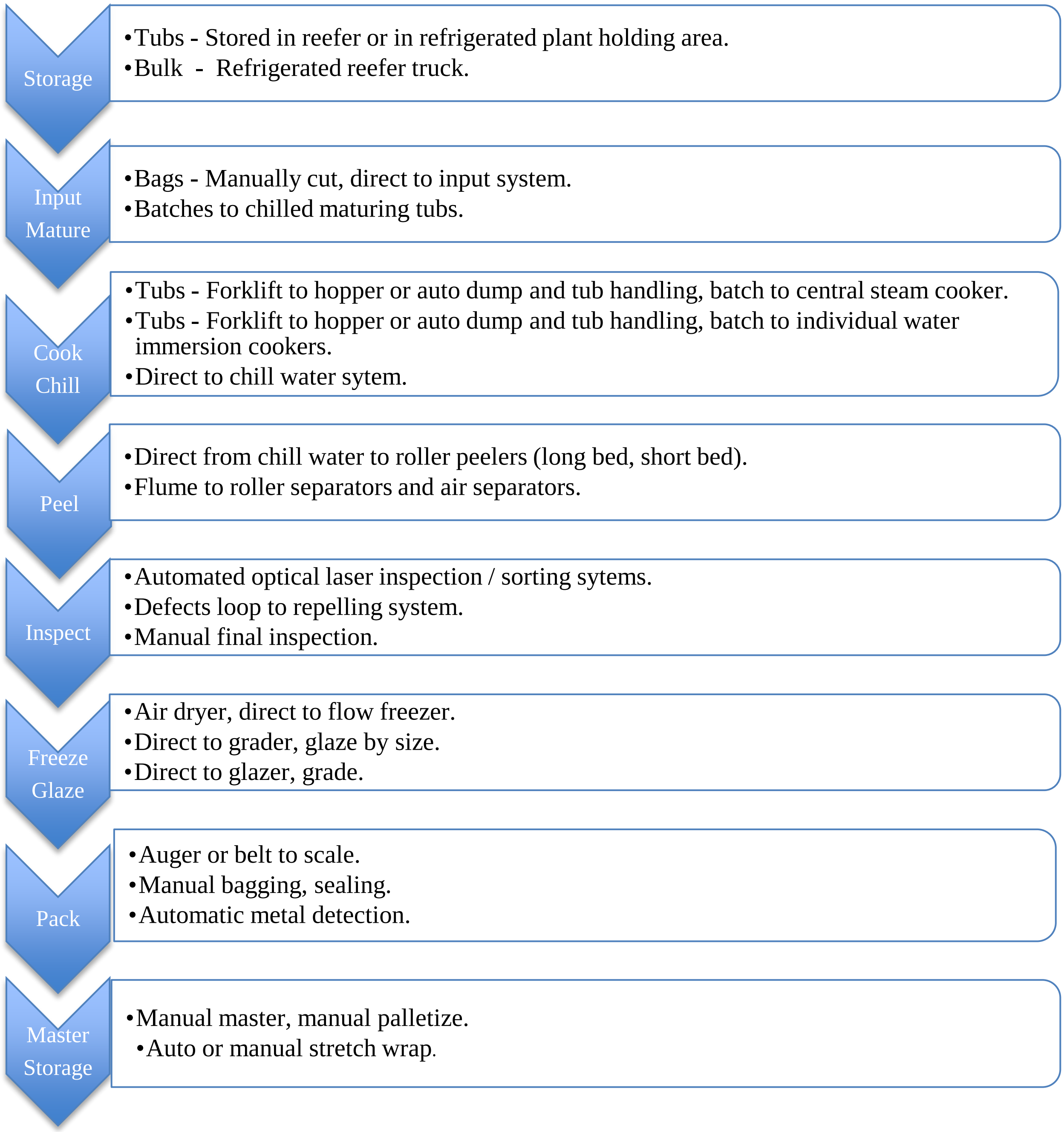
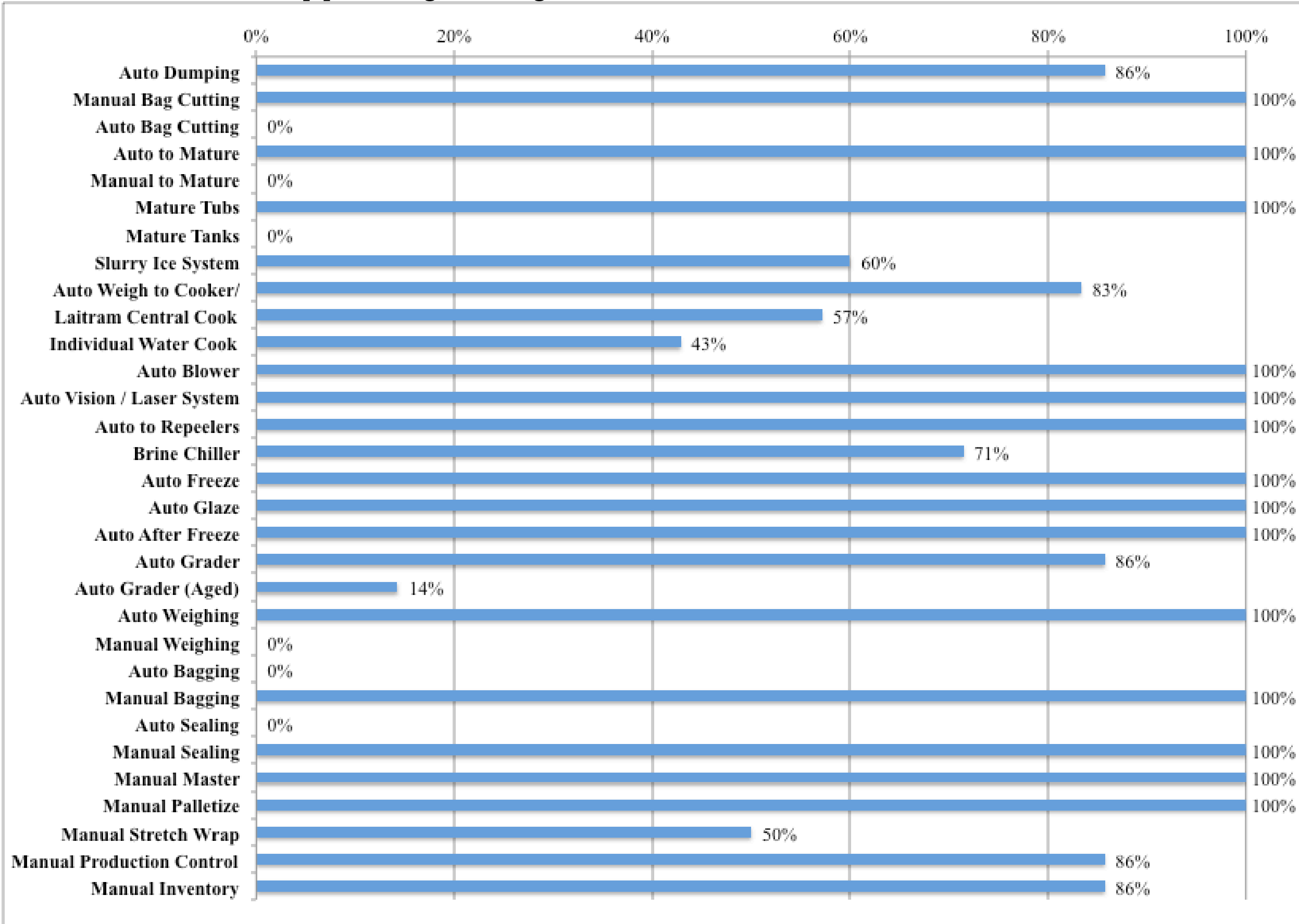


Exhibit 2.26: Cooked and peeled processing



The following chart illustrates the state of technology currently employed based on survey responses (5) for shrimp plant operators.

Exhibit 2.27: Current shrimp processing technologies



Shrimp producer survey respondents indicate there is high level of processing automation in all processing plants. However, within the industry, there are plants with varying degrees of the latest technologies. The most recent innovations have included low temperature steam cooking, automated cleaning of rollers, and one installation of thawing systems to permit production of twice frozen C&P shrimp. The opportunities for automation and improvement are in the packing/mastering operations, and automation of handling and storage in the maturing operation.

> ***Conclusion***: *NL is a world leader in production of C&P coldwater shrimp, though opportunities for further innovation and automation remain.*

Offshore Shrimp - The offshore shrimp processing sector is a mobile industry, harvesting and processing shrimp from water adjacent NL to as far north as Greenland and west as Ungava Bay. Most vessels are purpose built for shrimp processing, though some have the capability to process turbot as well. All shrimp processed is done in either whole cooked or whole raw product forms for markets around the world.

Exhibit 2.28: Offshore shrimp processing

Storage
- By catch separator used to remove large bycatch species while dumping contents of condend into holding tanks.
- Bulk in holding tank below stern ramp.

Input Process
- Manual separation of by-catch species and debris.
- Quality determination of catch (black heads, colour, etc.)

Size Grade
- Automatic size grading.

Cook Chill
- Immersion cooking of shrimp destined for EU, US, Asia.
- Refrigerated chill tank and treatment.

Freezing
- Separate tunnel freezer to permit individually quick frozen cooked or raw whole shrimp by size category and grade.

Weigh and Pack
- Individual weigh heads permit weighing to pre-determined pack specifications.
- Auto indexed packaging material to individual weigh heads.
- Packed in bags in finished carton of 1-10 kilo pack.
- Automated metal detection.

Whole Raw
- Transferred from grader to antioxidant dip.
- Automatically transferred to weigh scale, packed in 1kg-10kg pack.
- Plate frozen manually, mastered and stored.

Storage
- Palletized finished product stored in refrigerated hold.
- Maximum capacity of 500 mt.

The processing area aboard offshore vessels is limited, ~60'x140'x7', due to vessel size. Further, the processing area deck is below the trawl deck and accommodations areas making it difficult to access for removal and installation of new equipment. As a result, processing retrofits are challenging and costly. Though processing technology is advanced, there is significant room for improvement through installation of low temperature steam cooking, automation of plate freezing, materials handling systems, and optical sorting of shrimp to separate discoloured shrimp from the catch.

> ***Conclusion**: The offshore shrimp sector is quite mechanized; however, cooking and materials handling methods could be improved and R&D regarding colour grading is required.*

2.2.3 Groundfish

There was 35,416 mt of groundfish landed in NL in 2013, which is comprised of up to 20 different species. Each of these species has a range of sizes, and many of the sizes are processed differently to meet various market needs. Further, there are 45 licensed groundfish processing facilities and several vessels that process offshore. Due to the diversity of species, sizes, product forms and number of producers, adoption of technologies to be internationally competitive is challenging. This has resulted in many species being processed to minimal requirements, whole frozen or H&G, and a general lack of investment in state of the art processing technologies.

There are currently four primary groundfish species landed in NL that comprise 90% of landed volume. Three of these species have the majority of production on offshore processing vessels. The attributes of each of these three primary species produced are discussed:

- **Turbot (Greenland halibut) –** In 2013 there were landings of 10,981 mt, valued at $53 m or $2.19/pound. The inshore harvest comprised ~45% of total landings with an average landed value of $1.35/pound. Offshore vessels land finished product that had an average landed value of $2.63/pound[9].

  Inshore landings are processed at licensed groundfish plants using locally designed process flow lines. Most turbot is processed into headless and gutted (H&G) format and packed bulk for sale to market. All processing is currently conducted manually with each line worker removing the head and any remaining entrails. The H&G turbot is then washed, weighed, frozen in blast or plate freezers and packed into a bulk pack by individual fish size ranges.

  The offshore harvest is taken by both purpose built and multi-disciplined vessels that fish both turbot and shrimp. Turbot is frozen at sea either in H&G form or whole form for 400-1,000g sizes. The most technically advanced at-sea processing operations use automation for heading (Baader 424 or Josmar JM 205) with a vacuum-gutting device, though supplementary manual processing is done for removal of the gonads. The fish is then size graded using an arm style grading machine that provides the general target pack

[9] DFO NL 2013 landings

weight; subsequently, manual weighing is completed. Fish fall directly into a bleeding tank from the grading machine. The product is packed in trays, which are automatically transported, loaded and unloaded from the plate freezers, ejected from the pans and pans washed using the Optimar Giske AS materials handling system.

- **Flounders –** The flatfish landed in NL is comprised primary of yellowtail with plaice bycatch. The quotas for yellowtail are assigned under enterprise allocation and harvested using offshore freezer vessels. Small yellowtail is packed whole for market desiring a center of plate whole product. Larger yellowtail, whether destined for market or subsequent shore based processing, are processed into H&G using automated heading and gutting equipment. Size grading is done using a flip belt inline grader rather than an arm grader, and fish fall directly into a bleed tank. Larger packs, ~23kg, are frozen using vertical plate freezers and finished product is random total weight. Horizontal plate frozen product, 6kg or 12kg, are layer packed declared weight.

  Research indicated that removing both the head and tail prior to putting the fish in a bleeding tank could reduce bruising of flatfish fillets. This previous research has resulted in an ongoing project to design and test an integrated heading, tail cutting and size grading machine.

  Yellowtail processing continues to be completed ashore utilizing Baader heading and filleting machine and Marel flow lines. Research to develop an integrated x-ray and 2-3-axis water jet cutting device for bone removal and portioning is underway.

- **Redfish –** In 2012, 88% of the redfish landed in NL was from offshore vessels, with a total of 195 mt landed by inshore harvesters. The volume of landings more than doubled in 2013 (2,999 mt) versus 2012 (1,300 mt). On offshore vessels, redfish is produced into three different style packs. Small redfish, <100g, are packed whole round in vertical plate freezers at random weight up to 23kg. Redfish in the 200-400g size range are done H&G, layer packed, frozen using the Optimar handling system for horizontal plates, and packed into 6kg packs. The >400g size are packed H&G in vertical plate freezers. All redfish are size graded utilizing a flip belt in line grader, with automatic diversion of product destined for vertical plate freezing, while the 200-400g size are layer packed manually then transferred to the Optimar handling system.

Offshore groundfish processing vessels require a high degree of flexibility to process the various sizes and species encountered. To meet this requirement, higher levels of innovation specific to the needs of these vessels is required in order to improve quality and yield recovery. Further, there is demand for smaller packages, 6kg versus 23kg, which will necessitate replacing much of the vertical plate freezing capacity with horizontal plate freezing and associated weighing and materials handling systems.

Cod is the only one of the four primary groundfish species which is harvested primarily by inshore vessels and currently has no H&G or whole production, but is processed into fresh or frozen fillets or split salted fish. Further, the resurgence of northern cod abundance due to an environmental regime change has resulted in renewed interest, and concern, regarding harvesting, production and marketing of cod when a commercial fishery commences in 2J3KL. The overall NL quota, 11,000 mt, has not been fully utilized, 80% harvested.

This fishery is prosecuted as a directed fishery in 3Ps and is harvested as a bycatch species in flatfish fisheries and through a sentinel program. Estimates are that the current spawning stock biomass (SSB) is at 28% of the limit reference point (LRP) of 600,000 mt. Given the current growth trajectory it will still be several years until the LRP is achieved, permitting a modest commercial fishery as achieving the LRP only means the stock is out of the critical zone and into the cautious zone. The commercial fishery for 2J3KL cod, once LRP is reached, may be 10%-15% of the SSB (60,000-90,000 mt), to ensure a positive growth trajectory continues. Coupled with other NL adjacent cod fisheries a total commercial quota of 70,000-100,000 mt should be available in the mid-term[10].

Due to the potential for cod to be the dominant groundfish species in coming years, coupled with the fact that consumer demand for cod is in fillet or portion formats, the remainder of this section is dedicated to documenting current practices for processing cod.

The following is reflective of the current process flow in a cod processing operations.

Exhibit 2.29: Inshore cod unload and transport

Unload
- Bulk - Maually place in offload buckets, hoist to shore
- Pans - Lift pans to shore, several per lift.
- Tubs - Lift tubs to shore. (Offshore trawlers)

Weigh
- Bulk - Weigh, place in tub with ice and water slurry.
- Pans - De-ice, weigh, place in tubs with ice and water slurry.
- Tubs - De-ice, weigh, place in tubs with ice and water slurry.

Transport
- Tubs - Direct to plant.
- Tubs - Refrigerated reefer truck or open deck truck.

[10] There remains uncertainty regarding stock growth due to recruitment.

Exhibit 2.30: Inshore cod processing

Storage
- Tubs - Stored in reefer or in plant holding area.

Filleting Splitting
- Hopper to hand cutting line.
- Hopper to hand heading line.
- Hopper to auto heading machine.
- Heading machine to auto filleting or auto splitting machine.

Trim Salt
- Automated skinning or manual fed skinning.
- Manual trim lines. (Limited Flowlines)
- Manual salt split fish in tubs.

Portion Grade
- Manual portion. (Limited automatic portioning)
- Manual grade. (Limited automated grading)

Pack
- Manual weigh.
- Manual shatter pack.
- Manual fresh pack in styro masters.
- Manual - Salt bulk continers/ pallets.

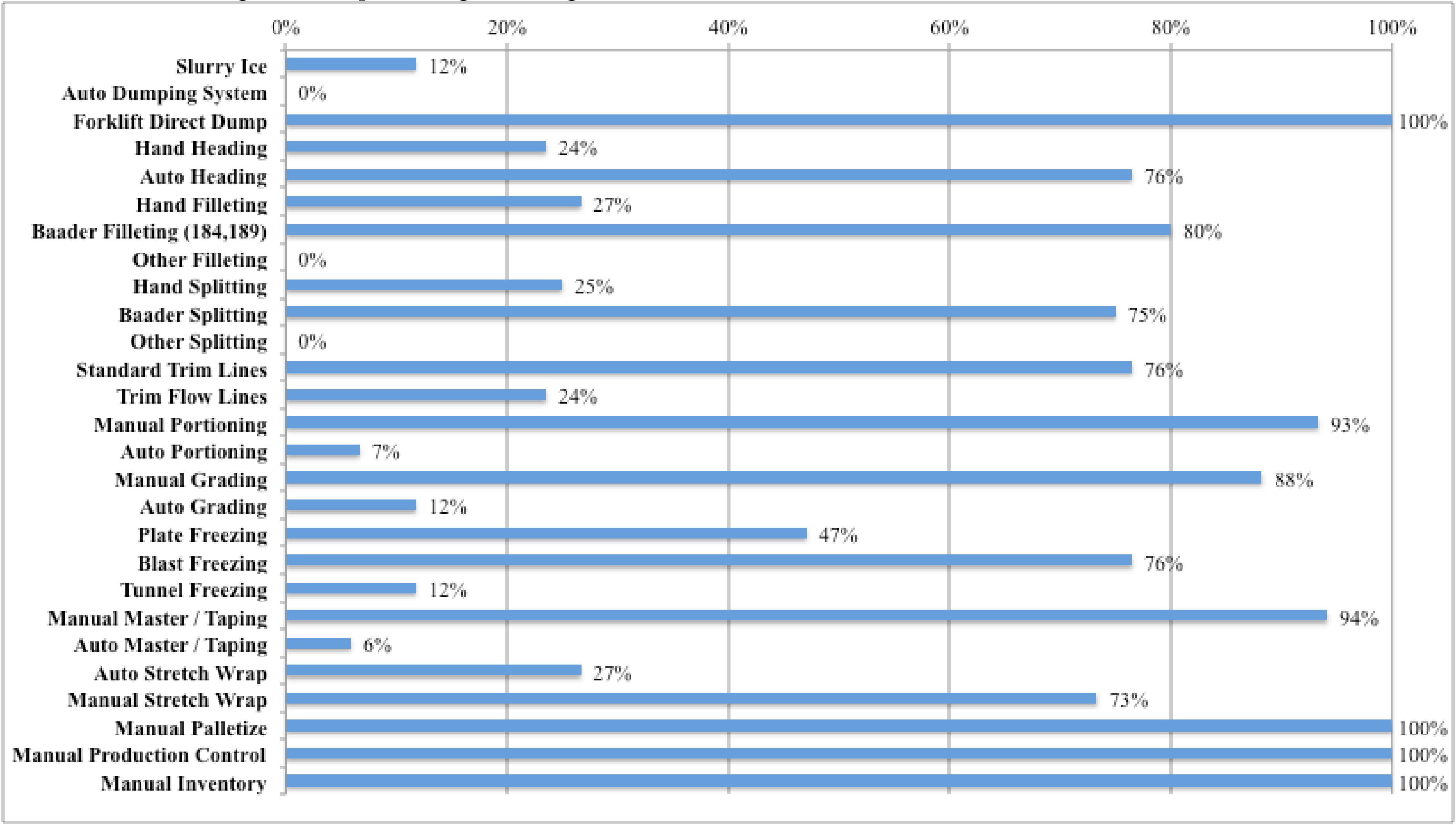
Freeze
- Shatter - Manually load / unload plate freezer.
- IQF - Manually load trays on blast racks.
- Rack - Pallet truck, or forklift to blast freezer.
- Rack - Roll to blast freezer.
- IQF - Manually feed IQF tunnel freezer.

Glaze
- Blast - Manually unload racks, dip to glaze.
- Tunnel - In-line glaze.

Master Storage
- Shatter Pack - Manually master, auto tape, auto metal detection, manual palletize
- IQF - Auto grade, auto master, manual check weigh, auto tape, auto metal detect, manual palletize.
- IQF - Manual grade, manual master, manual check weigh, manual tape, manual metal detection, manual palletize.
- Fresh - Manually check weigh, add ice /gel pack, apply lid, and palletize.
- Auto or manual stretch wrap.
- Pallet - Forklift to Cold Storage.

As illustrated in the flow charts, there is a myriad of processes employed, many of which remain manual processes. The following exhibit documents responses from groundfish processing survey respondents (18) regarding which process methods are currently employed.

Exhibit 2.31: Current groundfish processing technologies



Review of the responses from groundfish producers indicate there is limited technologies employed to process cod or other groundfish species, except in one facility. Since the moratorium, limited investment has occurred with the exception of a couple of facilities where cod has remained a primary species. In many instances, technologies that were prevalent in the early 1990's, such as Baader filleting machines, no longer exist. While many plants have participated in cod processing in recent years, most processed salt cod and this was either processed manually or with the aid of Baader heading and splitting technologies.

> ***Conclusion****: The state of technology employed for cod processing remains focused on manual processing in the majority of licensed plants.*

2.2.4 Pelagics

Pelagic supplies in 2013 were 64,847 mt, comprised almost entirely of three species including capelin, herring, and mackerel. In most of the 43 licensed pelagic plants, processing is done into a whole frozen form and methods for doing this are quite similar. A few operators complete value added production on herring and mackerel by filleting, butterflying, or processing into portions for curing.

The following flow charts reflect the current process flow in pelagic processing operations.

Exhibit 2.32: Pelagic whole round processing

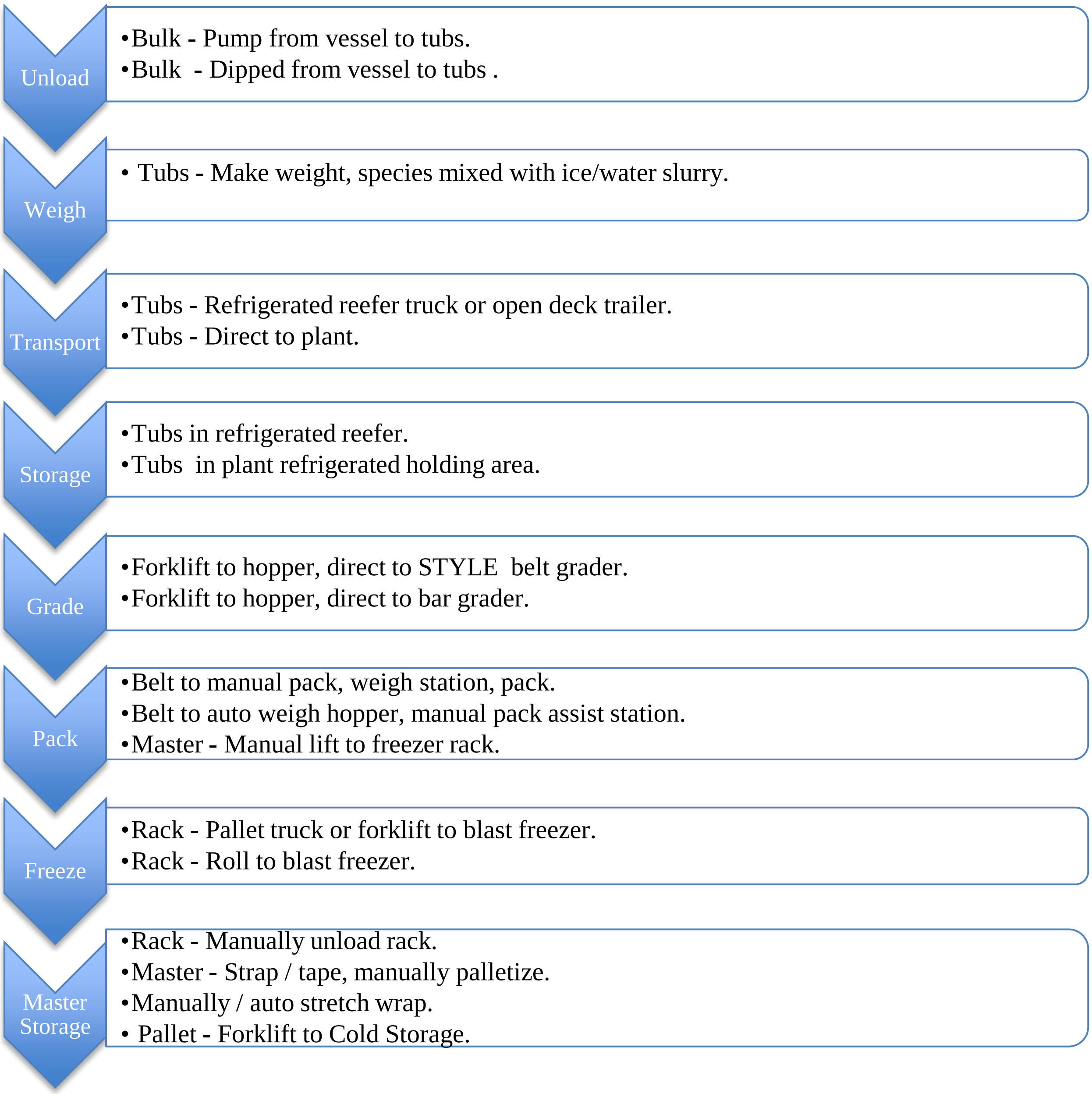


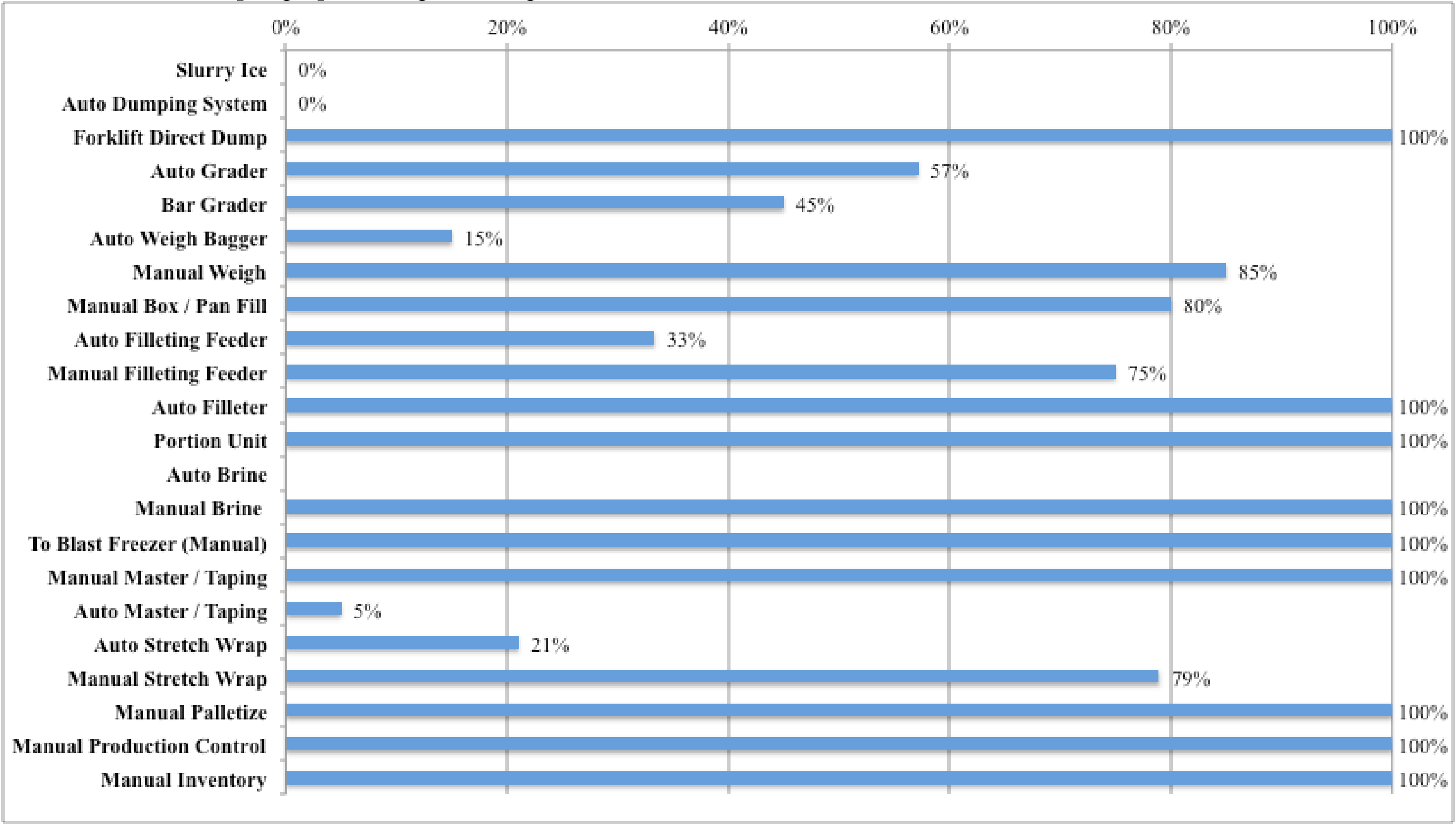
Exhibit 2.33: Pelagic fillet and portion processing

Unload	•Bulk - Pump from vessel to tubs. •Bulk - Dipped from vessel to tubs using net.
Weigh	• Tubs - Make weight, species mixed with ice and water slurry.
Transport	•Tubs - Refrigerated reefer truck or open deck trailer. •Tubs - Direct to plant.
Storage	•Tubs in refrigerated refer. •Tubs in plant holding area.
Grade	•Forklift to hopper, direct to STYLE belt grader. •Forklift to hopper, direct to standard bar grader.
Fillet	•Select grade to fillet / butterfly, other. •Convey to auto feeder, direct to automatic fillet unit. •Convey to manual feed. •Fillet using Baader 35, or VMK technology
Trim Brine	•Manual trim. •Manual brine treat, etc.
Pack	•Product to barrels. •Pack in master carton. •Master - Manually lift to freezer rack.
Hold / Freeze	•Barrels - Hold in barrels, rotate. •Rack - Pallet truck or forklift to blast freezer. •Rack - Roll blast freezer.
Master Storage	•Rack - Manually unload. •Master - Strap /tape, manually palletize. •Manually, auto stretchwrap. •Pallet - Forklift to cold storage.

Note: Some operators are value adding by filleting or portioning using Baader 35 and associated technologies (decades old). Others utilize VMK filleting technology. Product is then cured or frozen utilizing manual operations.

Survey responses (18) summarized in the following exhibit illustrate the current processing methods employed for pelagic processing.

Exhibit 2.34: Current pelagic processing technologies



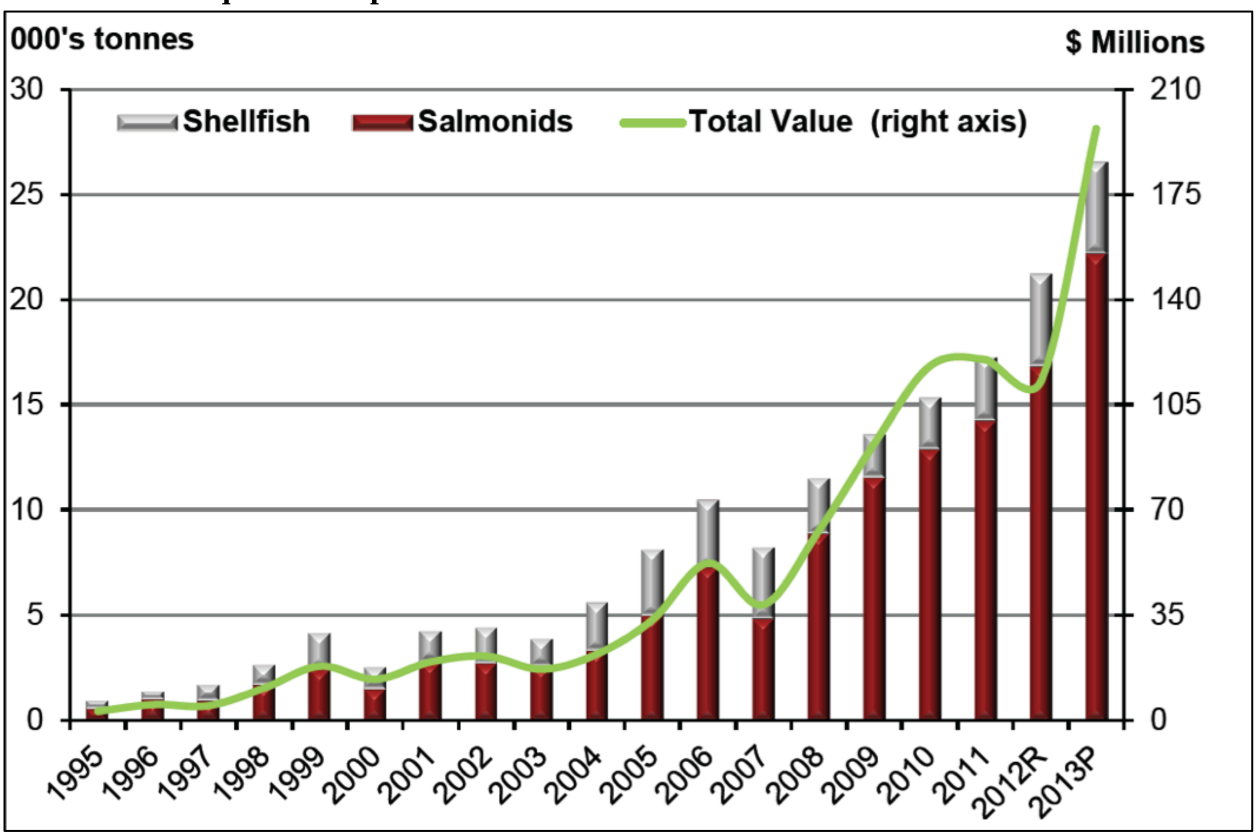
Pelagic plant respondents indicated that the state of technology in most operations is quite old. The only recent improvements in whole product handling are the Style grader and auto-weighing system. The challenge to modernization of this sector is two-fold; the volumes available are very low compared to producers in other jurisdictions (1,000 mt/day) who have highly automated operations, and finished product values and operating margins are quite low making capital investments difficult to justify.

Conclusion*: The state of technology employed for pelagic processing remains focused primarily on whole production with low levels of automation.*

2.3 Aquaculture

The aquaculture sector has shown steady and significant growth since the mid 2000's. From 1995 though to 2003 production remained below 5,000 mt. Over the past 10 years however, sector growth has been phenomenal, increasing almost five fold between 2004 and 2013. Production in 2013 was 26,551 mt, valued at $197 m, now comprising 17.2% of the total NL seafood production value. The majority the production is comprised of salmonids, 22,196 mt, while blue mussels represented the remaining 4,354 mt.

Exhibit 2.35: Aquaculture production and value



Source: DFA Seafood Industry Year in Review 2013

The NL DFA has recently released the Sustainable Aquaculture Strategy that is the culmination of two years of consultation and research. The premise of this strategy is based on sustainability, defined as:

'Sustainability refers to efforts to improve the standard of living by protecting human health, conserving the environment, using resources efficiently, and advancing long-term economic competitiveness. It requires the integration of environmental, economic, and social priorities into policies and programs.'

The report outlines the strategic direction for management, support capacity and research and development. It is anticipated that finfish production will grow almost twofold to 40,000 mt in the next three years, and shellfish production is expected to increase in volume and diversify into other species. It is estimated that 467 people are currently employed in the hatchery and grow out operations related to the aquaculture sector.

Exhibit 2.36: Aquaculture production NL - 2013

Species	MT	Value ($ million)		Employees
Salmonids	22,196	$	182	
Blue Mussels	4,354	$	15	
Total	26,550	$	197	467

Source: DFA Seafood Industry Year in Review 2013
Note: Employment is for hatchery and grow out operations only.

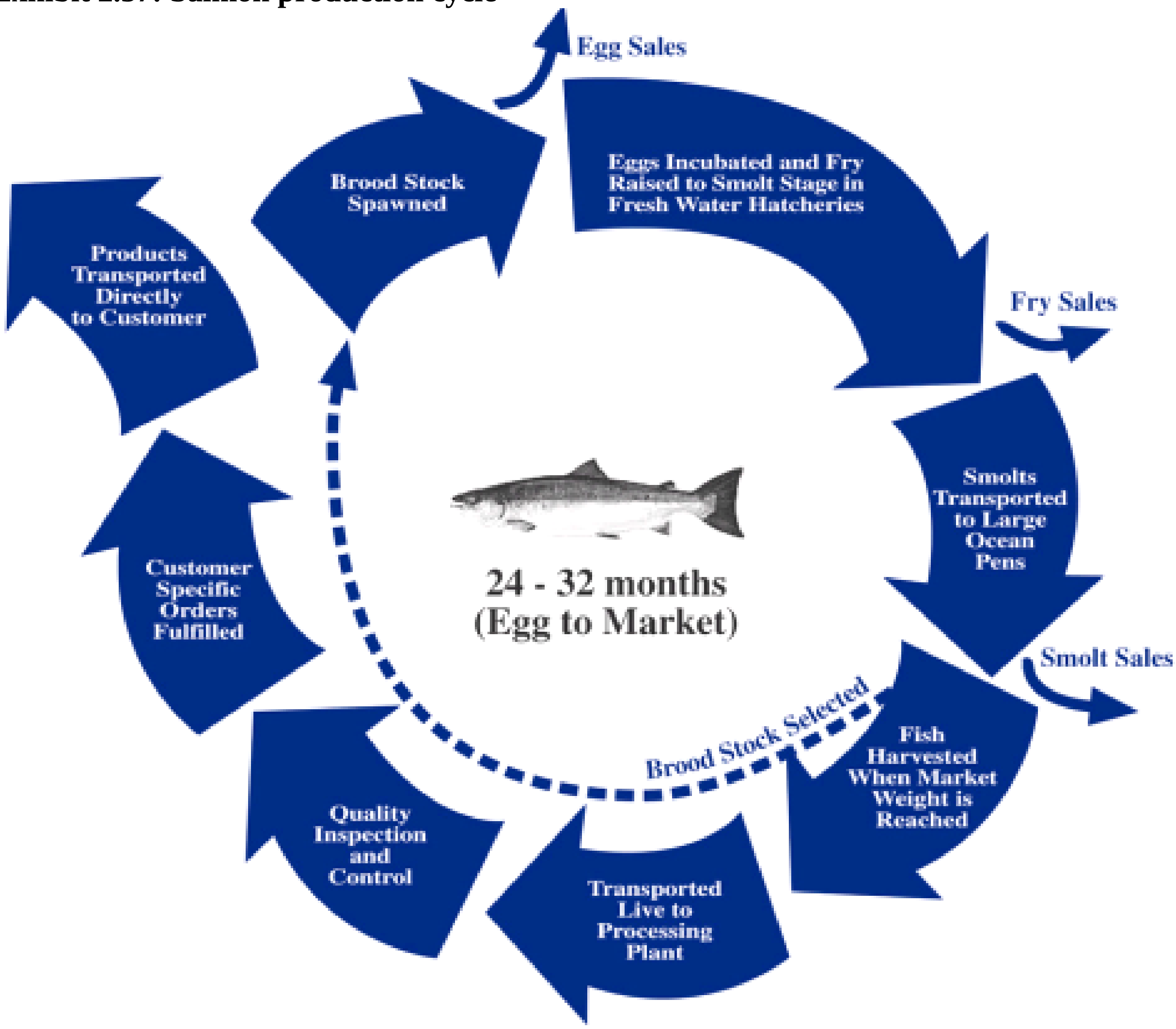
A number of recent initiatives within the industry have positioned the sector for future growth and development in a sustainable manner. These include, but are not limited to:

- The implementation of Bay Management Areas in 2014.
- Investments in biosecurity measures.
- Continued research and development initiatives in areas such as sea lice control, mussel culture, process technology, waste management, and marketing initiatives.
- The first organic certification (Canadian Organic Aquaculture Standard) for blue mussels in 2013.
- Processors being certified under Best Aquaculture Practices (BAP).

2.3.1 Aquaculture Finfish Growing and Processing

There are currently three salmon growers and one rainbow trout grower, all located on the south coast of the province. Salmon production is by far the most predominant and valuable finfish species grown and produced in NL. The following exhibit illustrates all the stages in the 24-32 month production cycle of salmon.

Exhibit 2.37: Salmon production cycle



The individual stages and processes related to salmon aquaculture in NL are further described.

- Broodstock are privately held by each of the main producers. Two of the three have a formal genetic selection program in place (mass selection & family based selection programs). Brood stock is held in the provinces of New Brunswick and Prince Edward Island. Multiple generations of broodstock supply the eggs. There is no anticipated shortage of eggs.

- Fry, fingerling and smolt production is done in state-of-the-art recirculation aquaculture systems (RAS). Both Cooke Aquaculture and Northern Harvest SeaFarms have smolt production facilities in NL. Smolts, 75g-200g, are stocked at the marine sites twice per year, fall and spring.

- Marine site leases vary in size according to location, but are sized according to the physical characteristics of the local ecology (fetch, water depth, current, prevailing winds, etc.). The leases are located in areas that are ice-free year round. Up until 2013, the active leases were subject to regular environmental monitoring program(s). The program is currently under review.

- Grow out systems use standard industry technologies, which are typically 100-meter diameter cage systems made of polyethylene pipe with 15-meter deep nets. Nets are changed annually and brought to shore for cleaning and servicing.

- The majority of the feed is supplied by multinational corporations (e.g. Skretting, EWOS) that have feed mills in New Brunswick and British Columbia, all of which comply with CFIA regulations. Cooke Aquaculture supplements some of its feed requirements with its own in-house feed mill, Northeast Nutrition, using standard industry formulations. Fish are fed from barges using blowers and automatic feed delivery systems.

- Both private contractors and in house veterinarians provide fish health services. The government of NL also has aquatic veterinarians and technical staff who conduct regular inspections of farm sites. All of the medications that are used in the treatment of fish are applied under veterinary authority. The veterinarians work closely with industry divers regarding general observations of inventory and mortality retrieval and analysis.

- Site operators use vaccines and medicated feeds to treat most bacterial pathogens. They use industry standard oral (SLICE®) and bath treatments (approved pesticides) to manage external parasites such as sea lice.

- Divers inspect all ocean-based systems on a weekly basis. Dead and moribund animals are netted out and returned to shore for disposal.

- Fish are grown to between 4-5 kilograms, at which time they are harvested using standard techniques such as stun-and-bleed on the deck of the harvest vessels. Cooke Aquaculture and Northern Harvest have dedicated processing facilities in NL. All of the fish are currently processed into head on gutted (HOG) form and subsequently shipped direct to market or to NB processing facilities for filleting or portioning.

Rainbow trout - Rainbow trout grown in NL comprise ~2,000 mt per year and are grown by one producer, Nova Fish Farms, which is a subsidiary of Cold Water Fisheries based on Ontario. Both of the current salmon producers have farmed rainbow trout in the past, but have since focused efforts exclusively on salmon. The attributes regarding the growing and harvesting trout are not significantly different than salmon; attributes varying from salmon are further described:

- Marine farms are all located in the Bay D'Espoir area, which freezes in the wintertime. The trout are moved to an overwintering location that is not affected by ice movement in the spring of each year.

- There are no local broodstock programs. Most of the eggs are provided by Trout Lodge®, based out Washington State. Fry, fingerlings and smolt-sized fish are produced outside of the province and trucked in each spring from PEI and Nova Scotia.

- Marine site leases vary in size according to location but are sized according to the physical characteristics of the local ecology (fetch, water depth, current, prevailing winds, etc.).

- Grow out systems use standard industry technologies, which typically are 70-meter diameter cage systems made of polyethylene pipe with 10-meter deep nets. Nets are changed annually and brought to shore for servicing.

- Northeast Nutrition, located in Nova Scotia, supplies the majority of the feed. Standard industry formulations are used. Fish are fed using blowers.

- Fish are grown to a harvest weight of 1-3 kilos, at which time they are harvested using standard techniques such as stun-and-bleed on the deck of the harvest vessels. All of these fish are processed to HOG form in St Albans, NL before being shipped to Nova Scotia for further value added processing (fillets, steaks) and shipment consolidation for delivery to marketplace.

Sector Challenges - The major challenges identified by aquaculture finfish survey respondents include:

- Operational factors including storm/ice damage and inclement weather, systems or equipment failures and waste management.

- Biological factors such as disease, algal blooms, and predation and in localized areas, pollution.

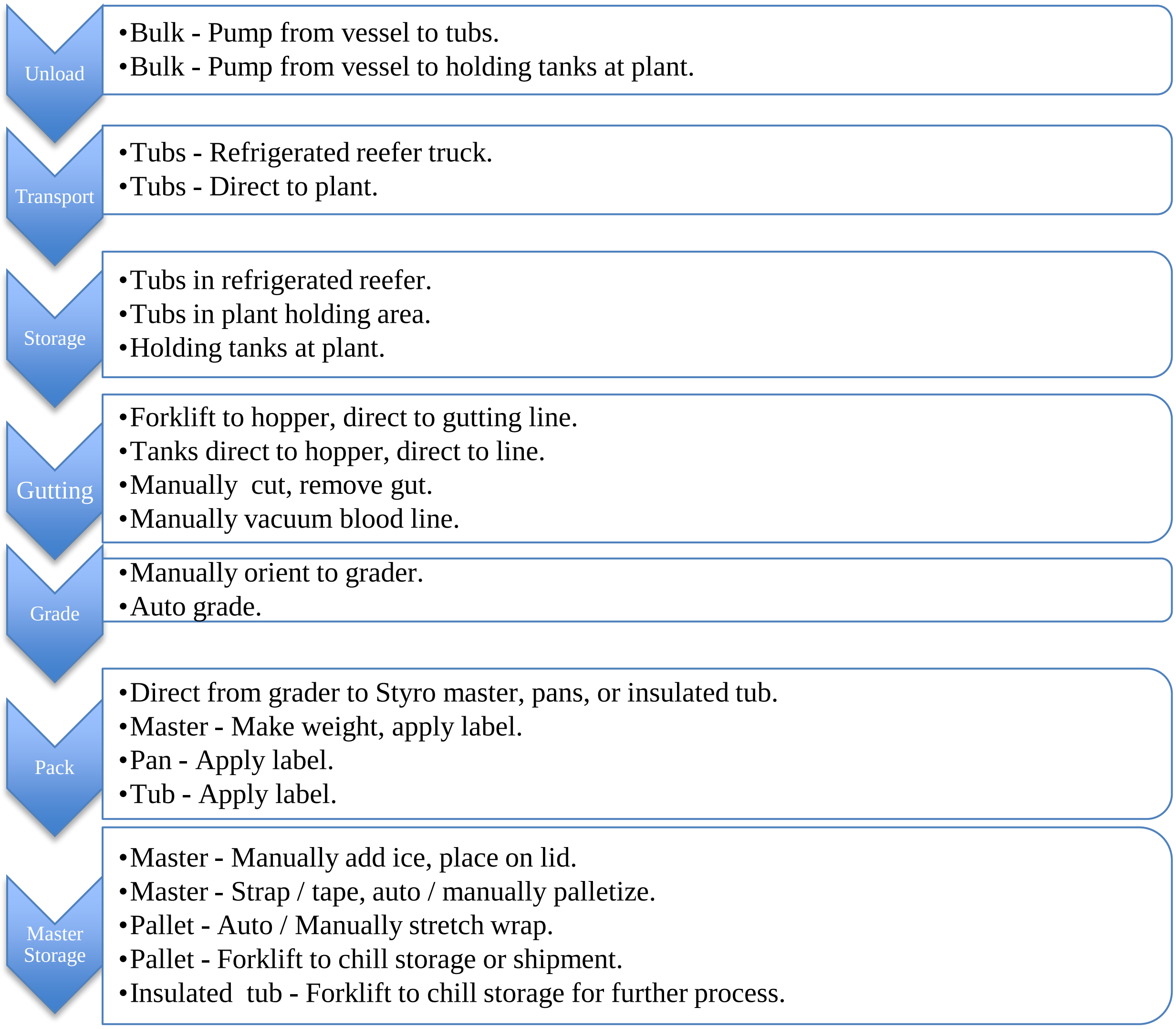
- Business factors including access to labour, markets and local services, and logistics of getting product to market with access to labour being the most important and common issue.

- Government factors such as tenure and access to leases, conflicting wild and aquaculture policies, difficulty in obtaining licenses, and meeting the requirements of the Canadian Shellfish Sanitation Program .

Salmonid Processing - Aquaculture salmon is an international commodity product, distributed worldwide from growing sites in Canada, Norway, Chile, Scotland and several other countries. Whereas salmon is such an abundant species and grown to specified sizes for particular markets, the processing technology has evolved to be a highly automated over the past number of years. As a result, to remain competitive, plants in Atlantic Canada, including those in NL, have had to keep pace.

The following process flowchart for processing of HOG salmon in NL is provided.

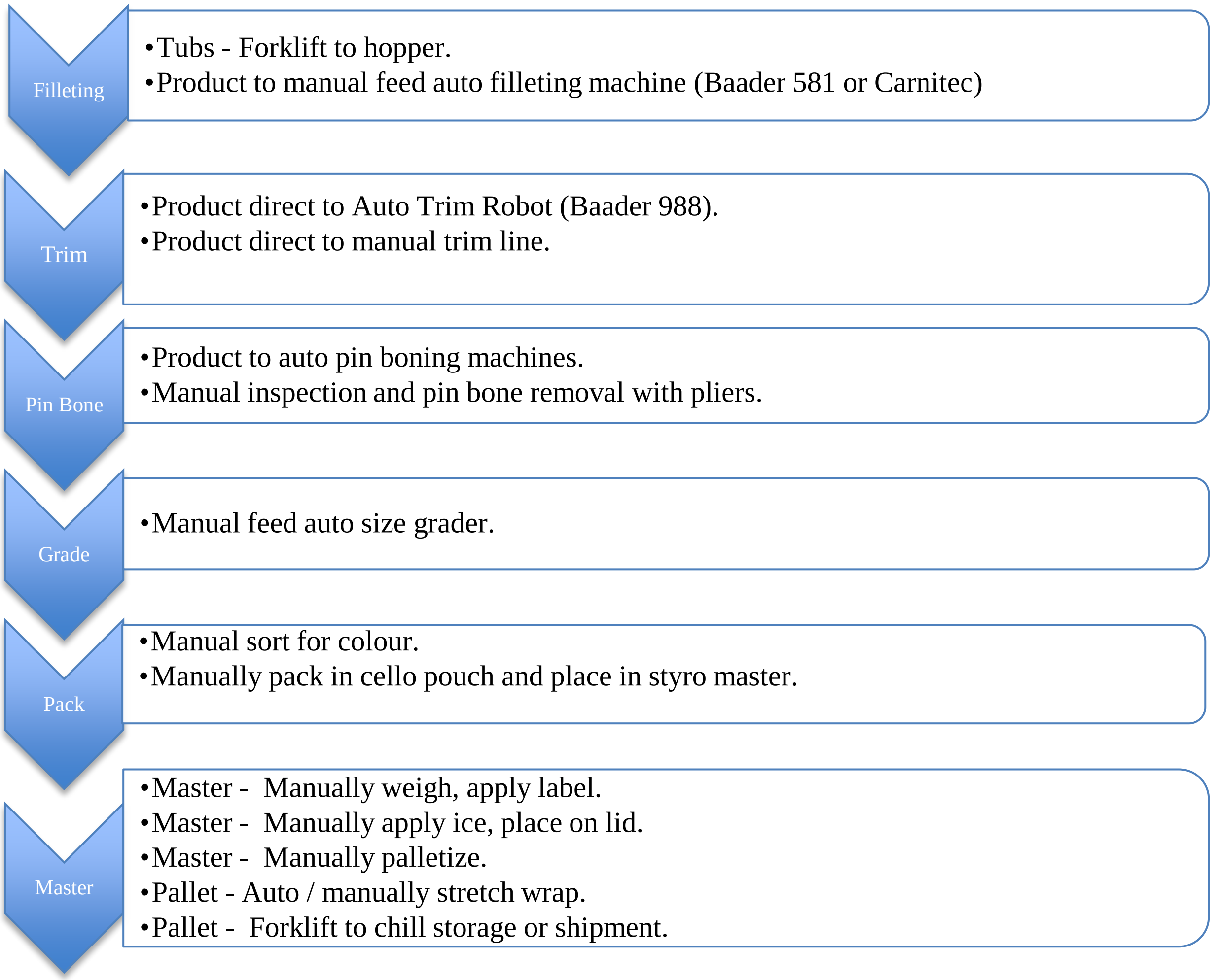
Exhibit 2.38: Salmonid head on gutted processing flowchart



Overall, the process is quite automated; however, there remains areas for improvement in the evisceration and materials handling processes. To maximize value of salmon aquaculture, there is a need to increase capacity to process into fillet and portion packs, both fresh and frozen, most of which is currently being done in plants outside of NL.

As illustrated in the following exhibit, the technology for doing fillet and/or portion packs employed elsewhere has a high level of automation.

Exhibit 2.39: Salmonid fillet processing flowchart



Areas for further automation in fillet production include size grading, colour grading and materials handling systems.

> ***Conclusion**: The grow out and production of HOG aquaculture finfish is advanced. There remains opportunity to develop a more value-added sector; however, labour and logistics challenges should first be addressed.*

2.3.2 Mussel Growing and Processing

Mussel production has grown over the past two years after very limited growth in the sector since the early 2000's. In 2013, there was 53 licensed grow out sites and production was 4,354 mt. Demand for mussels has increased across North America, resulting in stronger prices in recent years, which is anticipated to result in growth in the sector over the next five years.

There are 10 primary processors of mussels in NL that supply live bagged, frozen whole cooked and limited amounts of meats. In 2013, eight mussel growers and three producers received the first organic certification for blue mussels in North America. Anecdotal information suggests this generated significant market interest and increased trade.

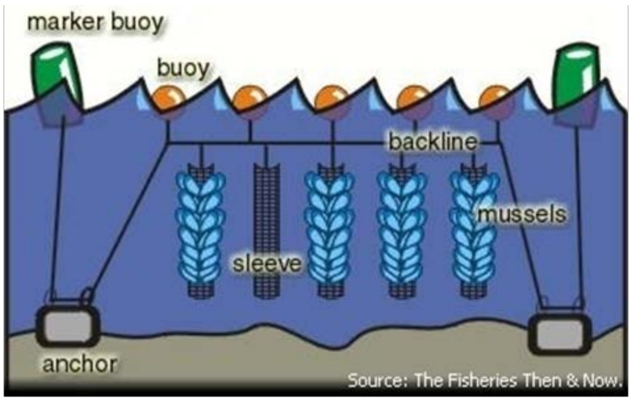
Mussel Growing - The attributes of the mussel growing and harvesting sector, include:

- Marine farms are all located primarily along the northeast coast, though there is growing activity off the Great Northern Peninsula and south coasts.

- Mussel spat (juveniles) are collected from the wild, typically in the spring, when the local mussel populations spawn naturally. Mussel producers deploy spat collectors, normally frayed pieces of rope or strips of plastic mesh with a high surface area for spat to settle upon, and collect mussel larvae drifting in the water.

- After the spat attach to the settlement surface material, they form a hard shell and are left to grow until the autumn when they are hand stripped from the collectors, taken ashore, de-clumped and graded into uniform size classes. These juveniles are then transferred into plastic mesh sleeves/tubes (socks), which are re-deployed to lease sites, where the socks are placed on longlines until such time as they grow to market size. The longlines can range from 100-500 meters in length.

Exhibit 2.40: Mussel longline



- In the spring and summer of the following year the operator will continue to add flotation to the longlines as the mussels continue to grow. There is no one season in which mussels are harvested. They remain flavourful and available year-round. The size of the meat will vary depending on the time of year. The Canadian Shellfish Sanitation Program oversees the regular testing of coastal waters to ensure that the waters are clean and the mussels free from toxins.

- In winter, bays are covered in ice and the mussel longlines are submerged approximately 0.6-1.0 meter below the surface so they do not freeze into the ice. Lines destined for harvest over the winter are marked with ice-poles or GPS markers.

- After 18-24 months, the mussels reach a marketable size of 55-60 mm. At which time the operators harvest up to 2 mt of mussels from each longline.

Mussel Processing - Mussel processing technology continues to evolve in the province. There are a limited number of processors with the majority process to fresh state for direct sale. The amount of value added production is limited, however, processors are endeavoring to move in this direction.

The following flow chart illustrates current practices regarding live mussel handling and production and value-added mussel production.

Exhibit 2.41: Live mussel handling at growout

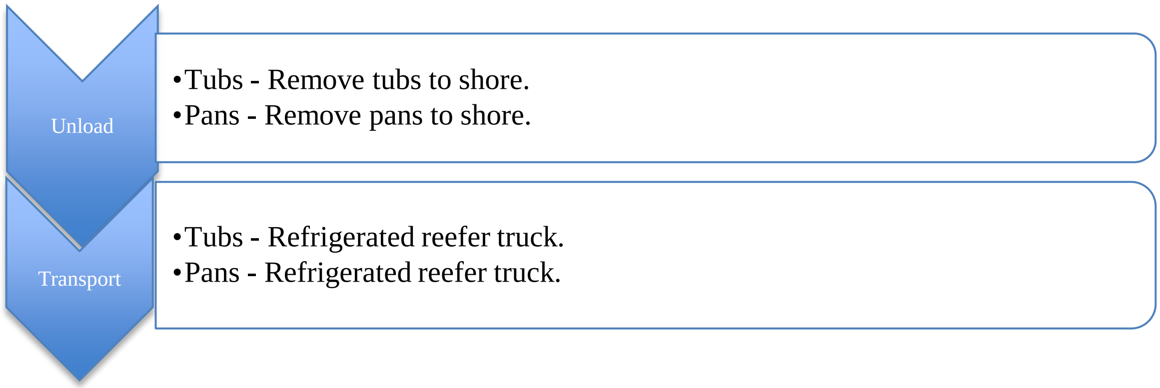
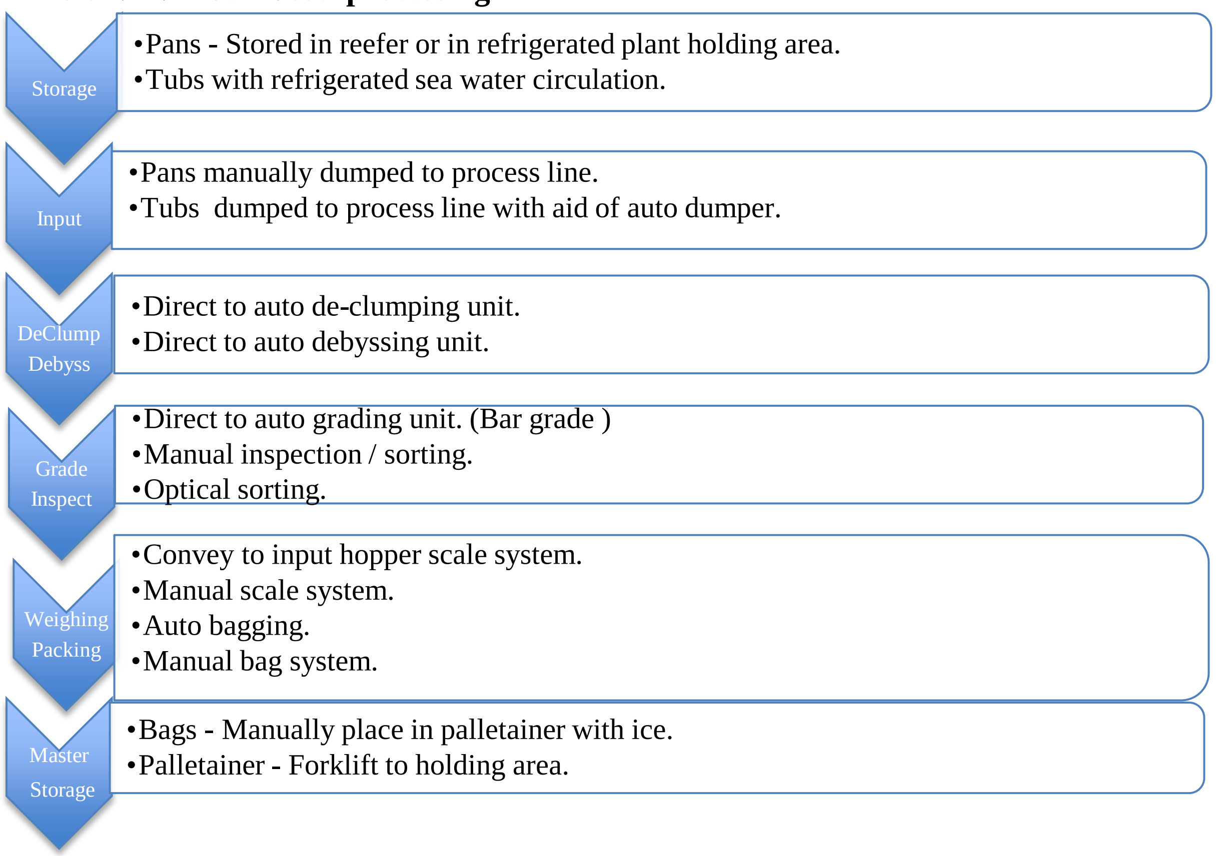


Exhibit 2.42: Live mussel processing



To conduct value added processing to mussels, the steps to the point of packing as per the live process flow, above, are first completed. Subsequent processing requirements are provided in the following exhibit.

Exhibit 2.43: Value added mussel processing

Input Weigh
- Tubs - Dump to input hopper. Convey to scale.
- Manual weigh
- Auto multi head weigher.

Pack
- Pans - Manually scoop mussels in to vacuum pack bag.
- Multi Head - Auto dump to rollstock unit.
- Bags - Semi auto sauce injection.
- Auto seal on vacuum rollstock unit.
- Manual seal on "Flip Flop" vacuum sealer.

Cook
- Bags - Manuallly to pans for cooker.
- Pans - Manually slide in Laitram Steam Cooker.

Chill
- Pans - Automatically to chiller.
- Pans - Auto exit chiller

Freeze
- Pans - Manually place on pallet, forklift or pallet jack to blast freezer.

Master Storage
- Pans - Forklift or pallet jack remove from blast freezer.
- Manually place bags in master, manually palletizee, auto or manual stretch wrap.
- Pallets to cold store via forklift.

Given that the water temperatures in coastal NL where mussels are grown are cooler than in more southern growing areas such as the Maritimes and eastern U.S., the growing times are significantly longer. This results in a higher quantity of small mussels on a line, which are rejected during production, as minimum desirable size in the market is 2.5". Therefore, it is essential that NL firms gain competitive advantage through processing rather than growing. As illustrated, there is high degree of automation in much of the processes, which is comparable to other Maritimes producers and more automated than US producers.

The NL industry has not been successful in implementing modified atmosphere packaging (MAP) for mussels, which is a growth market for retailers as it provides fresh product with an extended shelf life versus live bagged. This realizes a price premium at retail outlets and reduces the quantity of spoiled live product.

> ***Conclusion**: Mussel markets continue to expand and mature, resulting in demand for a more diverse, value-added, product line. The mussel sector should continue efforts to expand value-added product offerings.*

2.4 Logistics

Logistics includes the management of product flow from point of origin to point of consumption. For NL seafood producers, logistics responsibility starts at the plant door and ends when the product is delivered to the distributor or wholesaler. Therefore, logistics is a support function to the marketing requirements of all producers. Whereas NL seafood producers provide perishable fresh and frozen products, a temperature controlled transportation service is required. This requirement denotes a premium shipping service that limits the number of transportation service provides available.

There are several challenges to supplying markets from NL, including:

- Very limited and no dedicated airfreight services for perishable products.
- Seasonal weather conditions, which bring transport systems to a standstill, limit the ability to supply fresh products to markets.
- Ferry service operations do not give priority service to perishable products, resulting in shipping delays of up to three days. This limits the ability of producers to enter contract supply agreements for fresh products, and increases the cost of shipping all seafood products.
- Distance from the European market limits the ability to ship fresh products by sea. Improvements in product handling and packaging methods would improve the opportunity to avail specialized sea freight services.

Moving seafood to market uses three modes of transport, over the road truck transport (highway/ferry combination or roll-on-roll-off container vessels), ocean freight, or airfreight. Truck transport is the primary means to serve North American markets (directly by over the road-truck-transport) as well as Asia and EU via container ships, normally shipped Halifax. Historically, and as is currently the practice, most of NL seafood exports to the EU move on ocean vessels. Products moving in this mode are typically frozen seafood products, primarily shrimp. There has been some activity by air mode but this has traditionally been relatively small and served the fresh fish markets of the EU or Japan. Seasonally, there has been a road-feeder-service (RFS) that moves fresh product over the road/ferry service to an air hub city where it is trans-shipped by air to the EU or Japan.

Trucking Services – There are numerous small companies providing refrigerated over the road service for transport of both raw and finished product. These small companies, and processor owned trucks, provide services for collection and transport of all raw materials not landed directly to processing facilities, ~300 locations. Some of these same carriers also carry finished product either to export points or direct to buyers in the U.S. and Canada.

Major national carriers, Midland and Day & Ross, carry the majority of finished product. These operators have the ability to distribute products throughout North America and have the advantage of normally hauling both ways. Further, these companies have warehouses in NL, which permits consolidation of loads, reducing the likelihood of hauling less than load.

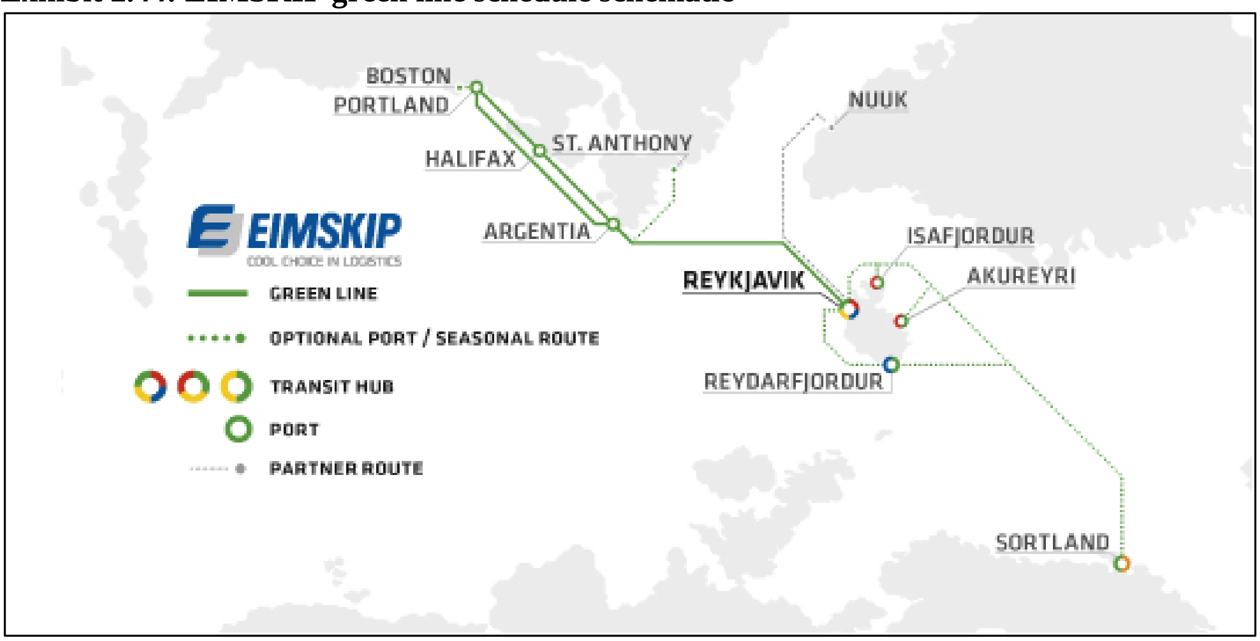
Most trucks servicing the seafood business are equipped with refrigeration capacity, reefers, to maintain product at desired temperatures. The majority of trucks used for raw material transport also have self-contained drainage systems and ceiling tarps to ensure good distribution of refrigerated air. The exception if for groundfish and pelagics which may be hauled on deck trailers in insulated containers with ice/water.

There are significant constraints in over the road delivery of fresh products, whether destined for the US/Canada market or to air shipment points on the mainland. Currently, this challenge is impacting the salmon and mussel sectors, but does have an indirect impact on groundfish species that could also be sold fresh. Often, fresh shipments must be returned to producers due to ferry service disruptions or no priority service being available at ferry locations. Ideally, shipment of perishable items would always take priority, even over previously booked priority slots, to provide the necessary support to industry to improve market values. Alternatively, having a chilled and cold storage area available at exit locations would permit consolidation of loads, re-icing and repacking of products could be beneficial in both reducing shipping costs and extending the shelf life of perishables.

Conclusion*: Logistical challenges for over the road transport of fresh products reduces the value of aquaculture production, and likely discourages producers from pursuing opportunities for live and fresh sales of other species.*

Ocean Services - Currently, the main service lane to the EU is provided by EIMSKIP , which has two vessels serving NL as a segment of their North American trans-Atlantic service. As illustrated in the following exhibit, Argentia, St. Anthony and Halifax are the Canadian ports that are called on for freight destined to the EU.

Exhibit 2.44: EIMSKIP green line schedule schematic



The service rotates via Argentia on a schedule that approximates every ten days between the two vessels. Seasonally, subject to weather, conditions in the port and the number of containers to load the vessels make a stop at St. Anthony where locally/regionally produced products, primarily shrimp, are shipped. At other times of the year all products are moved overland to Argentia or Halifax for shipment.

All products destined for the EU are trans-shipped from Icelandic ports by feeder vessels. Primarily, export shipments move to the UK or through Denmark, which is the gateway to mainland Europe for NL originated products.

Information gleaned from discussions with seafood, ocean line and customs brokerage representatives indicate there are no major issues associated with using this service to the EU markets. It is recognized that the service is limited to predominantly one service provider, which, given the limited shipping demand is not unexpected. However, it is uncertain that there is adequate capacity is in this service to meet possible growth in demand as a result of the CETA arrangement. This may prove a challenge in the future with limited competition for the lane.

Sea freight fresh shipments

Iceland successfully ships more than 14,000 mt of fresh fish annually to European destinations using carriers Eimskip and Samskip. Sea freight fresh exports started in 2000, have grown exponentially since 2011, and are anticipated to surpass air freight fresh shipments in 2015. This has significantly decreased shipping costs and reduced the carbon footprint of shipping by over 95%.

Improvement in shipping methods were identified by Matis through comprehensive research conducted on temperature control improvements throughout of the value chain. This includes pre-cooling prior to packaging, reconfiguration of loading in containers, modifications to the containers, and control of temperature when transferring product.

***Conclusion**: The CETA may permit an opportunity to competitively provide fresh seafood to EU consumers sea freight.*

Air Services – Industry stakeholders indicate there is little requirement for air service for EU destined products at the current time. In truth, there is very limited movement of seafood products by air to the EU or to other markets. Further, there is nothing moving now due to the inability to be competitive on traditional products that could be supplied from NL.

Competitiveness may be on price alone or it may be tariff related. Reduction in duties and increases in the quantity exported to certain countries may be determining factors, and not product cost alone. From discussion with the Gander International Airport Authority there is a readiness to develop a service to provide goods to market. However, there is a critical mass in the order of 12 mt/week that would be necessary to make any air service reasonably viable to the EU. Currently, this level of demand is not present for air shipment to the EU.

Air freight fresh shipments

Fly Fresh Freight Inc. was initially established in 2007 as a pilot project to determine the feasibility of consolidating shipments of perishable products for air freight to Europe via Iceland.

The outcome of the project demonstrated that high quality fresh products could be delivered to European markets. There was limited use of this service at the time; however, with elimination of tariffs in EU markets, this type of dedicated service could become feasible.

***Conclusion**: A dedicated and cargo air carrier service for delivery of perishable products to the EU should be evaluated when CETA is adopted. This may be particularly beneficial with continued increases in groundfish supplies.*

Product Carbon Footprint - One recent environmental trend is determination of 'food miles', which is the distance that food travels before reaching the consumer. Food miles are not an inclusive measure, as it does not take into account the method food is transported. Greenhouse gas emissions (GHG) measure the carbon footprint of products and take into account all aspects of energy consumption, and can be measured at any step of the handling chain. CO_2 equivalents are the common unit of measure when determining GHG.

Seafood CO_2 emissions vary depending upon the method of harvest, processing techniques and how finished product is distributed. The variables, which must be defined prior to calculating the carbon footprint of any seafood product, include:

- Average distance raw material is trucked to the plant.
- Actual yield from raw material to finished product.
- Amount of electrical and fuel energies used to produce the product.
- Method and distance of shipment of the product to the target market.

The Energy Reduction Handbook for seafood producers provides examples of the carbon footprint for some NL produced products and illustrates how to calculate a products carbon footprint depending upon method of harvest, processing and shipping method.

3.0 JURISDICTIONAL REVIEW

A review of jurisdictions where species similar to those found in NL was conducted. Specifically, the jurisdictions reviewed included Iceland, Norway, United Kingdom, the states of Alaska and Oregon, and Greenland. The following exhibit contrasts the volumes by jurisdiction. Both development and adoption of technologies for specific species are influenced by the quantities of those species available. For example, whereas NL harvests the most snow crab, the technology in NL should be more advanced than Norway that harvests ~10% of the volume. Conversely, NL lands only 6% of the volume of herring landed in Norway, so it would be expected Norwegian firms would have invested more capital for harvesting and processing herring than NL firms.

Exhibit 3.1: Species landing (MT) comparison by jurisdiction (2013)

	NL	Iceland	Norway	UK	Alaska	Oregon	Greenland
Snow Crab	50,806	-	5,420	-	29,705	-	1,973
Shrimp	83,878	10,857	-	-	-	21,533	44,940
Cod	8,066	236,051	471,315	13,500	309,043	-	14,775
Turbot	10,981	14,998	12,596	500	-	-	25,346
Flatfish	10,001	5,979	3,298	3,500	242,161	-	-
Capelin	30,070	451,023	155,148	-	-	-	242
Herring	29,575	157,446	506,230	45,400	22,732	-	-
Mackeral	5,145	153,815	164,608	98,800	-	-	-
Total	228,522	1,030,169	1,318,615	161,700	603,641	21,533	87,276

Source: DFA Year in Review 2013, Statistics Iceland, Statistics Norway, UK Fisheries Statistics 2013, NMFS, and Emanuel Rosing Director Fisheries Greenland
Note: Greenland shrimp includes 25% landed from offshore. Remaining offshore excluded as it is transshipped Denmark.

All jurisdictions have some means of supporting R&D efforts, testing and developing technologies, and introducing these technologies to the seafood industry. The larger institutions that provide these services are described in Appendix IV.

3.1 Snow Crab

In looking at snow crab, it is important to note that NL represents a large portion of the overall snow crab harvest in the world. In the above table, NL represents 60% of the landed volumes. Another key producer is the state of Alaska. In conducting this scan, discussions took place with a number of key technology providers who have spent time in Alaska and are very well versed on operations in both Alaska and NL.

3.1.1 Harvesting

The Alaskan fishery is managed under an Individual Fishing Quota (IFQ) system where individual fishermen are given a share of the harvest and can catch their share at any time during the fishing season. This has led to a safer and more efficient fishery, as fishermen can take weather and economic factors into account when deciding when to fish. [11] The fishing season runs from October until May and is fished on vessels ranging from 58'-165' in length. These vessels utilize large square metal traps that are baited with herring, sardines or cod. Crewing on a vessel will depend on size and ranges from 4-10 including the captain.[12]

While the season runs from October until May, the predominate fishing season in January until March. This is the time of the year when the crab has the optimum meat fill and the weather, while cold, has improved from the fall.

Traps are emptied on a sorting table, often up to 700 crabs per trap. All crab is sorted on deck and recently conveyor systems have been installed to speed up the process of getting crab to the hold and returning discards to the sea. The product is held in RSW systems with a trip lasting, depending on catch, from 8 -10 days.

In addition to this fishery, there are a number of smaller vessels, up to 58', fishing tanner crab. These are part of a diverse fleet that catch salmon, and pot cod. These vessels also have RSW systems.

Exhibit 3.2: Snow crab harvesting jurisdictional contrast

	NL		NS/NB/QU		Alaska
Vessel Size	**< 40'**	**>40'**	**<45'**	**>45'**	**58' -165'**
Season	April - July	April - July	Apr/May-Aug	Apr/May-Aug	October - May
Catch Method	**3' Conical Pot**	**3' Conical Pot**	**7' Concical Pot**	**7' Concical Pot**	**Square Pot**
Holding Method	Pens (ice)	Pens /Pans (ice)/ RSW	Pens (ice)	Pens /Pans (ice)/ RSW	RSW
Fishing Duration	**1 day**	**2 - 5 days**	**1-4 days**	**2-5 days**	**8 -10 days**
Pounds / Trip	2,500 - 7,000	25,000 - 60,000	4,000-20,000	20,000-100,000	175,000 -300,000
Unloading Method	**Pans**	**Pans**	**Pans**	**Pans**	**Brailer**

In terms of handling, Alaska uses RSW as the method of holding where most NL vessels use various methods of holding in ice. The unloading process in Alaska entails individual picking crab from the hold and placing it into a brailer bag, 1,500 pound capacity, which is then winched to the processing plant and dumped to hoppers going directly to production. The primary advantage in Alaska is that product is delivery live from the vessel hold directly to production, necessitating the boat to remain on station until all product moves to production.

In NL, when pans are not used on board, individuals must pick up the crab from the hold and place into pans that are winched to shore. In both cases, the initial handing is labour intense, however, storing crab in pans rather than bulk would improve the handling process on shore in terms of labour and quality. With numerous unloading locations, trucking, and occasionally oversupply, snow crab in NL may be held in ice storage for 2-4 days prior to processing, resulting in weak rather than lively crab going to production.

[11] NOAA - FishWatch: Alaska Snow Crab
[12] Alaskan Fishing 101 - F/V Northwestern

> ***Conclusion**: Alaska is further advanced in its holding methods through the use of Refrigerated Sea Water (RSW) and all crab is lively going to production. Both jurisdictions have room to improve unloading methods.*

3.1.2 Processing

Generally, snow crab processing plants in Alaska are much less automated than in NL. Though the output is the same, crab sections, the process involved in transforming the whole snow crab to sections in Alaska is much more manual, reminiscent of methods employed in NL 15-20 years ago. This includes a reliance on batch cooking, chilling and freezing operations resulting in inconsistent quality, lower product yields and higher staffing levels.

One plant in Alaska, Trident plant on St. Paul Island, has utilized automated butchering machines for many years. It has been observed however, that the quality of sections from the butchering machines have numerous defects, gill and mandibles remaining, which requires additional labour post-butchering not required in NL when manually butchering. The output quality from these machines has contributed to the recent re-development of the technology by two companies, Ryco, and Baader, who both introduced modified versions of the same machine in 2014.

A recent development in cooking technology by Laitram Machinery, Cool Steam Crab Cooker-Cooler, which has been introduced recently to NL, is also now being adopted in Alaska. This recent development in Alaska will likely result in modernization of the processing sector as equipment suppliers (Laitram and C&W) identify other areas for improvement.

> ***Conclusion:** Currently, Alaskan producers have no processing technology that is not currently available to NL producers.*

3.2 Shrimp

In reviewing the coldwater shrimp sector it is important to recognize that NL has been a significant player in that sector for a many years. The sector has matured since the 1990's as supply volumes increased. Other jurisdictions have not benefitted from increases in supply, which has resulted in those jurisdictions having less frozen at sea processing capacity. However, these same jurisdictions successfully secure frozen supplies for on shore peeling operations, supplying markets with either once frozen brined or twice frozen finished products. The exception has been Oregon, which has recently realized increases in local supplies. Further, wetfish trawlers, similar to those harvesting the inshore component of the NL shrimp resources, execute the Oregon fishery.

3.2.1 Harvesting

Oregon, which is a state managed fishery, has a substantial pink shrimp fishery that has realized supply increases over the past few years. There were 61 vessels active in the shrimp fishery in 2013[13], which landed 47.8 m pounds.

The only other similar fisheries for coldwater shrimp are executed in the Maritime Provinces. Though there are many similarities with the NL and Maritime fisheries, there are differences in terms of vessel size, and catch rates. Further, the fishery in the Maritimes yields larger shrimp, 50-60 count versus 80-90 count, than those harvested in NL.

The following exhibit contrasts the attributes of NL, Maritimes, Oregon and Greenland shrimp fisheries.

Exhibit 3.3: Shrimp harvesting jurisdictional contrast

	NL	NS	NB/QU	Oregon	Greenland
Vessel Size	>40'	45'-100'	45'-100'	55 -105 '	20-23 metres
Season	April -Nov (IS) Year around (OS)	Year around	May-Dec	Apr. -Nov.	Year around (Weather and Quota)
Catch Method	Trawl	Trawl	Trawl	Trawl	Trawl
Holding Method	Bags / Pens (ice)	Bags	Bags	Pens (ice)	Tubs (ice)
Unloading Method	Tubs	Tub	Tub	Buckets (loose shrimp)	Tubs
Fishing Duration	3 - 5 days	1-3 days	2-5 days	1 - 4 days	5 - 6 days
Pounds / Trip	20 - 30 mt	30-50 mt	30-50 mt	20 - 30 mt	30-50 mt

Maritimes based enterprises operate under an Individual Transferrable Quota (ITQ) system. The methods employed in the fishery and handling methods are the same; however, the catch rates, trip duration and capacity of vessels to land higher volumes provide a distinct cost advantage for these enterprises.

The fishery in Oregon operates under an Individual Fishing Quota (IFQ) system. Regulatory and industry personnel in Oregon indicate that some vessels fish using double riggings. Round sorting grates are used versus rectangular in NL. These round grates may offer some advantage in maintaining net configuration after the grate. Most vessels have up to date electronic technology onboard. In terms of holding, shrimp is held loose in the hold, iced in pens. To offload, shrimp are raked into buckets and the buckets lifted to shore. Apparently mesh bags were used at one point, however, this was stopped as some bag debris was found in the finished product.

The Greenland shrimp fishery functions under an ITQ system. The inshore quota is fixed at 43% of the overall TAC. Inshore harvesting is conducted using trawl with mandatory use of a sorting grate. Product is held in ice in small tubs on board. The offshore fishery is conducted similar to that in NL; however, they are required to land 25% of their catch.[14]

[13] http://www.dfw.state.or.us/mrp/publications/docs/shrimp_newsletter2014.pdf
[14] http://archive.nafo.int/open/sc/2012/scr12-048.pdf

It is interesting to note that the inshore fishery in Greenland employs the use of insulated boxes (tubs) to hold product on board. Previous work in NL indicated a number of potential benefits could be achieved through tubs, however a transition to tubs would pose a number of challenges given existing boat hold configurations.

Storing Shrimp in Insulated Boxes (Tubs)

In 2004, the Centre for Aquaculture and Seafood Development (CASD) conducted an independent study comparing boxed and bagged shrimp. A CASD technologist accompanied crew on the F/V Patricia S where they assessed the current bagging method and demonstrated proper boxing protocols using 380L Icelandic boxes. A new onboard holding tank was put in place to improve the manual on-deck process. For comparison purposes, 50% of the catch was boxed and 50% was held in bags using the standard method.

The overall results concluded that there are improvements in raw material quality when boxing shrimp. The study pointed out that quality improvements would be attained when product was chilled immediately after landing and handled in such a way to minimize breakage. The report pointed out that due to the hold design, incorporating boxing on the 45'- 65' fleet will impact the carrying capacity of the vessels as a result of the number of boxes the vessel can carry. Additionally, a transition to boxing would require changes to a number of on-shore protocols and procedures.

Source: Assessment of Two Stowage Methods Used in the Newfoundland and Labrador Shrimp Fishing Industry (2004)

3.2.2 Processing

The shrimp processing sector in other jurisdictions is progressing with the use of standard processing technology found elsewhere in the sector. In the past few years, Laitram steam cookers have been incorporated into processing operations. Stakeholders are continuing to work on fine-tuning other areas of the process including maturing and chilling systems. All plants have received certification to the British Retail Consortium (BRC) and the fishery is certified under the Marine Stewardship Council (MSC).

3.3 Groundfish

In looking at groundfish, the jurisdictions investigated included Iceland, Norway and USA (Alaska). There are vast differences in the quantity of cod landed in other jurisdictions versus NL. This has resulted in development and implementation of modern technologies in these countries to ensure the highest quality product that meet ever changing consumer requirements, utilization of most or all byproducts, yield improvements, and significant reductions in labour requirements.

The cod processing outputs in NL prior to moratorium was segmented basically into three categories. Saltfish producers who produced primarily green salted cod, and sold the finished product through a provincially owned crown corporation, the Newfoundland Salt Fish Corporation. Fillet producers who provided skin-on bone in cod fillets from small cod to the UK fish and chip market and produced blocks and fillet packs to US markets. The smallest category was those producers who did portion packs including tail, loin, center cuts and block and also provided full fillet shatterpack and roll packs.

Since the cod moratorium, the primary market, US, for NL production has moved to alternative species for block and much of the fillet packs. There remains limited trade of loin and tail products; however, demand for North Atlantic whitefish products in both the US and EU are now primarily for fresh fillets.

As illustrated in the following exhibit, the average value of fresh fillets in the markets returns significantly higher prices than any other individual or combination of products. This indicates that to have economically viable and vibrant cod processing and harvesting sectors, the industry must focus on how to provide fresh cod to market. Financial returns to industry from providing exclusively frozen fillet/portion/block production is unlikely to encourage harvesters to fish or plants to make significant investment in capital.

Exhibit 3.4: Groundfish market prices

Product	US $/Lb.		Years
Block - Cod Atlantic Pieces	$	2.43	(2008-12)
Block - Alaskan Pollock - Single Frozen	$	1.48	(2012-14)
Block - Alaskan Pollock - Twice Frozen	$	1.30	(2010-14)
Cod Tails 4 oz Atlantic - Twice Frozen	$	3.04	(2012 -14)
Cod Loins 4 oz Russia/Norway - Single Frozen	$	4.54	(2010-11)
Cod Loins 4 oz Atlantic - Twice Frozen	$	3.29	(2012-14)
Cod Shatter FAS 8 -10 oz	$	4.15	(2012-14)
Cod Fresh Fillet - Market Size	$	6.94	(2012-14)

Source: Urner Barry

In consultations, it was clearly recognized by all parties that the cod sector must be different than it had been in the past. It was suggested by most, that the fishery should be pursued year-round, new harvest technologies should be employed, and the processing sector must use modern processing technologies in order for the sector to be viable. An understanding of the market, and market promotional activities must support all of these efforts.

3.3.1 Harvesting

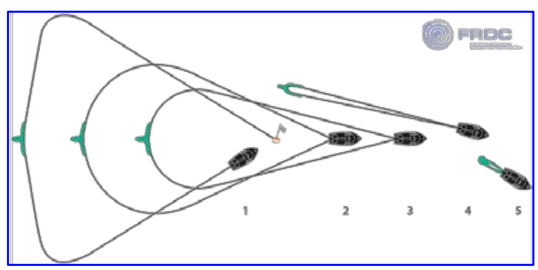
Iceland - The harvesting sector in Iceland has a range of vessel sizes that operate under different regulations. Each fleet has adopted technologies that provide the highest quality product is landed, and technologies have been developed to ensure utilization of the entire fish. The following exhibit provides a contrast of the Icelandic fishery to the NL cod fishery.

Exhibit 3.5: Groundfish harvesting jurisdictional contrast (Iceland)

	NL		Iceland						
Vessel Size	**< 40'**	**>40'**	**Coastal Fish License < 10 Meters(mostly)**	**Longline Max 15 Meters**	**Gillnet Approx 25 – 45 Meter**	**Longline Up to 50 Meters**	**Danish Seine 25 -30 Meters**	**Trawler Up to 29 Meters**	**Trawlers**
Season			May - August	Year Around Small ITQ	Feb - April Large ITQ	Year Around Large ITQ	Year Around Large ITQ	Year Around Large ITQ	Year Around Large ITQ
Catch Method	**Gillnet/ Longline Handline**	**Gillnet/ Longline Handline/Trawl**	**Hand L./Jigging**	**Long L, Hand L (Auto and Non)**	**Gillnet**	**Long line (Auto)**	**Danish Seine**	**Trawl**	**Trawl**
Holding Method	Pens (ice), Tub (Ice&Water)	Pens (ice), Tub (Ice&Water)	Tubs (Ice &Seawater and Ice)	Tubs (Ice &Seawater) Some Slurry	Tubs (Ice &Seawater)	Tubs (Slurry Ice, Ice &Seawater)	Tubs (Slurry Ice, Ice &Seawater)	Tubs (Slurry, Ice, Ice &Seawater)	Tubs (Slurry Ice,) Frozen at Sea
Unloading Method	**Bucket**	**Bucket, Pans**	**Tubs**	**Tubs**	**Tubs**	**Tubs**	**Tubs**	**Tubs**	
Fishing Duration	1 day	2-4 days	14 hours max	1 day	1 day	Up to 6 days	1 day	3 - 4 days	3 day fresh 2 -3 wks frozen
Pounds / Trip	**Varying**	**Varying**	**773 kg Max**	**5 – 10 mt**	**10 – 30 mt**	**~ 80 mt**	**Up to 25 mt**		

The groundfish sector has three distinct groupings, the <10m groups, Small ITQ, and Large ITQ. The <10m group is considered a small ad hoc group that recently entered the fishery. This group has a small quota assigned and can harvest from May to August. This is an Olympic style day fishery with a limited daily catch and limited monthly catch. The vessels in this group can fish only 14 hours per day.

The Small ITQ fishery is a year round fishery, executed by vessels <15m that utilize longline and jigging technology. This is considered a very productive fleet, with some vessels harvesting up to 2,000 mt per year. Fish brought aboard is immediately bled in cold water and ice slurry and stored in 400-liter insulated tubs under deck. This fleet generally does not gut their fish as gutting is conducted on shore where liver, and roe (in season) and gut material can be retrieved for by product processing.

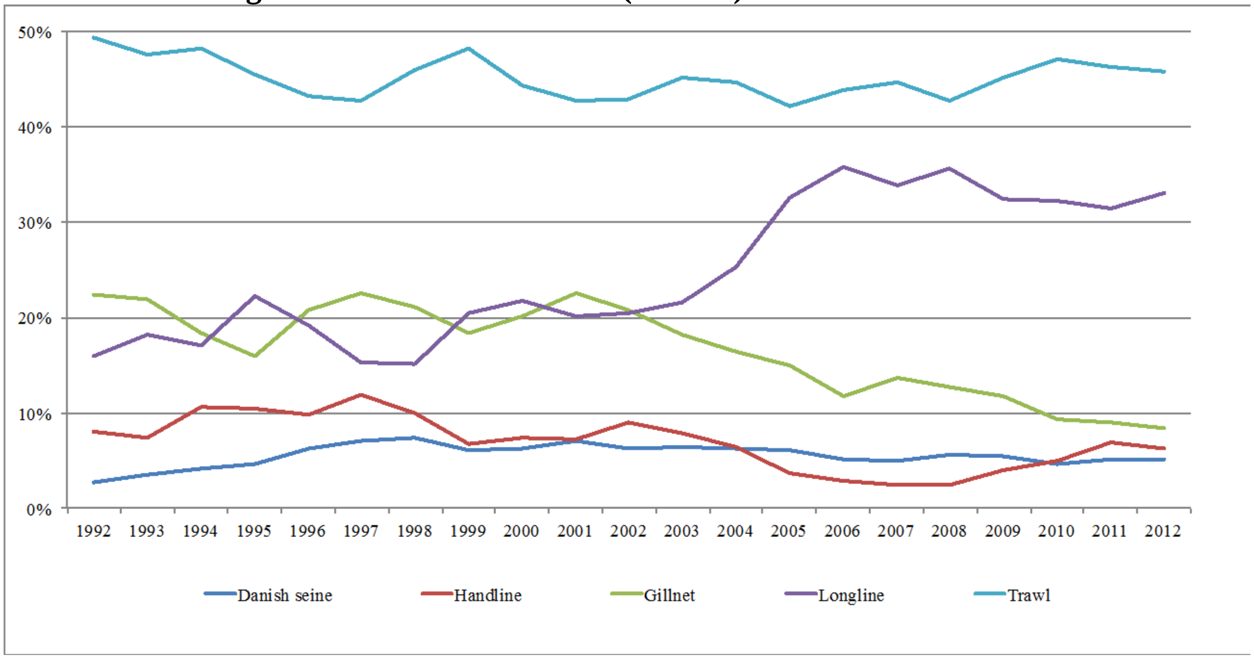


Danish Seine 1

The Large ITQ group has a range of vessel types. There are a small number of gillnetters that operate January to May. This is a day fishery that handles fish in the same fashion as the Small ITQ group. The number in the crew limits the number of nets. Large longline vessels also form part of this group, fish year round without area restriction. There is a group of small trawlers in the south that harvest using twin trawls and fish year round. This trawl fishery operates from Monday to Wednesday, on Thursday the fish is transshipped to the UK where it goes to auction on Monday. A group of ~30 Danish seiners fish year round for cod and flatfish, landing fish on a daily basis. There are two types of trawlers, wet fish and frozen fish. Wet fish vessels are on the increase and catch about 150 mt in a 3-4 day trip. Processing trawlers have onboard processing capacity to produce both fillets and HOG products.

Icelandic fleets harvesting groundfish use a variety of fishing technologies including handline, longline, gillnet, bottom trawl and Danish seine. Examining the groundfish fishing gear used between 1992 and 2012, the percentage of cod landed from longline has increased from 15.9% to 33.0% while the percentage of cod harvested from gillnet has declined from 22.4% to 8.4%.[15] This change in gear technology has occurred due to identified quality concerns, bruising and bloodspots, from gillnet cod.

Exhibit 3.6: Change in harvest methods used (Iceland)



Iceland Ocean Cluster

The primary purpose of the cluster was to foster new development by facilitating networking opportunities for marine industry participants. The cluster has completed numerous projects and analysis related to the seafood business. Many project initiatives have resulted in spinoff companies specializing in byproduct utilization, advanced processing solutions, trawler efficiency, energy reducing technologies, and collaboration amongst centres of excellence globally.

One analysis of particular relevance is an analysis of cod value which demonstrates how the value of exports has doubled, while landings have reduced 40%. This increase in cod value is attributed to modernization of the industry and full utilization of all products.

Norway - There are basically two fisheries in Norway, a coastal fishery and a large offshore fishery. The following exhibit illustrates the differences between these Norwegian fisheries and those in NL.

[15] Ogmunder H. Knutsson, Ph.D. Dean, School of Business and Science, University of Akureyri

Exhibit 3.7: Groundfish harvesting jurisdictional contrast (Norway)

	NL		Norway Coastal			Norway Offshore
Vessel Size	**< 40'**	**>40'**	**25' - 35'**	**35' - 60'**	**> 100'**	**> 100'**
Season				October - June with bulk in January to March		Year Around
Catch Method	**Gillnet/ Longline/H-Line**	**Gillnet/ Longline/H-Line/ Trawl**	**Auto Jig**	**Gillnet /Longline(Auto)**	**Danish Seine,Longline**	**Trawl**
Holding Method	Pens (ice), Tub (Ice&Water)	Pens(ice),Tubs (Ice&Water)	Tubs (Ice &Water)	Tubs (Ice &Water) RSW	Tubs (Ice slurry)RSW	FAS (H&G)
Unloading Method	**Bucket**	**Bucket, Pans**	**Tubs**	**Tubs / Pump**	**Tubs / Pump**	**Pallets**
Fishing Duration	1 day	2-4 days	1 day	1 day	2 -3 days	Up to 6 Wks
Pounds / Trip	**Varying**	**Varying**	**na**	**na**	**na**	**na**

Fish are caught using a variety of gears in the seasonal coastal fishery, including gillnet, longline, auto jigger and Danish seine. Vessels <35' using auto jigging technology usually have just one harvester onboard. The 35'-60' fleet utilizes both gillnet and longline technologies and operate in a day fishery with a 3-4 crew. The gillnet fishery is executed during the spawning season when fish congregate at volumes to ensure high catch rates. This fleet usually bleeds their fish in a bleeding tub and subsequently place the bled fish in a tub of either ice, or ice water mix. Gutting occurs on-shore to permit retention of all by-products for processing.

There is also a fleet of >100' vessels which use both Danish seine and auto longline. Some of these vessels have freezing at sea capability, whereas others use tubs with ice slurry or RSW. The trawler fleet process H&G and freeze onboard. They sell cod on the open world market for subsequent processing elsewhere.

Alaska - There are several fisheries in Alaska for Pacific cod. These include a large catcher/processor fleet that use trawl as its method of catch. The fish is all processed onboard, and recently efforts have been made to recover the gut, livers and roe. Additionally, these vessels are setup with an onboard meal plant to ensure full utilization of fish harvested.

There is also a longline fleet that utilizes auto longline systems to harvest cod. These vessels are also capable of freezing onboard.

Closer to shore, there is a fleet (200-250) of 30'-40' vessels that are jig boats. These vessels fish year round utilizing automatic jigging technology and operate with only 1-2 crew. Some of these vessels land up to 450 mt per year.

There is also a fleet of 25-35 vessels that engage in a cod pot fishery. This usually starts in March. These vessels are up to 58' in length and are also used in salmon and crab fisheries. They fish with a maximum of 60 pots. This fleet can harvest up to 680 mt per day, 19.4 mt/vessel. The boats are equipped with RSW holding systems and are tendered by larger vessels.

Conclusion: *There is a significant amount of automation aboard all fleet sectors in other jurisdictions and many of the offshore vessels have onboard processing and freezing capabilities. Further, fleet harvesting activity in Iceland is focused on meeting market needs, delivering product as required to ensure fresh product makes it to the market at the best time.*

3.3.2 Processing

Iceland - The practices and technologies for processing groundfish, in particular cod, have changed considerably since the early 1990's when NL was a major cod producer. The technologies in the world have been significantly upgraded to enhance throughput, increase yields, reduce labour content and improve product quality. Additionally, technologies that allow for the processing of various by-products now play an important role in maximizing the return from cod.

Iceland has transformed its cod processing sector through a number of changes, most recently a change to maximize value through a focus on fresh whole and fresh fillet production. With improved chilling and packaging technologies the shelf life of cod has improved significant. One scientific study of chilling and modified atmosphere packaging (MAP) resulted in extending shelf life from nine days to 14 days using chilling, and 16-17 days using MAP. When chilling and MAP were used together it was observed that shelf life could be extended up to 24 days.

These practices are contrary to what has occurred in Norway, a country with a large resource that has opted to focus more of frozen at sea H&G for overseas (Asia) markets, where product is destined for reprocessing. Most recently, Norway and Iceland have been working on a joint project to look at how best to improve the quality of Norwegian cod and increase their production of fillets similar to Iceland. As an example, in 2000, 35% of Norway`s cod exports was in fillet form whereas in 2011, fillets amounted to only 11%. In Iceland, the amount of fillet production was 75% in 2013.[16]

A second approach by Icelandic processors has been to maximize the outputs from the resource. Harvesters are now landing bled gut in fish to the plant where processors extract the gut for use in enzyme development. At appropriate times of the year, processors are also extracting value by processing liver and roe. Other initiatives to dry heads and frames have also increased value. Some companies are also extracting value by scraping added flesh from the backbone of split cod and utilizing the cod head by splitting and salting.

The processing industry in Iceland has been aided by two significant factors, the use of the country's research institute (MATIS) and the vibrant technology sector that has spawned a number of companies that develop technology for the seafood and other processing industries. The collaboration of these two groups, as well as industry participants, has seen continued development of new technologies and methods in the industry. The most recent example is collaboration between MATIS and technology supplier Skaginn to develop an onboard super chilling method for handling cod. The concept is to lower the temperature as quickly as possible which will help extend the shelf life. Additionally, they foresee the possibility of limiting the use of ice in the value chain with this approach.

Norway - Much of Norway's processing occurs onboard larger freezer trawlers processing either H&G or frozen at sea fillets. Some of the H&G product is processed as saltfish in Norway when markets demand; however, most is sold on the world market for subsequent processing elsewhere.

[16] News | About | English | www.matis.is

Raw material from the coastal wetfish fishery is processed in Norway. The fresh raw material is destined for both saltfish and fillet production, while some is sold fresh H&G to other producers in Europe. The saltfish plants utilize Baader technology for splitting, whereas the remainder of the process relies almost exclusively on manual labour. Products from the filleting operation go to either to fresh fillet or frozen loins and tails. Automation of filleting operations is ongoing due to the high cost of labour in Norwegian plants. Most are using Baader filleting technology as well as Icelandic technology for other processes.

Alaska - Groundfish processing in Alaska is conducted both on land and at sea. Large freezer vessels are equipped with filleting technology to allow for onboard processing of cod, Alaskan pollock and flatfish. Onshore plants are also equipped with filleting and surimi technology and are capable of processing high volumes daily.

> ***Conclusion:*** *Other jurisdictions have a high degree of automation for groundfish processing, both onshore and at sea. Some of these jurisdictions also have world class technology companies that design and produce state-of-the-art groundfish processing equipment.*

3.4 Pelagics

Pelagic supplies in other jurisdictions are much higher than those available in NL. While NL landed ~65,000 mt of combined capelin, herring and mackerel, other nations were landing hundreds of thousands of tonnes. The volume has a significant impact on the investments in technology for both the harvest and processing sectors in these countries.

Exhibit 3.8: Pelagic landings by jurisdiction (2013)

	NL	Iceland	Norway	UK
Capelin	30,070	451,023	155,148	
Herring	29,575	157,446	506,230	45,400
Mackeral	5,145	153,815	164,608	98,800
Other	57	107,053	283,413	21,100
Total	64,847	869,337	1,109,399	165,300

Source: DFA Year in Review 2013, Statistics Iceland, Statistics Norway, and UK Fisheries Statistics 2013.

3.4.1 Harvesting

Iceland - Harvesting of pelagics in Iceland is conducted by vessels >50 m in length. The vessels utilize both purse seine and pelagic trawl technology in their harvesting activity.

Exhibit 3.9: Pelagic harvesting jurisdictional contrast (Iceland)

	NL		Iceland			
			Capelin	Herring	Mackerel	Mackerel
Vessel Size	**< 40'**	**>40'**	**Over 50 Meters**	**Over 50 Meters**	**Over 50 Meters**	**Trawlers**
Catch Method	Gillnet/ Trap/H-Line	Gillnet/ Trap /Seine/ H-Line	Purse seine/pelagic trawl	Purse seine/pelagic trawl	Pelagic trawl	Pelagic trawl
Holding Method	**Bulk (ice/water slush) Ice**	**Bulk (Ice and Sea Water) RSW**	**RSW**	**RSW**	**RSW**	**Ice / Ice Seawater**
Unloading Method	Pump	Pump	Pump	Pump	Pump	Tubs
Fishing Duration	**1 day**	**1 - 2 day**	**1 - 3 days**	**1 - 5 days**	**2 - 5 days**	**2 - 3 days**
Pounds / Trip	40,000 lbs	75000 lbs	na	na	na	na

Note: Information regarding the quotas available by gear type and vessel size is not available.

When fishing capelin, the fleet begins fishing using trawl and as the fish moves closer to shoal water, they then employ seining. Product is quickly stored in RSW tanks onboard and delivered to shore when the vessel holds are full. The capelin fishery operates for a 3-4 week period. Some freezing at sea occurs as well as extracting and freezing roe at sea. Trips are of a short duration, however they may extend an extra day depending on the distance they have to steam from to the plant. Landings can be as high as 2,000 mt per trip.

The herring fishery operates for four months using the same vessels and technologies used for capelin. Mackerel is a relatively new fishery in Iceland and is executed by the same vessels using trawl technology. In summer a few handline day boats will also harvest mackerel.

Norway - Like Iceland, Norway has very large quantities of pelagics available. There is a small coastal fishery using seine; however, in recent years the trend has been to move to larger vessels, 50m-80m, which now harvest the vast majority of pelagics. These vessels can catch from 500 mt to several thousand tonnes per trip. In both sectors, most vessels are relatively new. In Norway, pelagics must be landed in a quality suited for food; therefore there is widespread use of chilling and RSW technologies.

United Kingdom (UK) - Of the three nations assessed for pelagic harvesting and processing, the UK has the lowest volumes with just over 140,000 mt of herring and mackerel combined. Like others, they also have some other species not common to NL.

In the UK, there are two sectors. There are just over 20 large pelagic vessels, 80m-90m, equipped with RSW that operate in the Scotland, Shetland area. These fish using pair trawling and purse seine. Recently, there has been a movement back towards the purse seine as it provides higher quality fish.

Exhibit 3.10: Pelagic harvesting jurisdictional contrast (UK)

	NL		UK		
Vessel Size	**< 40'**	**>40'**	**Up 15 Meters**	**10-15 meters**	**80-90 meters**
Catch Method	Gillnet/ Trap/H-Line	Gillnet/ Trap /Seine/ H-Line	Jigging	Seine / H-Line	Seine /Trawl
Holding Method	**Bulk (Some ice/water slush) Ice**	**Bulk (Ice and Sea Water) RSW**	**Ice / Seawater**	**Tubs (Ice/Water)**	**RSW**
Unloading Method	Pump	Pump	Tubs	Brailed / Tubs	Pump
Fishing Duration	**1 day**	**1 - 2 day**	**1 day**	**1 day**	**1 - 3 days**
Pounds / Trip	40,000 lbs	75000 lbs	NA	4 - 5 tonne	up to 1000 tonne

In the south of England, there are small purse seiners, 10m-15m, fishing pilchards and sardines. These vessels hold their catch in tubs in a mix of ice and seawater. There is also a handline fishery for mackerel. These vessels use automated jigging systems and the product is sold on the fresh market.

> ***Conclusion:*** *Other jurisdictions reviewed have a high degree of automation for pelagic harvesting utilizing both seines and pelagic trawls to execute the fishery. Small vessels fishing pelagics in the UK use similar methods to those in NL, though most of these small vessels have recently converted to automated jigging.*

3.4.2 Processing

The practices and technologies for processing pelagics have evolved considerably in jurisdictions where large volumes are processed. These high supply volumes have afforded processors the ability to invest in automation systems. These automated facilities require few people to operate, while maximizing the value of production.

RSW vessels land directly to the dock where the processing plant is located. Product is pumped directly to the plant as required to meet production, or pumped to the plant into bulk refrigerated holding tanks. Product moves through the process (mostly whole round) automatically including the packing, freezing and mastering process.

Iceland - Processing plants in Iceland are designed to handle high volumes in an efficient manner. Plants are highly automated and can process several hundred tonnes per day. An Icelandic technology provider, Skaginn, in conjunction with other Icelandic technology providers, offer a fully automated handling system that requires limited labour to operate when processing whole round. Product is pumped directly to the plant, enters a chilling system and the temperature is maintained throughout the process. The system uses automated weighing, batching, bagging systems for packing, automated tray movement, Automated Box Freezing (a plate freezer application) and automated cartoning and palletizing.

Filleting operations are also highly advanced with automated systems feeding Baader filleters, etc. Downstream processes are also automated as much as possible.

Norway - Like Iceland, Norway operates with large factories. Most of the production is in a whole form, however, there is some filleting occurring. In both cases, the facilities are highly automated. Some of these plants are doing over 600 mt per day. Technology developers and integrators such as Baader, Skaginn, and Cabinplant from Denmark have provided complete solutions for processors.

United Kingdom (UK) - Processing in the UK offers a range of processed pelagic products from whole round to fillets, butterfly product, and through to further value adding such as brining, smoking including retail packs and canned product. Most plants are equipped with the latest is process technology. Some operations are capable of processing up to 1,000 mt per day. Facilities are MSC and BRC certified.

Conclusion: *Other jurisdictions have a high degree of automation for pelagic processing. Some of these jurisdictions also have world class technology companies that design and produce state-of-the-art pelagic processing equipment, with some recent innovations incorporating robotics.*

3.5 Salmon Aquaculture

Salmon harvest has grown dramatically in recent years and is anticipated to reach 40,000 mt of harvest over the next few years. As illustrated in the following exhibit, NL salmon harvest now exceeds NB, but remains well below BC and other countries.

Exhibit 311: Salmon harvest (MT) by province and jurisdiction (2013)

	NL	NB	BC	Scotland	Norway
Salmon	22,196	18,837	75,808	168,889	1,239,876

Source: DFO
Scottish Farm Production Survey
Norwegian Statistics

3.5.1 Hatchery and Grow Out

Operators in the salmon business in NL, and other Atlantic Canadian provinces, either use or have access to state-of the art technologies for broodstock, hatchery and juvenile production. Many operators are now vertically integrated from broodstock to markets, similar to producers in other jurisdictions. Practices in these areas are well regulated in Canada, ensuring protection of consumers and the environment.

Grow out systems regarding location, technology and efficiencies are similar in other jurisdictions. One recent change in BC has been the use of High Density Polyethylene (HDPE) netting for predator nets and for some primary containment nets. These nets require no antifouling, as marine biofouling is limited. On-site cleaning with portable systems is deployed. These nets also have a greater tensile strength. In BC, these nets have improved containment and predator protection resulting in fewer escapes, and having no catastrophic failures to date.

Nutrition and feeding of salmon in NL utilizes state-of-the-art technologies. Feed delivery, storage, allocation and diets are similar in other jurisdictions. Most jurisdictions however, have advantage in terms of feed suppliers being closer than growers located in NL.

The grow out of salmon is similar in other jurisdictions including growth rates, survival and food conversion. Fish health management including on-farm diagnostics and procedures, veterinary support and infrastructure are at or better in NL than other jurisdictions.

Some prototype inventory management systems such as PisciMetrix offer improved management of in pen inventories.

3.5.2 Harvesting

The industry in British Columbia and in New Brunswick uses live well boats for harvesting fish. The processing plants are located close to the shoreline and are able to handle live fish pumped from the hold of these vessels directly to the kill station in the plants. This method is also the most common practice in Scotland. The scale of production in NL may preclude the use of well boats at this time, although an economic analysis may be warranted given the anticipated growth in the sector.

One of the latest technologies that offer promise in salmon harvesting is related to the stunning and bleeding process. Baader, through its 2013 acquisition of Seafood Innovation International Group of Australia, now offer a stunning and bleeding system. Referred to as the Baader 101, the unit is used onboard the harvest vessel where it utilizes percussive stunning and bleeding technology. This unique technology takes advantage of the fish's natural behavior where they swim into the stun and bleed system with minimum stress. This system offers labour reductions versus the current manual system with other claims of improved quality and shelf life. This stunning technology is currently in use, most recently in BC.

3.5.3 Processing

Salmon processing technology has evolved to be a highly automated process. The standard processing in most areas is to remove the gut material, clean the cavity, grade and pack into a chilled carton for shipment. The second process activity is to add value through filleting. Fillets are graded, iced and shipped to market. In some cases fillets are portioned and portion are sold to retail. Additionally, various other value added processes such a spicing, slicing, and smoking, does occur.

There are a number of key technology providers who continue to work with industry to identify areas where improvements can be made. Most jurisdiction process using similar technologies and methods of processing. The technologies have been developed and continue to be developed by a core of technology providers.

> ***Conclusion:*** *Other jurisdictions utilize similar technologies to those employed in Canada for salmon aquaculture.*

3.6 Mussels

The following exhibit contrasts the volume of mussels grown in NL as compared to PEI and Ireland.

Exhibit 3.12: Mussel jurisdictional contrast (MT)

	NL	PEI	Ireland
Rope culture	4,354	22,894	10,000
Bottom culture			5,527

Source: DFO
Irish survey results

3.6.1 Collection and Grow Out

The methodologies employed for spat collection and grow out in other jurisdictions are the same or similar to those utilized in NL.

Some prototype inventory management systems such as Shellfish Solutions AS offer improved management of on line inventories.

3.6.2 Processing

Prince Edward Island processors have continued to move forward with improved grading and packaging technology for further diversification of product forms, particular consumer ready convenient packages. This includes the use of MAP technology.

Ireland also utilizes MAP technology in their packaged product. Additionally, larger mesh bag sizes of up to 25 kg are utilized in Ireland for sale to the food service sector.[17]

> ***Conclusion:*** *Other jurisdictions utilize similar technologies to those employed in Canada for mussel line aquaculture.*

3.7 Other Species

3.7.1 Whelk

Harvesting: Whelk is harvested by inshore vessels (35' – 65') using conical pots. Product is landed on deck where it is drum sorted for debris and size; small whelk are returned to the ocean. Product is packed in poly woven, mesh bags and stored in pens on ice until landing. The Marine Institute continues with efforts to improve the sustainability through modified pot designs and onboard mechanized sorting.

Processing: Whelk is processed in either whole in shell or meat product. A couple of processes are employed in the processing of whelk including the use of specialized, pressurized steam cooking and standard crab cooking technologies. The processing of meat product involves the use of a number of mechanical and manual processes, brine shell separation tank, as well as

[17] Development of best practice and new technology for grading, handling, transportation, conditioning and storage of mussels for SMEs in the European mussel industry , Swansea University, UK. p14

manual inspection and removal of shell material. This process is similar to other jurisdictions. Mechanical size grading and IQF freezing is also utilized while some use blast freezing.

3.7.2 Sea Urchin

Harvesting: Sea urchins are harvested in NL by individual divers operating in small open boats in shallow coastal waters. Divers locate sea urchin usually on kelp beds and utilize a hand held rake and net bag to gather urchins and then bring them to the surface. Product is held onboard in tote pans.

For the most part, diving is the most common harvest method worldwide. In Maine and NB there is limited use of a drag fishery. Efforts to use other technologies such as ring nets, whelk pots, etc. have also been tested but commercial viability is yet to be demonstrated. Norway is currently investigating the use of ROV technology with a vacuum application.

Processing: The processing of sea urchins in roe is a highly manual operation. Processing occurs in plants on flattop tables where a specialized device is used to manually crack the urchins to expose the roe. Roe is manually removed using a spoon shaped device. Roe is visually colour graded, gut content is separated using tweezers, then the roe is subsequent treated and packed.

Other jurisdictions such as Maine use similar processes with a high labour content. Past effort to mechanize in NL have not had successful outcomes. Efforts are currently ongoing in Quebec to mechanize the shell removal but it is not yet at a commercial stage.

3.7.3 Sea Cucumber

Harvesting: Sea cucumber harvesting is a relative new and evolving fishery in Canada. Harvesting is conducted using a modified scallop rake. Some jurisdictions such as British Columbia use a dive harvest.

Cucumbers are taken on deck where they are manually sorted from debris, etc. Product is then stored in a live condition in tote pans for transport to port.

Processing: As indicated, the sea cucumber industry is new and processing methods continue to evolve. Processing in NL is limited to a few processors and is predominately a manual operation. Research by the Marine Institute has resulted in the commercialization of an automated splitting/gutting unit that has been used successfully by several producers. A similar device was also recently developed by ABCO for a NS client. Challenges remain in removal of the flower as well as muscle meat removal. Processors continue to explore options for drying and full product recovery. Efforts to develop other processing technologies are currently ongoing in Quebec.

3.7.4 Lobster

Harvesting: Lobster is harvested by small inshore vessels along the coast using pot technology in the spring and early summer. Pots are hauled, live lobster recovered, and pots reset. Lobster are size sorted, legal sized lobsters have a band applied to their claws using a manual applicator. Lobster are then stored a chilled salt water holding container or in the hold.

Processing: There is limited processing of lobster in NL. Most processors have simple, live holding systems where crates of product are held for shipment in a live form to customers in the Maritimes and eastern USA. A couple of operators have worked to process into meats, tails, etc.; however, these processes are quite manual as the limited volumes makes investment in technology challenging. There are many new and innovative technologies available from fabricators in Atlantic Canada for meat extraction, whole, splits and bagged boiler lobster.

3.8 Logistics

Other jurisdictions such as Iceland and Norway face very similar logistics challenges as NL, as they are remote from the market versus competitors, and there is no over the road transport to markets from Iceland. For the most part, these logistics challenges have been addressed collectively by industry, with the support of government, to the benefit of all.

With a focus on fresh product in order to maximize values, both Iceland and Norway have dedicated air carriers that service both the EU and US markets. Further there are sea carriers providing fresh product to the EU from both countries. Fresh product arrives to market on specific buy days (Monday/Thursday) for auction and permitting sellers to supply fixed quantities at specified periods of time under contract sales agreements.

3.9 Fish Auctions

There are several jurisdictions that use fish auctions. These auctions have the benefit of streamlining the selling transaction in many cases, and encourage individual harvesters to land the highest quality product. There are various forms of fish auctions, including:

- Shout auctions, whereby buyers view and then bid on individual lots of fish.
- Electronic site auctions. Some of these auctions permit buyers to view lots, and then bid on individual lots as they are offered. Others have remote landings auctioned off at a central location.
- On line auctions permit access to a broad base of buyers that can bid on individual lots of fish available.

The NL DFA sponsored development of an online shrimp auction in 2003. This system was developed to do catalogue sales of shrimp prior to landing. This method permitted directing vessels to specific plant locations in order to reduce logistics costs and handling. A mechanism for adjusting prices based on actual weights, shrimp size and product quality were incorporated into the vessel settlement component of the system.

The DFA also sponsored a cod auction pilot program for 3Ps cod. There was little uptake of the program, likely as a result of the limited number of interested buyers.

4.0 TECHNOLOGICAL REVIEW

The technological review was conducted using a variety of means. The tasks included discussions with industry stakeholders, and local and international technology providers who are familiar with the NL industry. Discussions were also held with research institutes, funding providers, and a thorough an Internet literature search.

4.1 Harvesting (Generic)

There are several technologies that can be incorporated into most fishing vessels in order to improve competitiveness through more effective harvesting, improving product value, or operating cost reductions. These generic solutions include:

- **Energy Efficiency –**The National Research Council (NRC) in St. John's conducts research on advanced control technologies to reduce energy consumption from marine vehicles. The NL DFA has published a number of energy efficiency fact sheets that describe the benefits of bulbous bows and anti-roll devices, propulsion systems, maintenance, fishing gear design, and fishing vessel design. The Marine Institute Centre for Sustainable Aquatic Resources (CSAR) is a world-class fishing gear research laboratory. CSAR has conducted numerous fishing efficiency tests in their flume tank utilizing 1:4 scale nets. Much of the work conducted for Canadian fishing gear, and many international projects, has been completed at the CSAR flume tank, including tests of many of the technologies discussed.

  There are several existing technologies that offer energy efficiency aboard vessels including:

  - ✓ Passive fuel monitoring systems (e.g. Floscan), active fuel pilot systems (e.g. Stellar Marine), or fuel tank designs that utilize fuel vapour.

  - ✓ Active fin stabilizers or anti-roll tanks have become more common in recent years and offer significant benefit over the use of fish deployed over the sides to provide stability.

  - ✓ Bulbous bows provide fuel savings versus contemporary hull designs, and have been recently included in larger fishing vessels in NL.

  - ✓ Trawl designs have been modified in recent years to incorporate new netting materials, smaller diameter twines, larger meshes, modified warps and energy efficient trawl doors. Having the trawl operate as effectively as possible permits a larger net opening, resulting in improved catch rates, and can also provide fuel savings through drag reduction.

- **Mapping –** Efficiencies in many fisheries may be achieved through seabed mapping technologies such as OLEX, single beam sonar, or WASSP , multi beam sonar, that better permit identification of specific bottom types, provide more accurate definition of location through visual cues such as identification of holes and bottom contours. The benefit of the OLEX system is they provide a shared database for all seabed mapping, under condition of contributing information, which is updated regularly to provide current graphics for most fishing areas adjacent to NL.

These technologies are both used extensively in the Nova Scotia lobster and snow crab fisheries, where identifying suitable bottom to set individual or a string of traps is necessary. These, or similar systems, have become more common on larger vessels, but offer significant benefits to the small boat sector.

- **Liquid Holding Systems –** Both RSW and Chilled Sea Water (CSW) technologies improve the landed quality of many species, and permit fishing vessels to remain at sea for a longer period of time. RSW systems are designed for each vessel and require mechanical refrigeration to both chill seawater and maintain target water temperatures. The CSW system is provided by charging the hold(s) with ice prior to departure then adding seawater when harvesting. The RSW system is more capital intensive but ensures a consistent water temperature is maintained throughout the trip. The CSW system requires a much lower capital investment (sealing of hold, aeration system, monitoring system) and can be as effective as RSW for short trips.

  Not all species lend themselves to holding in RSW or CSW. Flatfish when stowed in a liquid medium will create solid layers, not permitting the aeration system to work effectively. Shrimp cannot be held in these systems as legs, tentacles and telsons break off or shed from the shrimp and plug the aeration system. All pelagic and other groundfish species, and crab are effectively held in these types of systems.

4.2 Processing (Generic)

There are several common elements of all seafood production operations, including materials handling, energy use, and management systems in support of production.

- **Materials Handling –** All manufacturing processes require materials handling systems to reduce labour content, worker fatigue and ensure a safe working environment. This broad demand for materials handling systems has resulted in many custom and multi-purpose systems being developed and brought to market.

  Most seafood processing plants have some level of automated materials handling system; however, most of these systems are employed after the product is brought to the process and prior to packaging of finished products. It is these front and back end systems that offer opportunity for further automation.

  There are hundreds of materials handling manufacturers and distributors, which can provide off-the shelf and custom solutions to many automation challenges in the seafood processing sector. Further, there are companies in Eastern Canada who have worked to address many materials handling processes specifically for seafood. Some of these automation opportunities include:

  ✓ Warehousing storage systems for raw material and finished product.
  ✓ Auto pan dumping, washing and stacking systems (C&W, 3X Staal, etc.).

- ✓ Packaging automation including form/fill/seal machines for value added products (mussels in sauce), automatic package makers, bag blowers, automated vacuum and vacuum forming machines, package indexing systems, package palletizing, and automatic pallet wrapping systems.
- ✓ Operator assisted technologies such as vacuum lifts can reduce labour demand, worker fatigue and increase worker safety in packaging, mastering, and shipping processes.

There are also many robotics companies that can automate packing processes utilizing optical systems and robots. These robotic systems can be programmed to do a number of different tasks, providing flexibility to pack different sizes of product and species.

Many of these materials handling solutions may have been given consideration by producers at some point. It is likely that the payback of these systems would be lower than other opportunities as there are fewer service labour tasks than direct production tasks. Regardless, as labour availability continues to decline and the existing workforce continues to age, these options must be considered.

- **Energy Efficiency –** The NL DFA sponsored an industry project with the objective of identifying energy reduction strategies for seafood processing. Evaluation of existing processing operations provided a ranking of opportunities for energy reduction based on payback of investment in the technologies. Ranked in terms of payback these technologies were:

  - ✓ Refrigeration heat recovery systems.
  - ✓ Using an electric forklift in place of propane powered forklift where appropriate.
  - ✓ Using a biomass boiler in place of oil fired boiler, when an existing boiler needs replacement.
  - ✓ Installation of boiler heat recovery systems.
  - ✓ Use of oxygen trim sensors in boiler system.
  - ✓ Replacing inefficient boilers with fuel-efficient models.

  Audit findings also indicate that refrigeration systems and boilers are not always properly operated. An audit of operational procedures and mechanical systems by qualified engineers can identify procedures that increase fuel consumption and systems that are not matched properly to their intended use.

- **Management Systems –** Many operators indicated that they have a number of management information specific to a given technology, such as Marel's weigh systems that monitor input/output weight and calculate yield. However, no respondents indicated they have real-time integrated data reporting. There were few using bar code and there no producer indicated they use RFID technology.

  Companies such as Marel with their INNOVA Software and WISEFISH with its suite of programs can provide integrated solutions that provide real-time information regarding many aspects of production and archive this information for subsequent historical analysis. These types of systems improve management decision making, reduce office labour that may be used to manually collect and analyze production data, and provide improved product traceability.

4.3 Snow Crab

Recently, there have been some automation projects, many of which most producers are aware of and all now may acquire. These technologies and descriptions are provided in the following exhibit, and further described.

Exhibit 4.1: Snow crab processing technology innovations

Technology	Manufacturer	Attributes	Status
Cool Steam Crab Cooker	Laitram Machinery	Utilizes steam as opposed to water to cook. Claims of higher yield and energy savings.	In use.
Steam Crab Cooker	ABCO Industries Limited	Similar claims as above. Adapted from fruit and vegetable industry, now used in lobster	In use for lobster.
Baader 2801 Butchering Machine	Baader Food Processing Machinery	Automated butchering unit. Rated 18 -30 pieces per minute.	Trialled in NL in 2014. Commercial use in 2015.
RYCO Butchering Machine	RYCO Equipment (Seattle) (NL representative C&W Industrial)	Automated butchering unit. Rated up to 45 pieces per minute.	Tiallled on West Coast of US 2014.
C&W Auto After Freezer	C&W Industrial	Glazed product automatically transferred into a flow through freezer and auto exits.	In use. (One in NL)

Cooking - Laitram Machinery has adopted their low temperature steam cooking technology broadly used for shrimp for the snow crab and lobster sectors. The technology utilizes steam as opposed to water immersion for the cooking process. The unit, referred to a Cool Steam Crab Cooker-Cooler, has been installed in two plants in NL over the past few years, including the latest model which permits two pan high, two pans wide pass. Laitram claims that the technology can increase yield, 1.0%-1.5%, and result in fuel energy savings of 60%-80%. Laitram partnered with a local firm, C&W Industrial regarding the installation and integration of an automatic chilling system for the unit.

ABCO Industries Limited has also developed low temperature steam cooking technology that is used extensively in the fruit and vegetable business, and in the past two years has had many installations in the lobster sector.

Butchering - The most recent technology gathering interest in snow crab processing is automatic butchering. Two companies, Baader Food Processing Machinery and Ryco Equipment have developed technologies that automate butchering, reducing labour requirements and worker fatigue. Both units require manual loading into a feed mechanism that carry the crab through several processes resulting in a cleaned crab section ready for pre-packing inspection.

Demonstration programs were initiated in 2014 for both devices, one in Benoits Cove and one in Seattle. The operating premise for both systems are very similar and both are modifications of the original Flohr Manufacturing unit that was initially commercialized in the mid 1990's.

After Freezing - Local engineering firm C&W Industrial has developed an automated after freezer to handle snow crab after glazing. Glazed product continues along a belt and is transferred automatically into the after freezer where the product reaches its required temperature, -18°C, before proceeding to mastering.

> ***Conclusion:*** *New technologies are currently available for the snow crab processing sector which offer benefits for labour reduction, higher yields and improved quality.*

4.4 Shrimp

The following table identifies the latest technologies that have recently become available to shrimp harvesters. Many of these innovations permit improvement to both harvesting and onboard handling processes.

Exhibit 4.2: Shrimp harvesting technology innovations

Technology	Manufacturer	Attributes	Status
Boxed Shrimp	Promens Canada Bonar Plastics	Extend shelf life, improve colour, less breakage. (Impact on carrying capacity)	In use
By Catch Shrimp Separator	Tri Nav Marine Brokerage (Distributor)	On-board saparation unit to separate shrimp and by-catch.	In use
By Catch Shrimp Separator (on -board type)	Marel (Iceland)	On-board saparation unit to separate shrimp and by-catch.	In use (Offshore vessels)
By Catch Shrimp Separator	Optimar(Norway)	On-board saparation unit to separate shrimp and by-catch.	In use
Rolling Rock Hopper Gear	North Atlantic Marine Hampidjan Group Vonin Canada	Easier to move on bottom. Energy efficient, environmental impact	In use
Dynema Rope / Twine	North Atlantic Marine Hampidjan Group Vonin Canada	Light weight, energy efficient, easier to handle. Stronger twine. More expensive.	In use
Dimpled Floats	North Atlantic Marine Hampidjan Group Vonin Canada	Moves easier through water Energy efficient.	In use
Twin (Double Trawl)	North Atlantic Marine Hampidjan Group Vonin Canada	Quicker catch. Must consider engine size if considering.	In use
Pelagic Doors	North Atlantic Marine Hampidjan Group Vonin Canada	Less energy, more spread, less bottom contact. Must have good sensors when using.	In use. Trial in NL 2013.
Modofied Trawl Mesh Design	North Atlantic Marine Hampidjan Group Vonin Canada	Less drag	Various modifications in other areas.

> ***Conclusion:*** *New shrimp harvest technologies provide energy savings, less impact to habitat and onboard handling improvements.*

Whereas NL shrimp producers are world leaders in the coldwater C&P business, most technologies have been adopted. The following exhibit provides some recent innovations and their benefits.

Exhibit 4.3: Shrimp processing technology innovations

Technology	Manufacturer	Attributes	Status
Central Cool Steam Cooker	**Laitram Machinery**	**Utilizes steam as opposed to water to cook. Claims of higher yield and energy savings.**	**In use. (A number in NL)**
Shrimp Peeler	KM Fish Machinery	Peeling fresh shrimp. Product looks like hand peeled. (Opportunities for niche products)	Denmark
Shrimp Defrosting	**Cabinplant**	**Controlled Defrosting**	**In use**
	3X Technology		**In use**

> ***Conclusion:*** *With anticipated shrimp supply declines, diversifying processing to produce niche products and incorporating defrosting technology may permit plants to add value and diversify supply streams.*

4.5 Groundfish

Groundfish technology has and continues to evolve. This is an area that offers the greatest opportunity for technological advancement if quantities of groundfish return to levels that will sustain the investment.

A number of technological advances in harvesting and onboard handling systems have been made since the cod moratorium. These technologies have provided the opportunity for small inshore vessels to remain viable in the groundfish sector, and provided benefits to larger vessels.

Exhibit 4.4: Groundfish Harvesting Technology Innovations

Technology	Manufacturer	Attributes	Status
Auto Deep Sea System (Longline)	Mustad Longline AS	For large vessels. Sets and hauls from 30,000- 65,000 hooks daily. Complete with auto baiting and hook cleaning	In use. .
Auto Coastal System (Longline)	Mustad Longline AS	Vessels over 35', 8,000 - 25,000 hooks daily. Complete with auto baiting.	In use.
Electric Jigging Machine	Oilwind (Faroe Islands)	Computerized, auto jigging reel.	In use.
DNG Jigging Reel	DNG	Computerized, auto jigging reel. One person can operate 3 or 4 reels on a small boat.	In use.
Optim-Ice	Optimar (Iceland)	Slush ice system that quickly chills product, improves quality, and extends shelf life. Vessel size and stability to be considered.	In use
Rotex On Board Bleeding and Chilling	3 X Technology (Iceland)	Specific design for vessels >30'. Seawater and ice slurry to remove blood and reduce temperature.	In use
Rolling Rock Hopper Gear	North Atlantic Marine Hampidjan Group Vonin Canada	Easier to move on bottom. Energy efficient, environmental impact	In use
Dynema Rope / Twine	North Atlantic Marine Hampidjan Group Vonin Canada	Light weight, energy efficient, easier to handle. Stronger twine. More expensive.	In use
Dimpled Floats	North Atlantic Marine Hampidjan Group Vonin Canada	Moves easier through water Energy efficient.	In use
Twin (Double Trawl)	North Atlantic Marine Hampidjan Group Vonin Canada	Quicker catch. Must consider engine size if considering.	In use
Modified Trawl Mesh Design	North Atlantic Marine Hampidjan Group Vonin Canada	Less drag	Various modifications in other areas.

***Conclusion:** Many new groundfish harvesting and handling technologies are available that can address some of the challenges posed by the anticipated resurgence in groundfish abundance, while reducing crew requirements, improving quality and reducing energy costs.*

There have been numerous advances in groundfish processing technologies particularly cod, due to the high volumes available in Norway and Iceland. Faced with similar challenges as NL, declining workforce and need to increase value of finished product, automation of many of the labour intensive processes and improvements in handling methods to maintain quality have been adopted. Some of these changes were occurring at the same time that the NL cod fishery was declining and new technologies such as Flowline Trimming technology were being adopted here. Today, a number of new technologies are operating or are about to be introduced in various jurisdictions. These are summarized in the following exhibit and further described.

Exhibit 4.5: Groundfish processing technological innovations

Technology	Manufacturer	Attributes	Status
Groundfish Heading Technology			
Baader ISO33	Baader Iceland	Minimizes head loss on whitefish	In use
Baader 1741	Baader Food Processing Machinery	Replaces Baader 417 whitefish header	In use
Curio 3027	Curio Ltd. (Iceland)	Low head loss. (Whitefish)	In use
Groundfish Filleting / Splitting Technology			
Baader 582	Baader Food Processing Machinery	Replaces Baader 184, 185. Smooth cut, cutting blades replace scraper blades and stickle blades.	In use 2015
Curio 2011	Curio Ltd. (Iceland)	High yield, easy switch between whitefish species	In use
Baader 541	Baader Food Processing Machinery	Auto adjust for a range of fish sizes (whitefish)/ Neck blood removal device.	In use (One in NL)
Groundfish Skinning Technology			
Baader 59	Baader Food Processing Machinery	Optimal performance on whitefish when used with Baader 582	In use.
Curio 2030	Curio Ltd. (Iceland)	High yield recovery.(Whitefish)	In use.
Skaginn	Skaginn (Iceland)	Ideal for soft fish when used as part of the "super chill" processing system	In use

Heading – Upgraded heading methods have been developed to increase the amount of meat recovery in the heading process. The Baader IS033, designed by Baader Iceland, is reported to minimize loin meat loss while removing the head. The Baader 1741 replaces the Baader 417, which was the most common unit used in NL in the 1980's. The Curio 3027 unit is manufactured by an Icelandic company, Curio ehf., and is operating in a number of Icelandic plants and is reported to achieve improved meat recovery than previous units.

Filleting – Many rebuilt Baader 184 and 185 filleting machines are available on the market and some are still in operation in NL; however, there have been significant advancement in these technologies as well. The Baader 582 is the newest commercial unit, due to be installed in Alaska in early 2015. This unit replaces the Baader 184 and 185 and operates similar to the Baader 581 salmon-filleting machine. This unit differs from the Baader 184 in that the stickle knives and scraper blades are replaced by cutting blades, reportedly provide higher meat recovery and improved operating flexibility. The Curio 2011 allows the operator to easily switch between species, size ranges, and speed. A number of the Curio units are in use in Iceland, Norway and the USA.

Splitting – The newest splitting machine on the market, the Baader 541 replaces the B440. This new device can handle a slightly broader range of sizes, 45-110cm, operates at 30 versus units per minute, and removes block from the neck reducing the labour requirement for scrubbing after splitting.

Skinning – Baader claims that their newest skinning machine, Baader 59, operates best when coupled with a Baader 582 filleting unit. The Curio 2030 is suitable for cod and other species. Skaginn, an Icelandic company, offers a new skinning machine as part of the 'super chill' processing system. Skaginn claims that this specially designed unit can skin soft fish without damage and minimum yield loss.

Trimming - Trimming and portioning is the most labour intensive process when doing high value fillet portion packs, and dealing with poor quality fillets. Innovations in trimming combine vision, robotic and logic systems working in unison in order to maximize the value of each fillet. Several new trimming devices and processing lines are now available, as illustrated in the following exhibit and further described.

Exhibit 4.6: Groundfish trimming innovations

Technology	Manufacturer	Attributes	Status
Marel Super Chiller Solution	Marel (Iceland)	Places fillets (whitefish) in sub zero state before skinning and trim/pin bone.	In use
Marel Flowlines	Marel (Iceland)	Complete with Intelligent Portion Machine, individual trim stations with auto weighing, grade and output delivery.	In use
Valka X Ray Guided Cutting Machine	Valka (Iceland	Uses X-Ray and 3 D Images combined with robot controlled water jets to remove pin bone from cod	In use. (Iceland)
Marel FleXicut	Marel (Iceland)	Uses X-Ray and 3 D Images combined with robot controlled water jets to remove pin bone, and portion cod.	Being fine tuned
Mesa Technology	Traust Know How	Increase recovery from Cod	In use

- Marel Super Chiller Solution. The system is specially designed to build strength in the fillets by placing them in a sub zero state before proceeding to the skinning, bone removal and trimming processes. There are three of these systems now operating in Iceland.

- Marel Flowline. In combination with contact chilling, the Flowline comes complete with Intelligent Portion Machines (IPM), individual trimming stations, automatic output weighing, grading and delivery systems.

- Valka X-Ray Guided Cutting Machine. Using a combination of X-Ray and 3D image processing, together with robot controlled water jets, the unit can locate and remove pin bones and cut portions. There are five of these units operating in Iceland. Valka also offers a Trimming Flowline designed to work with the X-Ray guided Pin Boning Machine.

- Marel FleXicut. The unit is equipped with high-resolution 3D X-Ray and two water jet cutters. The X-Ray locates the pin bone, which is removed with water jets. These same water jets can also complete fillet portioning functions. Marel are still fine tuning the unit to give better results than manual operations can achieve. Marel has one unit in production.

By-product Processing - A number of unique technologies are available for by product adding including a unit to remove flesh from the backbone of split cod, cod head splitting and tongue and cheek removal units. The Mesa (Traust Know How) product offers an opportunity to maximize recovery from cod.

Grading - Grading technology continues to evolve. There are a number of companies that provide off the shelf solutions that can tie in with other process technology. These include Marel, Marelec and Baader.

Packing - The following table outlines some of the latest developments in packing and handling solutions that are in use in the groundfish operations.

Exhibit 4.7: Groundfish packing innovations

Technology	Manufacturer	Attributes	Status
Valka Rapid Aligner	Valka (Iceland)	The unit is a grader that automatically aligns fillets into final boxes. Capable of interleaving, label printing, and weigh.	In use
Valka Ice-Doser	Valka (Iceland)	Auto dispenses ice into fresh pack.	In use
Marel Ice-Doser	Marel (Iceland)	Auto dispenses ice into fresh pack.	In use
Optimar Ice-Doser	Optimar (Norway)	Auto dispenses ice into fresh pack.	In use
Deep Chill Slurry Ice	Sunwell Technologies Inc	Reduces temperature and preserves product.	In use
Ice Slurry Machine	C&W Industrial Fabrication	Reduces temperature and preserves product.	In use

Note: Many of these packing systems are applicable to other species.

- Valka Rapid Aligner. This unit is a grader that will align the fillets automatically into the final boxes they will be shipped in. The system is capable of interleaving, label printing, and check weighing.

- Valka Ice-doser System. Designed to automatically dispense ice into fresh pack boxes. The system ensures accurate dosing of product as required. Other ice dosing systems also exist.

> ***Conclusion:*** *There is a myriad of new groundfish processing technologies, and supplier options available for these technologies.*

4.6 Pelagics

The technologies for harvesting and processing pelagics have evolved considerably in jurisdictions where large volumes of pelagics are processed. As indicated in the Jurisdiction Review, large supplies of raw material in countries such as Norway, Iceland, and Scotland afforded harvesters and processors the ability to invest in technological upgrades. As NL's volumes are not of the scale of the others presented, it is not likely the full extent of the available technology can feasibly be implemented. There are, however, opportunities to make improvements in situations where the economics can be justified. These may be through the application of individual pieces of technology that could fit into a long-term modernization strategy.

One of the key technologies in harvesting pelagics is the use of RSW systems. Given the configuration of the NL fleet, in particular the ranging vessel sizes, RSW, as it currently exists is not a possible for all but some method more effectively chilling fish should be considered. Other technologies due consideration are the latest electronic technology to allow more efficient fish finding and net minding. Both would improve the economics of harvesting through higher catches and energy reductions.

Plants in other jurisdictions have become highly automated with some of these plants processing over 1,000 mt per day. Technology developers and integrators such as Baader, Skaginn, and Cabinplant offer turnkey plant solutions. They work with other equipment suppliers to integrate the technology into automated processes as required. A summary of these technologies are presented and further discussed.

Exhibit 4.8: Pelagics processing innovations

Technology	Manufacturer	Attributes	Status
Automatic Pelagic Processing System (whole)	Skaginn (Iceland)	Fully automated from fluid ice chilling, grading, auto weighing, batching, bagging, auto tray pack, plate freezeing, and automated cartoning.	In use in Iceland, Europe,
Baader 220 /221 Auto Pelagic Processing Line *(depending on RM size)* - Baader 488/489 Auto Feed - Baader 221/220 Fillets/etc - Baader 56 Skinner	Baader Food Processing Machinery	Disigned around fillets, butterfly, and pieces, Baader offers two versions, fully automated (L A) or a semi automated (LSA). Baader offers entire system from grading to final pack. Systems are built for high volume processes.	In use in Iceland, Noway, Scotland, and Germany for past 15 years.
Robot Trimming Packing Line	Cabinplant (Denmark)	Unit removes head, tail, visera, size grades and place in can.	One unit in Greece. Custom design.
Pelagic Systems Integration	Cabinplant (Denmark)	Cabinplant is an integrator that utilized other technologies to automate large pelagic plants.	Europe
VMK (Full Line)	Arenco VMK (Sweeden)	Full range of equipment from auto feed, sex sorters, filleting, butterfly and skinning machine. Also provide hoppers, scalers, and handling technology.	In use in various loactions. Filleting units in NL
Roe Extraction Process	Traust Know How (Iceland)	Automated capelin/herring roe extraction system	Norway

Turn Key Solutions - Skaginn, in conjunction with other Icelandic technology providers, has a fully automated handling system that requires limited labour to operate when processing whole round. The final piece of the automation solution for Skaginn is vision sorting that will remove non target species or broken pieces as they enter the process. Some highlights include a chilling system that maintains the temperature throughout the process, the use of automated weighing, batching, bagging systems for packing, automated tray movement, Automated Box Freezing (a plate freezer application) and automated cartoning and palletizing.

Fillets / Butterfly, Pieces - Baader provides complete lines for pelagic processing. The Baader 220/221 line is designed to provide fillets, butterfly fillets, pieces and gutted trunks. They have two specific lines, the LA line is totally automated and requires one person for five production lines. The LSA line is semi automated and requires a person to feed the Baader 220/221 machines. The fully automated line consists of a Baader 488 automatic feeder, a Baader 220/221 heading and filleting unit and a Baader 56 skinning machine.

Arenco VMK from Sweden provides an array of fillet, butterfly, knobbing and pieces technology. This includes specialized hoppers, auto feeders, sex sorters, scalers and skinning machines that allow for the automated processing of these value added products.

Robotics - Cabinplant, an integrator that utilizes others process technology to automate large pelagic processing plants, has recently developed a pick and place robot to pickup, remove the head, tail and gut while picking up small pelagics, then automatically placing them in a can. This one unit, built for a specific customer, has resulted in considerable interest from others in the pelagic processing and canned fished fields. It is likely that this technology will be further developed and adapted.

Roe Extraction - Capelin roe extraction is common in Iceland. Two of the technology suppliers in Iceland include Skaginn and Traust Know How.

> ***Conclusions:*** *Technologies exist to fully automate pelagic processing operations; however, the limited volumes available to producers in NL will likely limit investment.*

4.7 Salmonids

4.7.1 Growing

Overall, the industry in NL is considered to be at or close to state of the art in most technologies in place. The following offer opportunities for consideration.

- Grow out systems (e.g. physical location, technologies, efficiencies, etc.)
  - ✓ Industry is at or has access to state-of-the-art technologies.
  - ✓ There is a push to develop new farming areas along the south shore, west of Bay D’Espoir toward Isle aux Mort.
  - ✓ The industry in British Columbia has been using HDPE netting (from India) for predator nets and for some primary containment nets. These nets require no antifouling, as marine biofouling is limited. On-site cleaning with portable systems is deployed. These nets also have a greater tensile (breaking) strength. In BC, these nets have improved containment and predator protection (fewer escapes, no catastrophic failures to date).

- Performance of stock (e.g. growth rates, survival, feed conversion, etc.)
  - ✓ Prototype inventory management systems for both finfish (PisciMetrix®) and shellfish (Shellfish Solutions AS®) may be worth adopting in the NL aquaculture sector to improve management information systems.

- Maintenance practices and procedures
  - ✓ There is some suggestion that the finfish industry should consider deploying daily mort retrieval systems (as in some areas of Norway and BC). This may not be practical with the current site selection process (too much exposure to waves).
  - ✓ Waste disposal (particularly for morts and from net washing) is one area that requires adoption of technologies used in other regions (e.g. geotextile bags, biosecurity protocols, organic material digesters). The need for improved waste management is presented as Sustainable Management Issue 2 in the NL Sustainable Aquaculture Strategy 2014.

4.7.2 Harvesting

The following technological advances offer opportunity for consideration and assessment.

- The industry in British Columbia and in New Brunswick use live well boats for harvesting fish. The processing plants are located close to the shoreline and are able to handle live fish pumped from the hold of these vessels directly to the kill station in the plants. The location of sites in relation to plants in NL may preclude the use of well boats at this time, although an economic analysis is warranted.

- One of the latest technologies that offer promise in salmon harvesting is related to the stunning and bleeding process. Baader, through its 2013 purchase of Seafood Innovation International Group of Australia, now offer a stunning and bleeding system. Referred to as the Baader 101, the unit is used onboard the harvest vessel where it utilizes percussive stunning and bleeding technology. The unique technology takes advantage of the fish's natural behavior where they swim into the stun and bleed system with minimum stress. This system offer labour savings versus the current manual system with other claims of improved quality and shelf life. While the stunning technology is currently in use, the fully integrated system deserves consideration.

4.7.3 Processing

Salmon processing has evolved to be a highly automated process. There are a number of technology providers who continue to work with industry to identify areas where improvements can be made. The following outline some of the technologies that have developed.

Exhibit 4.9: Salmonid processing innovations

Name	Manufacturer	Attributes	Status
Baader 142	Baader Food Processing Machinery	Auto gutting, efficiency, data gathering	In use
Ryco 645	RYCO Equipment (Seattle)	Auto gutting, efficiency	In use
Baader 581	Baader Food Processing Machinery	Smooth cut fillet unit, auto adjust, computer controlled.	In use
MS 2730	Marel (Iceland)	Filleting unit, auto adjust, computer controlled	In use
Baader 988	Baader Food Processing Machinery	Auto trimming robot	In use
Marel ITM2	Marel (Iceland)	Auto trimming robot	In use
Deep Chill Slurry Ice	Sunwell Technologies Inc	Reduces temperature and perserves product.	In use
Ice Slurry Machine	C&W Industrial Fabrication	Reduces temperature and perserves product.	In use
Valka Ice-Doser	Valka (Iceland)	Auto dispenses ice into fresh pack.	In use
Marel Ice-Doser	Marel (Iceland)	Auto dispenses ice into fresh pack.	In use
Optimar Ice-Doser	Optimar (Norway)	Auto dispenses ice into fresh pack.	In use

Gutting - The Baader 142, with upgrade kits and complete with Autofeed System improves the gutting process for salmon. The central feed allows two operators to feed four machines. The unit is complete real time data gathering capabilities and is integrated into a central data bank.

The Ryco 645 is designed for a range of wild and farmed salmon. The unit can clean up to 50 fish per minute at a wide weight range of 2 -18 pound.

Filleting - The latest filleting technology is the Baader 581. The unit can handle salmon from 2-7 kg at a speed of up to 25 fish per minute. All tools are computer controlled and it is not necessary to pregrade fish from 2-7 kg. The resultant fillets are very clean and can be integrated with the down steam Baader automatic trimming line. The entire system has complete real time data gathering capabilities and is integrated into a central data bank.

Marel has a range of salmon filleting machines, the latest design is the MS2730. The unit automatically adjusts for various fish sizes and can process fish up to 25 fish per minute. The unit is designed to fit the down steam automated trimming solutions. The entire system has real time data gathering capabilities and is integrated into a central data bank.

Trimming - The Baader 988 automated trimming robot is an advanced and unique trimming unit for salmon and sea trout. The B988 calculates the optimal cutting pattern and is designed for all kinds of trims along the belly side, back side and belly of the fillet. The unit can handle up to 50 fillets per minute and is tied into the Baader 581 trimming unit. A Baader 518 fillet transfer unit is required to redirect fillets from the filleting to the automated trimming process. For remaining defects, the Baader 560 on line trimming area can accommodate minimal manual trimming. The entire system is offers real time data gathering capabilities and is integrated into a central data bank.

The Marel ITM2 is a second generation trimming robot that trims up to 50 salmon fillets per minute. The unit is complete with back and belly knives, surface knives and a tail trimming knife. The ITM2 provides increased efficiency, precision cutting and consistent quality. The entire system is complete with real time data gathering capabilities and is integrated into a central data bank.

Packing - Valka Ice-doser System. Designed to automatically dispense ice into fresh pack boxes. The system ensures accurate dosing of product as required. Several other automated ice dosing systems also exist.

Other technologies will need to be explored and adapted from other industries as the industry matures and further enhancements in value added production come on stream. In particular this will apply to sophisticate slicing machines, shelf life extension solutions, innovative packaging applications such as Modified Atmosphere Packaging (MAP), vacuum packing, skin packing, and retail applications.

> ***Conclusion:*** *There are many automation opportunities available to salmon producers which, if the investment permits, would allow expansion of value added opportunities in NL.*

4.8 Mussels

There are numerous methods for spat collection, removal of spat from collectors, socking, and harvest of mussels from the socks. Many of the methods used are quite suitable for start-up operations whereas other methods require significant investment that may be generated from long standing commercial mussel operations. Handling technologies are available to separate debris such as kelp aboard the barge. A complete system for at sea handling that entails cleaning, chilling, and transfer of product to shore could further be explored to improve the process. Holding methods that include optimum chilling such as slurry should be considered as it may extend the live shelf life.

The following exhibit provides a list of opportunities for technology upgrades to improve in-plant handling practices.

Exhibit 4.10: Mussel processing innovations

Name	Manufacturer	Attributes	Status
Complete Plant Tech	Charlottetown Metal Products	Multiple technologies	In use
Various Handling Tech.	C&W Fabrication	Multiple technologies	In use
Econo Bag Weigh System	Luciano Cocci	Weigh and bag system for live Shellfish	In use
MAP and Vacuum Tech	Multivac	Full system including roll stock	In multiple industries
Deep Chill Slurry Ice	Sunwell Technologies Inc	Reduces temperature and perserves product.	In use
Ice Slurry Machine	C&W Industrial Fabrication	Reduces temperature and perserves product.	In use
Valka Ice-Doser	Valka (Iceland)	Auto despenses ice into fresh pack.	In use
Marel Ice-Doser	Marel (Iceland)	Auto despenses ice into fresh pack.	In use
Optimar Ice-Doser	Optimar (Norway)	Auto despenses ice into fresh pack.	In use

Upgrades in the declumping, debyssing, grading, inspection and packaging continue. Equipment providers such as Luciano Cocci from Italy, continue to add to their line of mussel processing technologies. They provide unique weighing and bagging solutions as well as other specialty solutions for mussel processing. More locally, Charlottetown Metal Products (CMP) continue to provide complete processing solutions. Local provider C&W Industrial also provides various processing and handling solutions for mussel processing.

Sunwell, and other manufacturers, provide a unique slurry ice system with some recent introductions in the Atlantic Canada. Slurry ice has proven to extend shelf life, which may provide significant benefits to producers selling live product.

Some of the greatest opportunities lie in value adding through further processing such as adding sauces, MAP and vacuum packing. The ability to process volumes at speed is critical to this area and to do this, a critical market mass is required to justify the investments required in automating these processes. Requirements for various packaging technologies will grow as production increases and markets expand.

> ***Conclusion****: Continued implementation of innovative processing methods and packaging technologies will be important in diversifying mussel product lines.*

4.9 Emerging Technologies

The following are some of the technologies that are currently either in the conceptual or initial production and testing phases. Most of these more recent innovations utilize several technologies and require combinations of specialized lighting, mechanics, and chemical understanding. These developments are occuring in various locations throughout the world. Many solutions can be adapted to other food industries.

The following exhibits details developmental technologies relevant to the harvesting sector. As indicated, some of these initiatives are being developed under government direction or with government funding. Of particular interest may be the LED Light project that could be applicable to reducing bycatch of small pelagics and groundfish in shrimp catches.

Exhibit 4.11: Emergining harvesting technologies

Technology	Manufacturer / Developer	Attributes	Status
Percision Seafood Harvesting	Initiative of New Zealand government and three seafood harvesting companies.	Will eliminate traditional trawl nets to allow fish to be landed alive on deck similar to aquaculture practices.	Developmental
LED Light	Pacific States Marine Fisheries Commission and Oregon Department of Fish and Wildlife	Reduction in by-catch of Eulachon (smelt) using LED lights on the fishing line of shrimp trawl.	Development trials in 2014 in Oregon showed positive results.
Fish Selector	Star-Oddi (Iceland)	Video cameras and computers that scan the fish in the trawl and if approved (size/species) it goes to the cod end, otherwise released.	Research / Developmental
Pressure Vacuum Pump	SINTEF (Norway)	System creates a vacuum in the storage tank, fish are transported in a closed system.	Developmental

There are several developmental or initial trials utilizing new technologies for the processing sector. Of particular interest should be the misting system and controlled atmosphere packaging that permits ocean shipment of fresh product.

Exhibit 4.12: Emerging processing technologies

Technology	Manufacturer / Developer	Attributes	Status
COOL NOVA	CoolNova (Germany)	Freezing / thawing system. Using a mist system, freezing is faster and minimum drip loss in thawing.	Small units in use in Europe
BluWrap	BluWrap (California)	Extends shelf life through controlled atmosphere.	Started moving seafood from Iceland to US in 2014 via ocean freight. Also doing work in South and Central America
High Pressure Processing	Initiative of CCFI and industry partner OCI.	Alternative method to process shellfish (crab, shrimp, lobster) for raw meat extraction.	Developmental
Robotics	Various	Opportunities to automate and reduce labour requirements	Used in other industries.
Robotics	Cabinplant (Denmark)	Head, gut and pack robot for sardines	One unit in Greece
Pulsed Light Technology	Research initiative by SEAFOODplus.	Reduce level of spoilage through decontamination procees.	Research

Conclusions: *Emerging technologies are quite complex, some utilizing multiple technologies. Many of these initiatives will be very costly and require increasing levels of technical expertise to operate and maintain.*

5.0 GAP ANALYSIS

The gap analysis provides a direct comparison of the current practices primarily used in the NL seafood industry against alternative practices derived from best methods used in other jurisdictions and existing proven technologies. This gap analysis identifies the specific process where the value chain may be improved through employing these methods or technologies. The financial justification for modifying current practices and technologies employed is dependent upon factors related specifically to each individual vessel, processing facility or aquaculture operation.

Issues regarding industry structure, regulatory measures, and current policies all can have a significant impact on the ability of stakeholders to invest in initiatives that impact the long term viability of all species and sectors. This gap analysis is completed considering how the industry currently exists. This precludes drawing conclusions regarding changes around these issues, or the impact they may have on implementation of the various technological advances identified in this gap analysis.

5.1 Snow Crab

The snow crab industry in NL has continued to evolve over the past 20 years with the development and the adoption of new technologies in both harvesting and processing. The NL snow crab sector is a world leader in processing and many of the technological innovations were conceived of and developed in NL and other Atlantic provinces. As seen in the past, there has always been room for further improvement through innovation in both harvesting and processing of snow crab. As illustrated in the following exhibits, there remains room for further improvement in both the harvesting and processing components of the sector.

Exhibit 5.1: Snow crab harvesting gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Set pots	GPS, plotter	Olex/WASSP	Set on specific bottom type, higher catch rate.
Potting	Pot on bottom	Collar on bottom	Exclude softshell and small crab. Less habitat impact.
Exclusion of undersize crab	Voluntary escape mechanism	Mandatory escape mechanism	Higher survivability of captured undersize crab
Sorting	On deck	Sorting table on deck	Worker comfort. Higher survival of returns.
Holding	Bulk in pens	Net bags in pens.	Reduce labour, faster unloading. Less limb loss. Liveliness improves due to less handling.
		RSW or CSW(1)	Faster loading. Longer trips. Lively when landed.

Note: 1) CSW is chilled seawater. Hold is sealed, charged with ice then seawater added at harvest location.

Of particular note in the harvesting sector is that snow crab escape mechanisms are voluntary rather than mandatory, which is the case in other DFO regions. Given the ecosystem policies in place at DFO, the capture of non target snow crab is contrary to the intent of this policy. There are several known benefits and possible long term benefits to the sector to have escape mechanisms. These benefits include, sorting labour aboard the vessel would be reduced, undersize snow crab would not incur any damage from handling aboard if they successfully escape, and the long term benefit may be a higher survival rate of undersize snow crab to reach maturity and reproduce.

There are various practices employed by producers of snow crab. This is due to technologies rapidly changing, which has resulted in producers employing different generations of equipment. The following exhibit cites, for the most part, the least effective practice currently employed and states the benefits that would be realized by adopting the alternative practice(s).

Exhibit 5.2: Snow crab processing gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Holding	Refrigerated chllroom	Live tanks or misting system.	Maintains liveliness, extended raw shelf life.
Feeding line	Manually dump	Autodump	Reduced labour. Auto pan wash. Feeds to prescribed capacity, improved product flow.
Butcher	Manual	Baader or Ryco	Reduce labour. Reduce fatigue and soft tissue injuries.
Barnacle Removal	Machine or barnacle buster	Modified machine integrated with butchering	Reduced labour content, improved product flow of barnacled product resulting in better yield.
Size grading	Manual	Automate section grading (Marel, Marelec)	More accurate, less labour.
Packing	Manual with grading	Left/ right previous separation	Reduced labour.
Cooking	Gondola immersion Batch	Steam	Yield improvement. Energy savings.
Chilling	Batch	Gondola immersion	Possible yield improvement. Most effiicient, controlled temperature.
Refreezing	Blast or cold storage	Auto Freezer	Reduced labour, controlled temperatures.
Mastering	Manual	Auto Master	Reduce labour.
Stretch Wrap	Auto and manual	Auto	Reduce labour, stronger pallet wrap.
Cold Store	Forklift, stacking	Racking System	Less damage, easy access and management of inventory.
Information System	Manual	Automate, RFID, Bar Code	Contolled inventory, reduce labour, improved traceability.

5.2 Shrimp

From the assessment conducted, it appears that the shrimp industry in NL has kept pace with technologies used in other jurisdictions; however, some opportunities for improvement exist. The risk of a declining resource has and will continue to impact investment in technologies acquired for the shrimp industry.

Exhibit 5.3: Shrimp harvesting gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Deploy Trawl	GPS / Plotter	Olex/WASSP	Set on selected bottom type. Improve catch rates. Avoid more sensitive bottom habitat and species.
Trawling			
Twine / Rope	Standard	Dynema rope / Twine	Energy savings, less drag, long lasting.
Trawl Floats	Round	Dimpled floats	Energy savings, easier movement through water.
Trawl Type	Single Trawl	Twin trawl	Higher catch rates, larger swept area (larger engine).
Door Type	Ground Doors	Pelagic Doors Fuel efficient ground doors	Energy savings. Higher catch rates through improved net geometry. Less habitat impact.
Warps	Steel	Dynema rope	Energy savings.
Net Moitoring	Some in use.	Net sensors	Higher catch rates.
Data Logging	Some in use.	Auto logging	Information reporting and integration.
By Catch Sorting	Not used	Automated separator	Reduce labour .
Bagging	Manual	Auto bagging. Boxing via conveyor/hoist	Improved quality. Less worker fatigue.
Holding	Bags bulk in pens.	Boxing or use of pen bags.	Improved quality. Reduce labour.
Fuel Monitor	Some passive systems in use.	Passive or active fuel monitoring.	Energy savings.

The shrimp C&P processing sector have been innovative, developing and implementing the most current technologies for processing of coldwater shrimp. With supply reductions, the sector may need to diversify to other supply sources such as frozen industrial shrimp or alternative frozen shrimp species. Further, improved returns by producing higher value, smaller retail or raw peeled product, could contribute to the long-term viability of this sector.

Exhibit 5.4: Shrimp processing gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Unloading	Manual bag to tubs, dump bags from tub.	Boxed or pen bags hoist directly to wharf.	Reduce labour. Improved quality.
Cutting Bags	Manual	Auto bag cutting and dumping.	Reduce labour. Provide controlled feed rate.
Defrost	Not currently at plant	Auto system	Industrial shrimp to increase production.
Maturing	Tubs	Tank system	Reduce labour, auto feeding and less cleaning.
Cooking	Immersion cooking	Central steam	Yield improvement. Energy savings. Improved colour of shrimp.
Packing	Manual	Automated index system.	Reduce labour.
Mastering	Manual	Automate	Reduce labour.
Stretch Wrap	Manual	Automated wrap system.	Reduce labour, stronger pallet wrap.
Cold Store	Forklift, stacking	Racking system	Less damage, easy access and management of inventory.
Information System	Manual	Automate, RFID, Bar code	Contolled inventory, reduce labour, improved traceability.
Offshore			
Species separation	Some manual	Automate.	Reduce labour.
Cooking	Immersion	Central steam	Yield improvement. Energy savings. Improved colour of shrimp.
Colour grading	Note done.	Optical sorting system.	Improved product value. Reduce labour.

5.3 Groundfish

The groundfish sector has not been a predominant group of species in recent years; however, the anticipated increase in groundfish stock abundance will require a modernization of fishing and processing methods in order to compete with current world suppliers. In contrasting current practices in NL to other jurisdictions, it is clear there is a significant gap in both the harvesting and processing sectors.

A number of changes have occurred in the harvesting sector. Harvesters worldwide have modified their methods of fishing with the objective of reducing crew size, reducing equipment costs, improving catch rates, saving fuel, and reducing impacts to other species and habitat. This has resulted in many significant advances in gear technologies. There has also been an increase in value derived from each fish, which has moved the bar up significantly regarding onboard handling and storage methods. As a result, changes in the fishing and handling methods continue to evolve.

Exhibit 5.5: Groundfish harvesting gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Deploy Trawl	GPS / Plotter	Olex/WASSP	Set on selected bottom type. Improve catch rates. Avoid more sensitive bottom habitat and species.
Trawling			
Twine / Rope	Standard	Dynema rope / Twine	Energy savings, less drag, long lasting.
Trawl Floats	Round	Dimpled floats	Energy savings, easier movement through water.
Trawl Type	Single trawl	Twin trawl	Higher catch rates, larger swept area (larger engine).
Door Type	Ground doors	Fuel efficient ground doors	Energy savings. Less habitat impact.
Warps	Steel	Dynema rope	Energy savings.
Net Moitoring	Some in use.	Net sensors	Higher catch rates.
Data Logging	Some in use.	Auto logging	Information reporting and integration.
Longline (Manual)	Manual bait and feed	Auto longline	Reduce labour. Energy savings, shorter trip.
Handline (Manual)	Manual jigging	Auto jigging systems	Reduce labour. Higher catch rate.
Bleeding	Bleed tubs, chilled water	Bleed and chilling system.	Improved quality through controlled bleeding and immediate chilling of the catch.
Gutting	Manual gutting Dispose of gut	Automated stunning/gutting. Retain liver and roe.	Reduce labour. By product utilization.
Holding	70 litre totes with dry ice, stored on deck.	Tubs with slurry.	Improved quality. Shelf life extension.
	Pens with dry ice	RSW/CSW or pen bags.	Improved quality. Reduce labour.
Fuel Monitor	Some passive systems in use	Passive or active fuel monitoring	Energy savings.
Unloading	Pan or put in pans / tubs	Unload slurry tubs with hoist Hoist and dump pen bags.	Reduced labour. Improved quality.

Iceland is recognized as the world leader providing high value cod products. For decades, Iceland has continued to be innovative, effectively maximizing the value of each fish harvested. Given the fishery is such an integral part of the Iceland economy and Icelandic psyche, as it is in NL, making the most of the resource was not driven from a desire to improve, but was a matter of necessity. From this necessity, several manufacturers (Marel, Skaginn, Valka, etc.) moved from a technology concept to become world-class seafood industry equipment suppliers.

Ideally, the NL groundfish sector could emulate Icelandic methods; however, the volumes available likely will not permit this in the mid term. Therefore, the actions that are required are to simulate them given the confines of the existing business model, likely requiring NL groundfish participants focus on practices in the short term, while adopting technologies over time.

The following exhibit illustrates the significant gaps in practices and technology.

Exhibit 5.6: Groundfish processing gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Product Grading	Not completed.	Grade by size and quality.	Imrpoved quality and pack mix.
Short Term Storage	Product iced in tub.	Transfer to slurry ice.	Improved quality. Extended shelf life.
Input to Line	Tubs dumped to hopper	Auto tub / pan dumper	Reduce labour.
Heading	Manual Auto old technology	New heading technology.	Reduce labour. Yield improvement.
Filleting	Manual Auto old technology	New filleting technology.	Yield improvement. Improved quality, product texture.
Skinning	Baader 51, 47	New skinning technology.	Yield improvement. Improved quality, product texture.
Super Chill	Not completed.	Superchilling	Improved quality. Extended shelf life.
Skinning Superchilled	Not complete	New Skaginn skinner.	Yield improvement.
Trimming / Inspection	Manual Line Trim, pin bone, portion	Auto tail removal, flowline X Ray with pin bone removal	Reduce labour. Improved quality. Reduce labour. Improved quality.
Fillet grading	Manual	Auto grading of fillets or portions	Reduce labour. Improved size determination.
Packing (fresh/frozen)	Manual	Rapid Aligner (Valka)	Reduce labour.
Icing Fresh	Manual	Ice dosing (Optimar, Valka)	Reduced labour. Lower shipping weight.
Plate Freezing	Manual	Auto plate freezer	Reduced labour. Accurate turn times.
IQF	Blast freezing.	IQF freezer unit	Reduce labour. Improved quality.
Grading / Glazing	Manual	Auto Grader / Glazer	Reduce labour. Accurate pack weight.
Packing	Manual	Automated index system.	Reduce labour.
Mastering	Manual	Automate	Reduce labour.
Stretch Wrap	Manual	Automated wrap system.	Reduce labour, stronger pallet wrap.
Cold Store	Forklift, stacking	Racking system	Less damage, easy access and management of inventory.
Information System	Manual	Automate, RFID, Bar code	Contolled inventory, reduce labour, improved traceability.
Salt Fish			
Splitting	**Auto / Manual**	**Auto (Baader 541)**	**Improved texture, better yield, cleaner output.**
Salting	Manual / Auto	Auto Injection system	Consistent, control salt usage. Special packs, specific market.

The offshore groundfish sector has a small number of participants; however, the sector remains committed to finding innovative solutions to their challenges. This sector is unique in that the primary species harvested are yellowtail and turbot, which are processed primarily into HOG and H&G products. These fleets have implemented the newest harvesting and processing technologies and continue to conduct research to develop innovative solutions to address remaining challenges.

The groundfish challenge: In 2013, the groundfish sector comprised 13.2% and 16.3% of capture fisheries volume and value respectively, and 7.6% of the seafood production value in NL. Groundfish supplies are comprised of up to 20 different species of various sizes and quality, are harvested by all sectors, then produced in up to 45 plants into numerous pack styles to meet customer needs. The diversity of this sector coupled with the relatively historical low quotas available pose a significant modernization challenge. Other jurisdictions have significantly higher supplies available, which has both driven the need and permitted investment in technology.

Some groundfish species, yellowtail and redfish, are harvested almost exclusively by offshore freezer vessels, and much of the production on these vessels is destined for consumers desiring whole product forms. Technology investments in these sectors have been made regularly, and should continue to be supported in order to maintain markets and ensure that competitive advantage is not diminished.

The inshore harvest and processing sectors are very diversified and lack technical advancement both in harvesting and processing. The very nature of this sector poses significant challenges when considering a broad based modernization strategy. The default position of the inshore sector has been to rely on existing harvest technology, primarily gillnet, and either manual or use of older processing methods. This approach cannot meet market needs or provide a price that can sustain harvest and processing costs.

In practical terms, improving the value chain for groundfish cannot be done on a broad basis, which necessitates addressing the current structural challenges to maximize values. For example, harvesting less than 10,000 mt of cod, primarily in the summer, with more than 2,000 enterprises and processing in 45 plants has resulted in low valued products such as block and whole frozen fillets, with limited amounts of portion packs and no fresh fillets.

To maximize the value chain, ideally cod fillets will be either fresh or individually quick frozen (IQF), with only trimmings used for blocks. However, to realize this outcome harvest methods, handling methods, and processing methods all must change and there must be the logistical support for distribution of fresh fillets. With limited funding available for modernization of the sector, investment must be done pragmatically.

Conclusion: *Modernization of the inshore groundfish sector cannot be done effectively without structural change.*

5.4 Pelagics

Pelagics is considered to operate as a high volume, low margin business model. As previously illustrated, supply volumes available to NL vessels and producers pale in comparison to those in Iceland and Norway. As a result, these nations have highly technological industry models in which to operate. This has resulted in many gaps in operating practices and technology employed in the pelagics industry.

The large volumes available in other jurisdictions permit justification of investments to automate, which is not the case in NL. Therefore, similar to groundfish, the focus of the pelagics industry must be to adopt the best practices available, the technology that is appropriate given the limited scope of the business, and to innovate to provide niche products, all of which may permit a sustainable business model that provides the best possible returns.

Exhibit 5.7: Pelagic harvesting gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Holding	RSW, bulk	RSW or chilled sea water	Improved quality. Shelf life extension.
Fuel Monitor	Some passive systems in use	Passive or active fuel monitoring	Energy savings.
Catch Method	Gillnet, Trap, Seine	Trawl, European Seine (Requires larger vessel) and engine)	Fish rougher weather(no skiff), deeper, and larger catch.

To illustrate the scale of difference in production of pelagics, in Norway, there are only 3-4 large processing plants, some of which are processing over 80,000 mt per year with very few people. In contrast, the overall pelagic landings in NL in 2013 were just over 64,000 mt. This vignette reinforces the need for a unique approach to be adopted, rather than trying to emulate those that are successful, but operate on a different playing field.

Exhibit 5.8: Pelagic processing gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Holding	Tubs in reefers, chilled rooms	Tanks with refrigerated and circulated water	Reduced labour, less handling.
Input to plant	Tubs dump to hopper	Gravity feed from tank	Reduced labour.
Grading	Bar grader	Style grader	Capacity, accuracy.
Fillets			
Feed Filleting Unit	Auto / Manual	Baader 488/489 auto feed Baader220/ 221 filleter or VMK system	Less labour.
Value added Roe	Not completed.	Roe extraction systems.	Increased revenues.
Whole			
Weighing /Packing Whole	Manual or semi manual	Automated batch weigh, auto bag forming, auto filling.	Reduce labour. Higher throughput.
Freezing Preparation	Manual load blast rack	Semi auto loading system.	Reduce labour.
Freezing	Manual to blast	Auto to plate freezer	Reduce labour.
Mastering	Manual	Automate	Reduce labour.
Mastering	Manual	Automate	Reduce labour.
Stretch Wrap	Manual	Automated wrap system.	Reduce labour, stronger pallet wrap.
Cold Store	Forklift, stacking	Racking system	Less damage, easy access and management of inventory.
Information System	Manual	Automate, RFID, Bar code	Contolled inventory, reduce labour, improved traceability.

5.5 Salmon

The salmon industry is poised to grow in the coming years. If current challenges regarding labour availability and the logistics of moving fresh product to market can be overcome, then the opportunity to further modernize the business will improve. The salmon business in NL is advanced and operators are familiar with and have access to all modern technologies.

Exhibit 5.9: Salmon harvesting gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Stunning / Gutting	Auto stunning, manual gutting	Auto stunning/gutting with Baader 101	Reduce labour.
Vessel Holding	Fish held in boat well in water after bleeding	Live pump to live holding vessel	Improved quality. Extended shelf life.

Currently, the majority of salmon is shipped whole fresh, much of which is destined for fillet or portion production in plants on the mainland. With increases in supply anticipated, there can be significant savings realized by producers by doing fillet and portion production in NL.

Exhibit 5.10: Salmon processing gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Offloading	Pump to tubs at plant.	Pump to plant tanks	Lower labour. Improved control of product.
Transport	Tubs in ice slurry in reefer truck	Refrigerated tanks truck	Lower labour. Improved control of product.
Holding	Tubs with slurry and tanks	Tanks with chilled seawater	Lower labour.
Input to Line	Dumptubs to hopper	Pump to hopper	Lower labour. Improved quality.
Gutting	Manual / semi automated	Automated Baader142 gutter	Lower labour.
Filleting	Auto Carnitec	Auto Baader 581 or Marel	Yield improvement. Consistent quality.
Trimming	Manual	Baader 988 auto robot or Marel ITM2	Lower labour. Yield improvement.
Sleaving Fillets	Manual	Auto poly fillet wrap unit	Less labour
Icing	Manual	Auto ice doser	Less labour.
Value adding	Not completed	Auto Slicing Portioning MAP Auto Additives / Spices Auto Skewer unit Vacuum packaging	High end portion control. Retail portion market. Shelf life extension. Retail market speciality item. Retail market. Speciality retail items..
Mastering	Manual	Automate	Reduce labour.
Stretch Wrap	Manual	Automated wrap system.	Reduce labour, stronger pallet wrap.
Cold Store	Forklift, stacking	Racking system	Less damage, easy access and management of inventory.
Information System	Manual	Automate, RFID, Bar code	Contolled inventory, reduce labour, improved traceability.

5.6 Mussels

The mussel business in NL continues to have growth opportunity. Mussel farm operators vary significantly in size, so the ability to invest in the most modern technologies may only be possible for the larger operators at this time.

Exhibit 5.11: Mussel grow out and gap analysis

Process	Current Practice(s)	Alternative Practice(s)	Benefits to be Realized
Predator dispersion	None	Shellfish saver laser	Improved productivity
Cleaning	Manual remove debris	Auto system	Reduce labour. Less debris to be handled on land.
Holding	Pans	Tubs with chilling solution	Reduce labour. Improved quality.

An ongoing challenge associated with year round open water production of fish and shellfish (e.g. long-line production of oysters and mussels, cage culture of finfish species) in regions that experience below freezing winter conditions is dealing with ice. This is a particular problem in eastern Canada for the mussel and oyster industries as well as for cage culture of finfish in some regions. The challenges associated with ice vary with different conditions, including:

- During ice-in (early winter) and ice-out (spring), it becomes difficult and nearly impossible to access the offshore sites to manage or harvest the aquaculture crop, as the ice is unstable and not easily traversed.

- As winter ice becomes thick enough to travel across, it remains risky to travel out onto the ice with trucks, snow machines and sleds to access production sites that can be several kilometers offshore.

- Additional capital is required to deploy submersible aquaculture infrastructure to enable producers to sink lines below the surface to prevent the gear from being damaged or destroyed by moving ice.

Possible mitigation measures may include automated ice monitoring and reporting, use of buoyant vehicles when harvesting on ice, relaying product to near shore locations for overwintering, and developing pump ashore facilities for holding harvestable product.

Over several decades, the industry has developed technologies and practices to enable them to manage the challenges associated with ice. Once stable ice has set in, producers travel across the ice to gain access to their longlines that have been submerged, 6' or more as necessary, and marked with ice poles. Specialized chain saws are used to access the line which is hoisted over an A frame structure which holds the backlines above the ice surface. The backlines are severed from the main line and mussels dropped into an insulated container for transport.

The greatest opportunities for the processing sector are in value adding through further processing such as adding sauces, MAP and vacuum packing. The ability to process volumes at speed is critical. A critical mass of supply is required to justify the investments needed in automating these processes. Requirements for various packaging technologies will grow as the markets continue to expand, therefore it is essential to modernize this processing sector where possible to ensure they progress away from the commodity bagged live mussel market.

Exhibit 5.12: Mussel processing gap analysis

Process	**Current Practice(s)**	**Alternative Practice(s)**	**Benefits to be Realized**
Holding	**Pan / Tubs with CSW**	**Tubs or tanks with CSW**	**Reduce labour. Improved quality.**
Input to line	Manual forklift	Auto tub dumper.	Reduce labour.
Weighing	**Manual / Auto**	**Auto System, multi head**	**Reduce labour. Accurate weights.**
Bagging	Manual / Semi Auto	Semi auto (Cocci style)	Reduce labour
Icing	**Manual ice / slurry**	**Auto slurry flow system**	**Reduce labour. Improved quality.**
Value adding	Limited	Automatic solutions	Reduce labour, accurate weight, efficiency.
	Manual weighing	Multi head weighing units	**Reduce labour. Accurate weights.**
	Rollstock vacuum unit	Auto rollstock vacuum unit	Reduce labour. Cost savings.
	Vac Pac	MAP technolgy	Improved quality. Expanded market.
		Auto mixing units for sauce	Reduce labour. Controlled inputs.
		Auto sauce dispensers	Reduce labour. Controlled inputs.
Mastering	Manual	Automate	Reduce labour.
Stretch Wrap	Manual	Automated wrap system.	Reduce labour, stronger pallet wrap.
Cold Store	Forklift, stacking	Racking system	Less damage, easy access and management of inventory.
Information System	Manual	Automate, RFID, Bar code	Contolled inventory, reduce labour, improved traceability.

6.0 PROGRAM NEEDS

The Fisheries Investment Fund has four pillars that will form the basis of the programs through which funds will be invested. These include research and development, market development, fisheries science, and infrastructure.

The infrastructure program must meet the needs of the industry in achieving the goal of improving the operational efficiencies, product quality, and overall technological advances throughout the value chain. These goals can only be achieved through further collaboration with the industry to match priorities with that of the program.

The infrastructure program can work in conjunction with existing programs to ensure that there is no overlap as this program is designed around implementing infrastructural technologies into the industry. To ensure the objectives are achieved and efficiencies prevail, where possible, existing knowledge and capabilities should be utilized to administer the program. The program should be structured such that a series of checks and balances are in place to ensure objectives are met and policies are adhered to.

6.1 Existing Programs

There are a number of programs that exist at both the provincial and federal level that are accessible by the seafood industry stakeholders in NL. The Fisheries Technology and New Opportunities Program (FTNOP), an initiative of the Department of Fisheries and Aquaculture, is a program designed for the seafood industry in the province. The primary objective of the program is to provide support for harvesting, processing, and marketing initiatives to aid the industry in becoming more innovative and competitive.

The Fisheries Loan Guarantee Program, delivered by the Department of Innovation, Business and Rural Development, provides loan guarantees for acquisition of new vessels, licenses, combining of enterprises and vessel upgrading including new and innovative handling and storing equipment.

Most other programs are not tailored specifically to the seafood sector, however, applications from the seafood sector fall within the mandate. The following exhibit summarizes the agencies administering the numerous programs and an outline of the program attributes.

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Exhibit 6.1: Summary of existing NL based programs servicing the seafood sector

Agency	Category	Application Req'd	Proposal Req'd	Target Turnaround Time	Funding Cap	Proponent Contribution	Multi-year Contracting	Other
DFA	**FTNOP**	**Yes**	**Yes**	**90 business days**	**60% to $100k**	**40% Cash/Direct in-kind**	**No**	**Up to 100% for Associations/non-profit**
RDC Business	R&D Vouchers	Yes	No	Internal at this time	75% to $15K	25%	No	Project must commence within 3 months of approval.
	R&D Proof of Concept	Yes	Yes	Internal at this time	75% to $250K	25%	Yes 18 months	Project must commence within 6 months of approval.
	Industrial R&D Fellowship (IRDF)[1]	Yes	Yes	Internal at this time	$30K		2 Yrs Max	Funding also provided by NSERC (IRDF)
Academia[2]	Ocean Industries Student Research Awards	Yes	other[3]	12 weeks from deadline	$20K for Masters $30K for Doctoral		Masters - 2 Yrs Doc. - 3 Yrs	
CCFI	**Applied Seafood Industry Research**	**No**	**Yes**	**N/A**	**MI Overhead reduction**	**N/A**	**No**	
ACOA	Atlantic Innovation Fund (AIF)	Letter of Intent	Yes & forms	N/A	75%[4]	25%	Yes	80% for not for profit turnaround depends on complexity of proposal
	Business Development Program (BDP)	Yes	Yes	N/A	75%	25%	Yes	turnaround depends on complexity of proposal
NRC	**IRAP**	**Yes**	**Yes**	**$50k or less 20 business days $500k or less 30 business days > $500k 45 business days**	**$500k**	**Cost Shared**	**Yes**	**Cost shared with Applicant Will exceed $500k depending on project**
AAFC	AgriMarketing Program Market Development Stream	Yes	Yes[5]	100 business days	50% to $50k	50%	Yes	Up to $2.5 m for Not-for-Profit Max percentage contribution may be higher when aimed at new markets
	Assurance Systems Stream	Yes	Yes	100 business days	$1m/project	Min of 25% In-kind/Cash	N/A	Applicant contribution may be from other contributors/agencies. Stacking limit is 85%.
DFO	**Aquaculture Collaborative Research & Development Program (ACRDP)**	**Yes**	**Yes**	**60 business days**	**70%**	**30% Min 7.5% cash**	**N/A**	**The program budget is $2m/year**

Notes: 1. Application is made to NSERC and RDC. Proposal normally comes from the Company.
2. Business Collaboration/Partner required.
3. Other information required, e.g., letter of support from Industry Partner, transcripts, CV
4. Must be over $1 million
5. Must include a Long-term International Strategy

Source: FTNOP Review 2013

As illustrated, many of these programs focus on research and development activities and one off technology demonstration programs. These programs have met some of the ongoing needs of industry; however, a broad based modernization strategy requires different attributes.

In order to match the competitive limit of the other jurisdictions, a program of one off projects will not advance the overall industry at the required pace. The program must be able to deal with multiple projects of similar nature in order to reach the technology plateau of competitive jurisdictions. Ideally, the infrastructure program model will support a number of similar initiatives for numerous applicants.

6.2 Other Jurisdictions

Examining other jurisdictions for similar type programs, the European Maritime and Fisheries Fund was identified as an example of a program that supports infrastructural initiatives. These programs provide direct infrastructure funding for all sectors including harvesting, processing and aquaculture. This funding is available for all primary equipment; however, funding is normally contingent upon ensuring surplus capacity is not created.

These EU based programs provide funding ranging from 20%-40% depending upon numerous factors. In contrast, the FTNOP program provides up to 60% funding; however, these projects are one offs and have upper limit funding levels that are lower than many of the EU based programs.

The European Fisheries Fund (EFF) ran from 2007 to 2013 with a budget of 4.3 billion Euros. The fund provided financial assistance to priority areas within the seafood industry and coastal communities to help them adapt to changing conditions and become economically resilient and ecologically sustainable. Funding was provided for all areas of the fishery including aquaculture, sea fishing, inland fishing, processing, and marketing.

Countries within the EU are asked to forward a business plan for a funding program. The EU evaluates the programs submitted and if approved, the national governments will be funded to implement the program within its jurisdiction.[18] The fund is currently closed and a new fund is about to come on stream, the European Maritime and Fisheries Fund. This fund is set to run from 2014-2020.

As a representative country, Ireland, through Bord Iascaigh Mhara, (BIM) created a program with four categories, processing, business development, fisheries and aquaculture. Each grouping has a number of sub categories or programs. A number of these programs are funded through the European Fisheries Fund, some from other sources. In processing, eligible projects include new machinery and equipment as well as construction or modernization of a seafood processing enterprise. Funding is at 20-30% of eligible cost up to 500,000 Euros per project. A Fleet Quality, Hygiene and Responsible Fishing Scheme are funded at 40-60% at different maximum

[18] http://ec.europa.eu/fisheries/cfp/eff/index_en.htm

amounts, which vary, by vessel size. In aquaculture, one program is designed around innovation where funding of 40% of eligible costs is provided.

Another example is in Scotland where a fishing vessel modernization scheme is in place. Different levels of funding are provided based on geographic location. The maximum grant is 40% of eligible costs for vessel modernization with specific examples found that include the purchase of selective gear or fuel flow meters. The criteria are broad ranging and could include refrigeration or fish handling rooms. All projects should contribute to lasting economic benefit and avoid counterproductive efforts such as creating surplus capacity. These should be projects that would not otherwise be undertaken and result in benefits to the sector and communities.[19]

6.3 Capability and Needs of Industry

Several issues reflected in survey responses and consultations are significant at this point. As mentioned in the Current Practices section, R&D and technology investment in the harvesting sector was done regularly, albeit not by the majority of participants. However, the majority (91%) of enterprise owners stated that having funding support would influence their decisions going forward. The most significant reasons for not investing relate to lack of funds, knowledge regarding funding, or lack of cash flow. Most respondents indicated they do have awareness of what technologies they require to make their enterprise financially sustainable in the long term.

The majority of processors have made investments in new technology, with 56% receiving external funding. Going forward, 95% indicated a cost shared program would influence their decision to invest. Often, the ability to invest was limited by size and volume, which must be addressed under any new program initiative. This lack of participation by smaller producers may be associated with the process of application and reporting, lack of resources to make application and manage the project, or the percent or level of funding available.

The willingness of the industry to invest exists; however, the knowledge and awareness about funding programs was lacking in some sectors, particularly smaller vessel operators and plants. To ensure success through all sectors and that smaller operators and harvesters can participate, program staff should be located strategically around the province in order to be available to industry in the various regions. These staff could provide consultative assistance to the processors and harvesters related to the application process, project follow through and closeout. By necessity, the staff would be removed from the decision making process, and therefore free to assist industry stakeholders as required.

Based on the assessment, there is a range of needs to be addressed by an infrastructure program. Each sector, harvesting, processing, aquaculture, and logistics has unique needs though there is some overlap. The needs seem to fall into certain themes that will result in efficiency, revenue generation, or ecological measures.

[19] http://www.scotland.gov.uk/Resource/0040/00402592.pdf

6.4 Proposed Program

The programs offered under the European Maritime and Fisheries Fund provides a reference point. To some extent, these could be viewed as "turnkey" programs as they have been in place for some time, are perceived to be successfully meeting their objectives, and have been recently renewed.

The development of a new infrastructure program must focus on where the needs and priorities are within the industry. To this end, a consultative process with industry must be undertaken to ensure the needs are reflected in the development of the program.

6.4.1 Program Categories

There are four distinct categories that should be supported by the program. The first is in research and development, in particular the building of capacity within NL to invent, develop and produce advanced technology solutions. As indicated earlier, this must be a collaborative effort of technology companies, research institutes, industry and government. The program must be flexible enough to allow the innovative equipment fabricators and research institutes to participate directly, as the ideas and concepts that offer may not garner industry support in the short term.

The second category is technology implementation. This is a core piece of the program, as it will allow industry to invest in technologies that are state-of-the art and should bring the NL industry closer technologically with producers in other jurisdictions. These should not be one off technologies but funded on a broad basis to those who can and will invest in the future.

The third category is the area of value chain improvement and support. Efforts must continue to improve the value chain in order to maximize value by harvesting and handling product to ensure the highest quality and best yield recovery. Further, there is need for improvements in distribution systems to ensure access to markets as required throughout the year. This is of particular importance in the movement of fresh product from both wild and aquaculture sources to the US and Europe.

The final area is in that of training. Ongoing training is a must for any organization or industry. In particular, the program must support training geared towards the introduction of new, technologically advanced processing equipment. Additionally, as the industry transitions towards a groundfish based industry, there will be considerable demand for training processing workers. It has been over 20 years since NL was a significant player in the groundfish business and many workers will be new to this sector. Additionally, the industry has changed over that time and those involved must be trained in relation to new standards, expectations and process methods.

6.4.2 Required Capabilities

The delivery of the program will require expertise from a range of personnel. Each group and their specific capabilities are described.

Management: Management will lead the initiative by setting the priorities and being accountable for achieving objectives. The management team should entail a mix of federal and provincial counterparts to ensure each government views and objectives are represented. The management team will have a strong background in program delivery, a sound knowledge of the seafood business, and be well versed in government policy.

Administrative: The administrative function of the program will require strong competency in the accounting field and government policy. This group should be responsible for contract administration, budget management, settling invoices and general management of the overall files.

Technical: In order to ground truth individual proposals for funding, a strong technical team will be required. Members of the team should be versed in a range of areas within the seafood business including harvesting, processing and aquaculture. They should have a high level of knowledge regarding technologies used within their field of expertise, and be able to provide support to management and the administrative team on matters related to applications.

Support Services: This group should include field staff that will work with clients throughout the province to ensure they have access to funding opportunities they require. They should be involved in the day-to-day activities and work to develop and build strong relations with industry. When necessary, these staff should assist clients in completing funding applications, assist with project management, and provide assistance to close out files on behalf of clients. Additionally, they should provide support to other members of the team regarding inquiries of files they participate in and regional issues. These personnel may come from current program facilitators in the provincial and federal government in the province.

6.4.3 Governance

To ensure that funding is meeting the criteria of the program, the program would be subject to an audit process. Additionally, at the midpoint and end of the program, an independent program review process should be conducted. On a regular basis, due to the current changing nature of fishery resources, program management should hold update sessions and consultations with industry and a broader range of government representatives in order to ensure the program objectives meet the current needs of the seafood industry and is achieving its overall goals.

6.4.4 Implementation

The program should provide funding at similar levels to the European Fisheries Fund, funding in the 30%-40% range, with the remaining investments coming from industry. This will ensure solid buy in from the applicant and demonstrate their financial capacity to invest. Additionally, scale funding could be introduced to help assist those with less capability to invest. Again this is similar to the European fund.

The program will need to be somewhat flexible to handle the types of initiatives outlined. It is likely many R&D related initiative might require more than one fiscal year to complete. Therefore, the program should permit multi-year initiatives.

Many of these initiatives deal with what is currently categorized as primary processing, which is not currently eligible under existing programs. Referring again to the European funding program, primary processing is eligible, which likely contributed to many of the technological advances in those jurisdictions. Given the mandate of 'modernization', a broad based program that includes acceptance of multiple applications for primary processing is required.

Through the assessment, it was indicated that there has been lack of participation in programs, such as FTNOP, due to lack of potential applicant awareness. Any new program must have an effective awareness campaign to ensure awareness particularly to small vessel and processing operators, supported by ground efforts of field staff.

To meet the needs of those who will be served, efforts must be made to enhance NL made technological solutions. While local technology providers serve the industry with many solutions in materials handling and off the shelf solutions from other manufacturers, there is an opportunity to have more technologically strategic solutions developed in NL. This been a driver of success in countries such as Iceland, due to collaboration between technology providers, research institutes and the industry. This has resulted in a fisheries technology industry that provides leading edge solutions for fishing enterprises, seafood producers, and other industries, around the world. The program requires the flexibility to deal with initiatives brought forward from researchers and manufacturers in order to encourage this expertise in equipment development.

The program must be robust, and able to accommodate changing environments, yet prescriptive enough to give adequate guidance regarding eligibility requirements. The program must provide timely turn around on projects and straightforward guidance for claims and reporting.

7.0 RECOMMENDATIONS

Improving the competitive position of the NL seafood industry should be done in a selective and strategic manner, as the industry appears to be at the early stages of transition due to a change in environmental regime occurring on the Grand Banks and northeast coast. There is broad agreement that this transition will result in significantly lower quantities of shrimp in the short term and reductions in availability of snow crab, while groundfish abundance is expected to increase in the long term. Whereas shrimp and crab comprised 68% of the landed value and 40% of the production value in 2013, impact from these species declines will be broad and significant.

Delivery of an infrastructure program must give consideration to the transitional state of industry while effectively preparing industry to meet the challenges of the future. Past infrastructure investments have addressed the needs of the industry at the time, and that is reflected in current world-class shrimp and crab capabilities, and the less competitive position in pelagics and groundfish where supplies in other jurisdictions are significantly higher.

Given that species, crab and shrimp, supply advantages are lost due to an environmental regime change, then an approach that permits industry to do more with supplies available is one ingredient to mitigate the impact from an environmental regime change. This would include by-product utilization, improvement of handling and processing methods, and producing higher-valued products. This results in moving the industry from a volume driven to a value driven model, of which there are several successful examples. Supplementary initiatives that expand on the value driven model should naturally evolve, expanding industry capabilities resulting in a sustainable, yet possibly at lower than current, industry output value.

The body of this report clearly illustrates the current capabilities of the industry, capabilities elsewhere, new and emerging technologies and the gaps remaining regarding handling practices and current technological capabilities. It is with the recognition of the transitional nature of the seafood industry in NL that the following recommendations have been developed.

Collaboration is required to develop a species transitional plan, strategic goals and establish investment priorities. There are numerous areas in each sector where advancements could be pursued to improve competitiveness; however, with limited program funds and uncertainties regarding the value of investing in certain sectors a collaborative approach in setting priorities is required. This will permit program managers to determine the general scope of investment required in each sector and priorities within each species of the sector.

Initial consultations should be completed with each the harvesting, processing and aquaculture sectors to develop species transitional plans and determine investment area priorities. Ongoing collaboration to determine sector specific strategies will be required as the infrastructure program funding threshold and criteria are more clearly defined. Once the program has been established, a committee comprised of governments and industry should continue to refine priority areas and monitor outcomes relating to the defined strategies.

It is recommended that the federal and provincial governments engage industry stakeholders to develop a comprehensive transitional plan from shellfish to groundfish.

Capacity matching should be considered in developing strategies. To realize the highest value for raw materials and finished product, supply chain logistics must be effectively coordinated. Using an improved supply chain model would require:

- Supply is harvested when intrinsic quality is best to meet demands of the market.
- Each species is harvested as economically as possible, while not compromising the quality of the species.
- Capacity to harvest does not exceed the capacity to process or hold the raw material without compromising product quality.
- Coordinating harvest and collection activities in advance minimizes collection costs.

It is recommended that DFA retain the services of the Marine Institute to summarize available information regarding harvesting and onboard handling methods required to land the highest intrinsic quality product for all key species. The outcome should define the best season, capture and handling method for each species and fleet sector.

Producing convenient consumer products to EU consumers can help sustain the shellfish sector. The extent and duration of shellfish stock reductions are unknown; however, the shrimp and crab sectors will remain an integral part of the NL seafood industry. Investments in technology for these species should be driven by changing consumer preferences and the opportunity provided by elimination of EU tariffs.

Shrimp markets in the UK are very mature, resulting in the species being in the decline stage of the product life cycle. To maintain or grow consumer interest in coldwater prawn, it is necessary to provide innovative product offerings that reflect the desires of modern and emerging consumer groups. Mid and high income consumers demand high quality, healthy and perhaps most importantly, convenient food. The need for convenience is due to consumer having more active lifestyles, which has reduced the amount of time available to prepare healthy and tasty meals at home.

UK consumer focus group and survey results support the assertion that convenience is paramount. Regarding shrimp, 79% of focus group participants indicate a preference for single portion multi-packs. In response to this preference, one large prawn distributor in the UK has introduced ultra low protective glaze multi packs in a retail window package, thus addressing all primary consumer desires.

Adopting this type of product concept on an industrial level with the objectives of maximizing asset utilization and realizing maximum return for products may result in a shrimp processing sector significantly different than the one that currently exists. The outcome of this concept, as an example, utilizing available technologies may result in the following:

- Producer's source local fresh and regional and foreign frozen supplies to produce cooked and peeled products on a year round basis.

- The primary product from fresh local supplies are small portion, sandwich sized, tear off multi packs with little glaze or salt added, delivered fresh in modified atmosphere packages that provide shelf life of more than 20 days.

- Second and third tier products are similar but provided from once frozen offshore industrial supplies or foreign shrimp supplies.

- Fourth tier products would be provided in similar packs but in a frozen format, perhaps with sauces mixed or provided separately in attached pouches.

Adopting this industrial operating concept, or other value added concepts, would require significant retooling of plant production capabilities. The production changes required in this example would require installation of thawing equipment, modifying peeling operations to handle small industrial size shrimp, and providing an integrated weigh, form, fill, gas, seal and package system.

> *It is recommended that, if feasible and desirable, cooked and peeled shrimp producers move toward a high value product model and diversify supply sources to sustain the sector and realize the best market returns.*

Snow crab is on the opposite end of the product life cycle spectrum from shrimp. Whereas European consumers have little or no knowledge of snow crab and there is very limited sales of this species currently, products are only in the developmental stage. What is known about consumer groups in Europe is that the markets are geographically segmented, with high income consumers in the northwest demanding convenience, southwest consumers are more accepting of shell-on less convenient product but have lower incomes, and eastern Europeans have no tradition of eating shellfish and have the lowest income levels.

The one certainty is that the opportunity to move snow crab away from a commodity product to a luxury product is much easier to do in a virgin market, especially a wealthy virgin market like Europe. The chance to upsell snow crab and realize sustainable economic returns will be contingent upon what products are developed to meet consumer needs, and how they are introduced to the market. Given what is known about consumer preferences geographically, product offerings may be meat or snap and eat in northwest Europe, snap and eat or sections in southwest Europe and perhaps no opportunities in eastern Europe. Of course, the major mitigating factor in developing EU snow crab markets is the recent growth of a new snow crab stock adjacent to Norway and Russia.

If snow crab values are to be maximized in the EU markets, there is first a need for further understanding of geographic consumer preferences, similar product forms, and competitive product prices. Subsequently, product concepts could be developed and determination of technology needs defined. Regardless of the outcome of clarifying market needs and product concepts, it is very likely that production methods would move more to convenient product formats such as meat, snap and eat pieces, split shell products, etc. Given future labour limitations, a high degree of mechanization would be required if these products are to be produced in NL. This necessity for mechanization could provide the impetus for expanding equipment design and fabrication capacity within NL.

It is recommended that a comprehensive assessment of EU markets for snow crab be completed. Further, it is necessary to determine the impact of Barents sea snow crab resources on the market.

A strategic plan to address increased volumes of groundfish should be completed. If the environmental regime change continues, increases in commercial quantities of cod, flatfish and redfish can be anticipated in the mid term, five years. If stock management of these species remains conservative, supplies should increase significantly after this initial five year period. The challenge is how to achieve the highest value from these renewed species using the best investment strategy.

To illustrate the impact of different approaches, an example using modern cod processing is provided. Given one highly mechanized cod production line (two filleting machines) has a capacity to produce 450-500 mt per week, 100,000 mt of cod could be processed with five lines if operating year round. At $7.5 m per line this would be a $37.5 m investment; however, this investment is $75.0 m if the fishery operates six months and $150.0 m if operating only three months.

As provided by this example, the strategy to address this one specific challenge has extremely different capital investment requirements, yet results in the same outcome of 100,000 mt of whole cod produced. This example illustrates the need to recognize and address issues related to capacity and seasonality prior to committing funds that impact the long term structure of the industry.

Similarly, investment in the harvesting sector must also be very strategic. It has been demonstrated that there are numerous technologies that can be employed to increase harvest rates, reduce crew requirements and improve quality of landed product. However, adopting these technologies broadly across the existing fleets could quickly exhaust the scope of funds that may be available for such a program. Further, the outcome would be increasing harvest capacity that far exceeds the resources available to harvest in the mid term. This excess capacity approach is discouraged in existing European funding programs, and must be a key consideration in structuring an infrastructure support program for the inshore harvesting sector.

It is recommended that a working group comprised of governments and sectoral representatives develop a strategy that achieves maximum value from renewed groundfish resources within the confines of existing structural challenges.

Many EU markets require third party food safety and sustainability certifications. As all shrimp producers in NL have come to realize, selling products into upscale EU markets require complying with very demanding buyer requirements such as MSC certification, and British Retail Consortium (BRC) food safety standards. Most key species adjacent to NL have been MSC certified or are in some phase of assessment. However, many producers outside the shrimp sector have not pursued BRC, or similar food safety certifications. These food safety program requirements are much more rigorous than Canadian standards and normally require significant structural changes to processing facilities.

It is recommended that an infrastructure program encourage and support producers to secure internationally recognized food safety certifications.

Capacity building within the research and manufacturing sectors should be supported. The assessment identified many technologies available from suppliers elsewhere. However, there are numerous examples of research initiatives resulting in commercial equipment developments in NL. Once strategic initiatives have been defined, collaborating with R&D centres of excellence and equipment manufacturers should be completed. There have been several initiatives identified which could be developed using local research and fabrication capabilities. The specific areas of focus should be both short term, such as materials handling, and long term, including robotics and vision systems.

With collaborative efforts between industry, R&D centres and fabricators, increased capacity to develop innovative seafood products and technologies will result. These innovations will provide competitive advantage in some areas, contributing to the modernization objective.

An excellent example of similar collaborative efforts is the Iceland Ocean Cluster, which has provided a wealth of research that has supported value chain improvements. Similar collaborative efforts with other jurisdictions have occurred recently, with C-Core now collaborating with centres of excellence in Ireland.

It is recommended that industry, academia and governments collaborate with the Iceland Ocean Cluster to establish a similar cluster approach in NL.

Define and support training requirements for technological advancement and groundfish processing skills. Successful implementation of new technologies will require technicians to develop the skills to operate and maintain the equipment. Depending upon how broad based some equipment is adopted training approaches will vary. The most effective means of providing support for technical training may be to develop the capacity within existing institutions in advance of supporting acquisition of new equipment. These individuals could be used to train large groups or provide on site training at one location. In instances when very few acquisitions of new equipment are anticipated, the supplier should be retained to provide training and support services as part of the purchase agreement.

As industry moves back to processing groundfish, there will be a need for training initiatives to ensure processing practices follow the best methods, and provide workers with the necessary skillset to be safe and competent in their abilities. There will be specific needs for some of the more skilled positions such as filleting, which will still be required for bycatch species and extra large fish, trimming and monitoring of food safety compliance requirements.

> *It is recommended that the DFA collaborate with educational institutes to define the training needs that will support technicians and groundfish processing workers. These institutes should subsequently improve their capacity in these areas and develop training workshops and courses.*

A strategy to recruit technically competent people to the industry must be implemented. It is generally recognized that a chronic labour shortage is imminent, and perhaps already exists. Whereas implementation of technology to address production worker shortages is a solution, there must likewise be a solution to address skilled trade labour shortages. Anecdotal information suggests many of the trade's people in the industry are the same age demographic as production workers. With more technology to be introduced, and much of this technology of a highly complex nature, demand for skilled trades will increase at the same time these trades people are exiting the industry.

A working group should be established including representatives from governments, trade colleges, the processing sector, aquaculture sector and offshore harvesting sector. The objective of this group should include identifying the scope of the challenge (number of trades people needed), skill sets required, determine if any recent graduates are working in the seafood sector, and skills specialties provided through programs currently delivered. This information should form the basis of defining a multi-faceted strategy to fill these skills deficiency.

> *It is recommended a working group be established to develop a strategy to address the anticipated trades people labour shortage.*

The infrastructure enhancement program must be broad based and respond to changes in species abundance. The components of the program should include:

- R&D and fabrication capacity building.
- Broad based implementation of new technologies.
- Value chain improvement.
- Training support.

Both provincial and federal representatives that are well versed in the seafood sector should provide program oversight including establishing basic principles, monitoring program performance against the principles and changing needs of industry.

Program implementation could be completed using existing funding agencies that would have a broader mandate. Both FTNOP and ACOA have the required expertise, and with additional resources for the term of the program could successfully manage and deliver the funds available. Establishing a project funding threshold, $250,000, could be used to delineate the roles of each agency with FTNOP managing project funded to $250,000 and ACOA manage funding projects >$250,000. Field resources and technical support personnel should be used jointly by both agencies to ensure consistency and reduce the amount of time to build the required expertise.

The program should provide 30%-40% funding support, perhaps scaled to higher levels to encourage participation by smaller enterprises and producers. Support services should be provided by field personnel, particularly for small enterprises and producers which may lack the time or experience to make application, submissions and claims.

It is recommended a multi-faceted infrastructure program be implemented that provides 30%-40% funding scaled higher for small enterprises and producers.

APPENDIX I CONTACTS

Newfoundland and Labrador Processors

Contact Name	**Affiliation**
Karl Sullivan	Barry Group Inc.
Chris Pilgrim	Barry Group Inc.
Gregg Hardy	Quin Sea Fisheries Limited
Edgar Coffey	Cape Broyle Sea Products Limited
Vaden Oram	Terra Vista Limited
Jason Eveleigh	Notre Dame Bay Seafoods
Blaine Sullivan	Ocean Choice International
Ken Budden	Fogo Island Co-op Society Limited
Gilbert Linstead	Labrador Fishermen's Union Shrimp Company
John Head	Happy Adventure Sea Products
Robin Quinlan	Quinlan Brothers Limited
Gabe Gregory	Quinlan Brothers Limited
Paul Grant	Beothic Fish Processors Limited
	Bay Roberts Seafoods Limited
John Osmond	Codroy Seafoods Inc.
Chris Payne	Harbour Seafoods Limited
Rod Butt	Golden Shell Fisheries Limited
Brian Collier	Woodman's Sea Products Limited
Todd Young	3 T's Limited
Ross Butler	Hermitage Processing Inc.
Keith Watts	Torngat Fish Producers Co-op Society
Pete Crocker	Torngat Fish Producers Co-op Society
Graham Hiscock	Independent Fish Harvesters Inc.
Randy Barnes	Breakwater Fisheries Limited
Alberto Wareham	Icewater Seafoods Inc.
Andy Schnare	Northern Lights Seafoods Inc.
Kevin Wadman	Avalon Ocean Products Incorporated
Sean Allen	Allen's Fisheries Limited
Derek Green	Green Seafoods Limited
David Walsh	Atlantic Ocean Farms Limited
Finfish Aqua Contacts	Cold Ocean Salmon Inc. Northern Harvest Sea Farms NL Ltd Nova Fish Farms Gray Aqua Group Ltd
Shellfish Aqua Contacts	Badger Bay Mussel Farms Ltd B&B Farms Ltd LBA Enterprises Ltd Notre Dame Bay Mussel Farms Ltd Sunrise Fish Farms Inc.

Association Representatives

Contact Name	Affiliation
Derek Butler	ASP, St. John's, NL
Mark Dolomount	Professional Fish Harvesters Certification Board
George Joyce	SPNL, St. John's, NL
Dave Decker	FFAW, St, John's NL
Keith Sullivan	FFAW, St. John's, NL
Bill Broderick	FFAW, St. John's, NL
Harvey Jarvis	FFAW
Kevin Hardy	FFAW
Mildred Skinner	FFAW
George Feltham	FFAW
Tony Doyle	FFAW
Wayne Masters	FFAW
Gilbert Penney	FFAW
Joan Doucette	FFAW
John Boland	FFAW
Bruce Button	FFAW
Nelson Bussey	FFAW

Other Jurisdictions

Contact Name	Affiliation
Sverre Johansen	Assistant Director, Norwegian Seafood Federation
Lief Akse	Senior Scientist, NORFIMA, Norway
Christina Burridge	Executive Director, BC Seafood Alliance
Gunner Thordanson	Regional Manager, MATIS, Iceland
Sveinn Margeisson	CEO MATIS, Iceland
Alex Oliveira	Technical Program Director, Alaska Seafood Marketing Institute
Brad Pettenger	Director, Oregon Trawl Commission
Bob Hannah	Biologist, Oregon Department of Fish and Wildlife
Mike Montgomerie	Gear Technologist, Seafish, UK
Kathy Jacobson	Marine Fisheries Educator, Sea Grant, Oregon
Vegar Johansen	Research Director Fisheries Technology, SINTEF, Norway
Paul Gialason	CEO, Ocean Excellence, Iceland
John Fagan	Seafood Technologist, Bord Iascaigh Mhara, Ireland
Ian Mannix	Business Development Advisor, Bord Iascaigh Mhara, Ireland
Mark Stichert	Alaska Department of Fish and Game , Kodiak Office
Khristian Helgarson	Icelandic Ministry of Fisheries
Doug Heater	Manager, Bornstein Seafoods, Oregon
Emanuel Rosing	Director of Fisheries - Government of Greenland
John Burt	Royal Greenland , NL

Process Technology Suppliers - Other Jurisdictions

Contact Name	Affiliation
Dennis Crane	C&W Industrial, Bay Bulls
James Doyle	C&W Industrial, Bay Bulls
Gary Kananagh	Martak Canada, Paradise , NL
Bob Courage	Baader Canada , St. John's, NL
Thorir Einarsson	Baader North America, Aubrun, WA USA
Rob MacIntyre	Marel Canada, Halifax, NS
Kristman Kristmannson	Marel Iceland
Bain Blois	Blois Fish Processing Automation, Halifax
Garrett Fine	Laitram Machinery,Harahan, LA
Trausti Eiriksson	Traust Know How, Iceland
Kaj Christensen	KM Machinery, Denmark
	KM Machinery, Denmark
Ingolfur Arnason	Skaginn, Iceland
Ralph Astrup	Cabinplant, Denmark
Blair Shelton	Wise Dynamics, Halifax, NS
Carl Beaulieu	Cube Automation, New Brunswick.
Gudmunder Jon Matthiasson	Optimar, Iceland
Trobjorn Tronden	Cool Nova, Norway
Don Vokey	e-Sonar, St. John's
Con Dunphy	Atlantic Electronics, Mount Pearl
Bill Coady	CME Electronics, St. John's
Dean Bartlett	Vonin, Port de Grave
Dave Kelly	Spaniards Bay
Ron Coady	North Atlantic Marine Services
Morgan Snook	North Atlantic Marine Services
Jahn N Hoel	Mustad Longline, USA
Aqua Supplier Contacted	Fab Tech Industries Incorporated Go Deep International Newfoundland Aqua Services Northeast Nutrition Inc Novartis Animal Canada Inc SIMCorp Marine Environmental Inc

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Alaskan Fishing Machines/OILWIND : http://www.ptialaska.net/~mythosdk/AFM/

ARENCO VMK ; http://www.arenco.com/fish/

Baader Food Processing Machinery : http://www.baader.com/en/

Baader Island ehf : http://www.baader.is/e%20is%20machines.htm

Bank of Canada : http://www.bankofcanada.ca/rates/exchange/10-year-converter/?page_moved=1

BASIS International : http://www.isholf.is/basis/Products.html

bluwrap : http://www.bluwrap.com/

British Columbia Ministry of Agriculture and Lands: http://www.agf.gov.bc.ca

British Columbia Salmon Farmers Association: http://www.salmonfarmers.org .

Cabinplant : http://www.cabinplant.com/

Canadian Aquaculture Industry Alliance: http://www.aquaculture.ca .

Canadian Food Inspection Agency: http://www.inspection.gc.ca.

CMP : http://www.cmpequipment.com/

COOLNOVA : http://coolnova.org/

Curio : http://www.curio.is/

C&W Industrial Fabrication and Marine Equipment : http://www.cwindustrial.com/#start

Department of Fisheries and Oceans. http://www.dfo-mpo.gc.ca

Department of Fisheries and Aquaculture : http://www.fishaq.gov.nl.ca/

Department of Fisheries and Oceans : http://www.dfo-mpo.gc.ca/stats/aqua/aqua-prod-eng.htm

DNG Jigging Reel : http://www.dng.is/static/files/dng-c6000i-brochure.pdf

European Commission Fisheries : http://ec.europa.eu/fisheries/cfp/emff/index_en.htm

FAO http://www.fao.org/fi/agreem/codecond/codecon.asp

Gov.UK : https://www.gov.uk/government/collections/fishing-vessel-licences

KM Fish Machinery : http://www.km-fish.dk/

KORREKT FANGST BEHANDLING OM BORD I FISHKEFARTOY :
http://fangstbehandling.no/?p=5&lang=eng

Laitram : http://www.laitram.com/

luciano cocci : http://www.cocci.it/

marel : http://marel.com/

martak : http://martak.is/en

Mustad AUTOLINE : http://mustadautoline.com/products/select_fish/

New Brunswick Department of Agriculture, Fisheries and Aquaculture: http://www.gnb.ca.

Newfoundland & Labrador Aquaculture Industry Association http://www.naia.ca

Agriculture and Agri Food Canada : http://www.agr.gc.ca

NOAA : http://www.st.nmfs.noaa.gov/commercial-fisheries/fus/fus13/index

Nofima : http://nofima.no/en/

Nordic Supply Systems AS : http://www.nordicsupply.no/default.aspx?menu=38

NORTHWESTERN : http://fvnorthwestern.com/the-social/alaskan-fishing-101/

OILWIND : http://www.oilwind.fo/

Precision Seafood Harvesting : http://www.precisionseafoodharvesting.co.nz/

Prince Edward Island Aquaculture Alliance : http://www.aquaculturepei.com

RYCO : http://rycous.com/contact

SaveWave B.V. / Shellfish Saver http://shellfishsaver.com/

Seafish : http://www.seafish.org/publications-search

SeaSide: http://www.stansas.no/default.aspx?menu=25&id=35

Skaginn : http://www.skaginn.is/

SINTEF : http://www.fishinggearnetwork.net/wp-content/uploads/2013/06/Effective-catch-handling-systems-for-cod-haddock-and-Saithe1.pdf

Statistics Iceland : http://www.statice.is/

Statistics Norway : http://www.ssb.no/

STYLE INTERNATIONAL : http://www.style.is/

TrackWell : http://www.trackwell.com/?lang=en

US Commercial Landings : http://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus13/02_commercial2013.pdf

Valka : http://valka.is/

APPENDIX III NL FUNDING PROGRAMS

Department of Fisheries and Aquaculture (DFA)

Fisheries Technology New Opportunities Program (FTNOP): The primary objective of the program is to provide support for harvesting, processing, aquaculture development and marketing initiatives in order to diversify and increase the overall viability of the Newfoundland and Labrador seafood industry. This program is intended to aid the provincial fishing and aquaculture industry become more innovative and competitive, while building a safer and more stable foundation.

- Focus on research and development work in harvesting and processing sectors and growth in strategic areas of the aquaculture industry.
- The maximum contribution for any one project will not exceed $100,000. Projects initiated by DFA may be funded to 100%.
- Projects initiated by non-profit institutions, associations or community groups may be funded up to 100% of cost (depending on partnership contributions from other funding agencies), inclusive of contracted labour, material and supplies. In all proposals, there should be a demonstration of solid industry partnership and commitment to projects. This would be demonstrated through the provision of some partial funding, labour, or raw material costs, etc.
- The level of contribution for industry-led projects will vary by project, depending on factors such as: the level of risk to the applicant, the potential for broad industry application, and the nature of the applicant’s contribution, but will not normally exceed a maximum of 60% of eligible expenses.
- FTNOP funding does not replace existing administrative or overhead expenditures of any applicant.
- Eligible activities include,
    - recovery of discard
    - alternative harvesting, processing and aquaculture technology
    - pilot project
    - test fisheries
    - resource surveys
    - gear demonstrations
    - product development
    - market research /development and promotion
    - quality improvement
    - safety initiatives
    - energy efficiency initiatives
    - development of new growing areas

- promoting sustainable development

Research & Development Corporation (RDC)
The RDC offers four programs that are relevant to the seafood sector, either through institutional or corporate initiatives.

R&D Vouchers Program: This program Provides businesses with improved access to technical expertise and facilities required to support their research and development (R&D) activities.

- Eligible R&D providers are research institutes, academic institutions and laboratories.
- Provide up to 75% of eligible project costs to a maximum of $15,000 per project. The applicant must contribute the remaining 25% of eligible project costs.
- Eligible activities include applied R&D, prototyping, performance testing against pre-determined criteria, field trials and small-scale demonstration projects.
- Can be used to expand the reach of operations and engage external resources that the business would not normally be able to access, including expertise, infrastructure and equipment.
- Eligible applicants are innovative businesses, located in NL, with R&D needs and high growth potential.
- Eligible costs include facilities, materials, equipment access fees, related technical support and specialized consulting services in support of business research and development needs.
- Related equipment for the research provider may also be eligible.
- Software licensing or purchases, training courses, marketing related activities, standard contract services, and major capital purchases and internal salaries for the business are ineligible costs, as are those incurred prior to receipt of application by RDC.
- The maximum duration of any project is one year.
- All projects must commence within three months of approval.

R&D Proof of Concept: The objective of this program is to reduce the technical and financial risk of pre-commercial research and development (R&D) projects for businesses where R&D is required to realize the commercial potential of innovative products, processes or services.

- Eligible applicants are innovative businesses, located in Newfoundland and Labrador, with pre-commercial R&D needs and high growth potential.

- Funds up to 75% of the eligible project costs of R&D projects, to a maximum non-repayable contribution of $250,000 per project.

- Eligible activities include applied R&D, prototyping, performance testing against pre-determined criteria, field trials and small-scale demonstration projects.

- Eligible costs include incremental, out-of-pocket costs specific to the project including salaries for new R&D positions, specialized equipment, technical services, access to test facilities and equipment, field trials, project-specific technical expertise, minor renovations (maximum 20% of the contribution), project-related travel costs, intellectual property and patent protection, materials and other costs that support R&D.

- In some instances, existing salaries may be eligible if key project management or lead technical staff are required for the project. This exception is limited to no more than two positions and these salaries may only be supported at a contribution rate of up to 50% by RDC.

- Land, new buildings, marketing activities, administrative overhead and other costs unrelated to the specified R&D activities are ineligible costs, as are those incurred prior to receipt of application by RDC.

- The maximum duration of any project is 18 months.

- The project must commence within six months of approval.

Industrial R&D Fellowships (IRDF): The Natural Sciences and Engineering Research Council of Canada (NSERC) Industrial R&D Fellowships (IRDF) program provides financial support to companies to hire recent doctoral (PhD) graduates in support of their research and development (R&D) activities.

- The goal is to enhance industry capacity as an R&D performer, a key driver behind innovation and business growth

- Builds on existing programs at NSERC and the Atlantic Canada Opportunities Agency (ACOA) to enable small and medium-sized companies to enhance their R&D capacity. Through IRDF, RDC will partner with NSERC to enable Newfoundland and Labrador companies to hire recent PhD graduates in support of research and development. ACOA may also provide financial support to successful applicants through its Business Development Program (BDP).

- RDC will provide up to $30,000 a year for a maximum of two years in support of the fellowship.

Ocean Industries Student Research Awards: While this is not a business funding program, students are required to have industry collaboration. The program is a way for industry to have work completed by Masters and Doctoral students at MI, MUN or CAN.

- Designed for post-secondary undergraduate and graduate students in Canada and around the world who are interested in pursuing ocean industries-related studies and research in Newfoundland and Labrador at Memorial University, its Marine Institute, or the College of the North Atlantic.
- Relevant fields of study include areas such as offshore petroleum engineering, geoscience, ocean engineering, ocean technology including marine transport, fisheries, aquaculture, and other areas such as marine science that support R&D, innovation and the commercialization of ocean technologies.
- This year, RDC has introduced a new aspect to the OISRA award structure: students receiving awards at the Master's and Doctoral level are required to have industry collaboration involved with their research. This change came from recognizing the need to increase student engagement in Newfoundland and Labrador's ocean industries. This requirement will strengthen relationships between the business community and academia, as well as open up potential career opportunities.
- Provides up to $20,000 per year for 2 years for Masters Students, with $1,500 to the Research Supervisor.
- Provides up to $30,000 per year for Doctoral Students for 3 years (can be extended to 4 years), with $3,000 to the Research Supervisor.
- RDC awards are supplemental to all other awards, up to maximum in total annual awards of $35,000 at the Master's level and $50,000 at the Doctoral level.
- Eligibility is related to academic achievement, technological merit of the research plan, and relevance to industries.

Canadian Centre for Fisheries Innovation

Mandated to stimulate and support development of the aquaculture, fishing, and fish processing industries through research and development projects that focus on opportunities and problems in those industries and draw on the people and facilities of Memorial University of Newfoundland (MUN), the Marine Institute (MI), and other academic institutions.

- In the set-up of CCFI, MUN and MI agreed to reduce their charges for overhead costs from 65% to 30% of direct costs for projects in which CCFI is involved.
- Projects typically involve working with at least one industrial partner and undertaking research, developing and/or demonstrating new products, processes, or technologies, or disseminating new information.
- Overall goal is to encourage economic development by improving the international competitiveness, viability, and sustainability of the industries.
- Works at the intersection of industry need, academic institution capability, and government funding programs.

- Play the role of a catalyst, identifying industry needs and priorities and helping to initiate, fund, and/or manage research and development projects in response.

- Projects can be strategic or tactical in nature and can be initiated either by the industry or CCFI.

- The main criteria for initiating or supporting individual projects are:

  - ✓ importance to the industry,
  - ✓ potential impact,
  - ✓ innovation, and
  - ✓ likelihood of success.

- CCFI currently receives funding from DFA, approximately $1 million annually. Approximately 50% of CCFI's funding is used for administrative costs.

- CCFI leverages funding from other partners, including industry, federal and provincial governments. According to CCFI, in the last three years the leverage ratio has been 6.8:1.

Atlantic Canada Opportunities Agency (ACOA)

ACOA provides two programs relevant to the seafood industry, the Atlantic Innovation Fund (AIF) and the Business Development Program (BDP).

Atlantic Innovation Fund (AIF): The AIF focuses on R&D projects in the area of natural and applied sciences, as well as in social sciences, humanities, arts and culture, where these are explicitly linked to the development and commercialization of technology-based products, processes or services.

- Eligible applicants include private sector businesses, universities and research institutions.

- Federal and provincial departments, including government research laboratories and institutes, are not eligible for funding.

- Projects must:

  - ✓ demonstrate significant economic benefits for Atlantic Canada;
  - ✓ demonstrate the commercialization potential of the project;
  - ✓ support new or improved technologies or new applications of technologies;
  - ✓ have adequate financing for the duration of the project;
  - ✓ be incremental; and
  - ✓ support one or more strategic sectors or technologies.

- While not an absolute requirement, the AIF favours projects with a combination of the following desirable criteria:

  - ✓ includes private sector participation (for institutional proposals);
  - ✓ fills a gap in the Atlantic system of innovation;
  - ✓ improves the innovation capacity of private sector;

- ✓ is pan-Atlantic in scope;
- ✓ builds critical mass through networks or cooperation of existing or additional talent (researchers);
- ✓ leverages funding from other public and private sector sources;
- ✓ attracts new firms, institutions and researchers to Atlantic Canada;
- ✓ builds on research excellence; and
- ✓ fosters national and international affiliations.

- Eligible costs could include wages, salaries, capital costs and other operating expenses directly related to the research project.
- The fund can provide assistance of up to 80% of total eligible costs for projects led by not-for-profit organizations and up to 75% of total eligible costs for private sector-led projects.
- Private sector applicants seeking funding of $1,000,000 or less are not eligible under the AIF. Private sector applicants seeking funding of $1,000,000 or less for an innovation project may be eligible under other programs such as ACOA's Business Development Program.
- Contributions to the private sector are conditionally repayable based on the commercial success of a project.
- Contributions to not-for-profit organizations are non-repayable.

Business Development Program (BDP): The BDP is structured to assist in business set ups, expansions or modernizations. Relevant to the seafood sector, this program has been used to secure capital loans for equipment to increase competitiveness, capital contributions for innovative projects, and market research or promotion.

- Focus is on small and medium-sized enterprises, the BDP provides access to capital in the form of interest-free, unsecured, repayable contributions.
- Not-for-profit organizations that provide support to the business community may also qualify for non-repayable assistance.
- ACOA can provide an unsecured, interest-free loan towards the eligible costs of a new establishment, expansion, modernization or a project, which improves competitiveness.
- Contribution is repayable on a time schedule tailored to circumstances.
- Costs eligible for up to 75% financing include:
    - ✓ Marketing: Includes the development of a marketing plan, the hiring of marketing expertise to implement the plan, and related marketing activities such as labeling, packaging, promotional materials, advertising, product demonstrations and participation at trade shows.
    - ✓ Training: Includes the development of a training plan, the hiring of training expertise to implement the plan and related activities such as training materials, seminar fees, and wages during the time that employees received off-the-job training.

- ✓ Productivity/Quality Improvement: Includes the development of a productivity or quality improvement plan, the hiring of expertise to implement the plan, and related activities such as obtaining a recognized quality certification such as ISO, and the cost of needed technical equipment.
- ✓ Innovation: Includes costs related to researching and developing new or improved products, services and processes such as the labour costs of expertise, materials, special equipment, testing and patents.
- ✓ Consultant Advice: Includes the cost of hiring a qualified consultant to prepare a business plan, feasibility study, investigate licensing opportunities, conduct a venture capital search, technology transfer search or provide advice to improve your business skills.
- ✓ Business proposal development: Includes the cost of turning your idea into a viable business proposal, such as the completion of feasibility study, prototype development, and gathering information on markets and raw material suppliers. Maximum contribution is $10,000 for this activity.

- ➢ ACOA aims to process business proposals and make a decision on an application within a reasonable amount of time. An acknowledgement letter is sent to proponent within ten business days of receiving a signed and completed application, which will provide the name and contact information of the account manager or of an ACOA official who can provide any follow-up information or guidance.
- ➢ Eligible costs may include:
  - ✓ labour costs for engineers, scientists, technicians, draftsmen, market analysts, researchers and shop labour essential to the project;
  - ✓ materials purchased specifically for the project or issued from your inventory and used to produce sample products, prototypes or pilot plants;
  - ✓ special-purpose equipment purchased or constructed exclusively for your project, and associated rental and lease costs;
  - ✓ travel costs incurred solely for your project, excluding entertainment costs;
  - ✓ costs related to defining specifications of your products, service or process, including the use of sub-contracts and consultants;
  - ✓ other allowable costs include: testing services, patents, leased space, acquiring the rights to a technology, the preparation of a first-user manual, and marketing and feasibility studies;
  - ✓ acquisition of leading edge technology that is new to the applicant and will improve performance and productivity.

National Research Council (NRC)

Industrial Research Assistance Program (IRAP): Through IRAP, the NRC provides financial support, advisory services, networking and linkages, and a youth employment program.

- Provides financial support to qualified small and medium-sized enterprises in Canada to help them undertake technology innovation.
- The basic eligibility criteria for IRAP funding are:
  - ✓ Must be a small and medium-sized enterprise in Canada, incorporated and profit-oriented;
  - ✓ have 500 or fewer full-time equivalent employees; and
  - ✓ must have the objective to grow and generate profits through development and commercialization of innovative, technology-driven new or improved products, services, or processes in Canada.
- Advisory Services are provided to clients through all aspects of the innovation process, from concept to commercialization.
- Clients have access to the NRC's networks.

Agriculture and Agri-Food Canada (AAFC)

AgriMarketing Marketing Program: This five-year program began in 2013, under Growing Forward 2, with the objective to improve the agriculture, agri-food and agri-based products sector's competitiveness in domestic and international markets by supporting industry in gaining and maintaining access to markets and capitalizing on market opportunities (this includes fishing and aquaculture industries). It will achieve this objective through activities grouped into four streams:

- ✓ Breaking down trade barriers;
- ✓ Building market success;
- ✓ Market development; and
- ✓ Assurance systems.

- Both Market Development and Assurance Systems are contribution funding streams that support industry-led projects, for which industry applications will be accepted:
- The market development stream seeks to build and promote Canada's ability to expand domestic and export markets by undertaking promotional activities to help position and differentiate Canadian products and producers, and ensure industry's ability to meet market requirements.
  - ✓ The maximum AAFC contribution to a successful not-for-profit applicant normally will not exceed $2.5 million per year.
  - ✓ The maximum AAFC non-repayable contribution to SMEs for eligible projects that are intended to allow profits or increase the value of the business will not exceed $50,000 per year.
  - ✓ For both types of applicants, the maximum AAFC contribution normally will not exceed 50% of total eligible costs. However, AAFC funding levels may be adjusted

upwards where activities are aimed at expanding into new markets and downward where activities are aimed at established market maintenance. The applicant's contribution must be in the form of cash.

- The assurance systems stream seeks to support the Canadian agriculture, agri-food and agri-based products industry to meet buyer and market demands for assurance and to enhance its competitiveness through support for development of Canadian national assurance systems or standards, such as food safety systems, animal and plant health surveillance systems, market attribute/quality standards and traceability systems, and their related tools.

    - ✓ The maximum AAFC contribution normally will not exceed $1,000,000 per project.
    - ✓ A minimum 25% contribution to eligible costs is expected from applicants and can include both in-kind contributions and cash. In-kind contributions cannot exceed 10% of total eligible costs.
    - ✓ Government funding, from all sources (municipal, provincial, federal), is limited to 85% of total eligible costs for a project. The remaining portion of eligible costs must be cost-shared with the Applicant through cash or in-kind contributions.

Fisheries and Oceans Canada (DFO)

Aquaculture Collaborative Research & Development Program (ACRDP): The objective of ACRDP is to increase the level of collaborative research and development activity between the aquaculture industry and the department. The ACRDP teams industry with DFO researchers to undertake research activities that lie within the mandate of DFO but are based on the needs and priorities of the aquaculture industry.

- The key goals of the program are to:
    - ✓ Improve the competitiveness and sustainability of the Canadian aquaculture industry;
    - ✓ Increase collaborative research between the department and industry;
    - ✓ Facilitate the process of technology transfer and knowledge mobilization; and
    - ✓ Increase scientific capacity of the Canadian aquaculture industry for essential aquaculture research and development.

- The broad R&D objectives under which ACRDP projects may be considered are optimal fish health and environmental performance.

- The minimum industry contribution is 30% of the ACRDP amount requested, at least 7.5% of which must be a cash contribution.

- Expenses covered by ACRDP include:

    - ✓ Wages and salaries plus associated required payroll benefits of project personnel (scientific and technical) or post-doctoral or graduate student support;
    - ✓ Equipment directly related to the work. (Equipment purchased using ACRDP funding remains the property of DFO);
    - ✓ Laboratory and field supplies;

- ✓ Travel costs directly related to the goals of the project;
- ✓ Other expenses agreed to be necessary to the success of the project.

APPENDIX IV R&D CENTERS

One of the key findings of the assessment is the part that various research institutes play in the advancement of the fisheries and aquaculture sectors in their respective countries. The following is an overview of some of those institutes.

Iceland

MATIS- Icelandic Food and Biotech R&D. Matís is a government owned, independent research company, founded in 2007 following the merger of three former public research institutes. The organization pursues research and development aligned to the food and biotechnology industries, as well as providing Iceland's leading analytical testing service for public and private authorities.

Matís' vision is to increase the value of food processing and food production, through research, development, dissemination of knowledge and consultancy, as well as to ensure the safety and quality of food and feed products.

Matís employs approximately 100 staff in offices, laboratories or Food Innovation Centers located in 9 cities or towns around Iceland. The project turnover in 2012 was around $USD 11 million, of which 30% comes from the Icelandic Government.

Norway

NOFIMA - **Norwegian Institute of Fisheries and Aquaculture**, Norwegian Institute of Fisheries and Aquaculture. NOFIMA is one of the largest institutes for applied research within the fields of fisheries, aquaculture and food research in Europe. The institution was established in 2008 and has approximately 380 employees and customers from 49 different countries. The turnover in 2013 was 506 million USD. *Nofima was created through a merger of the former institutes Matforsk, Fiskeriforskning, Akvaforsk and Norconserv. The main shareholder is the State (Ministry of Trade, Industry and Fisheries) with a 56.8 % shareholding. The other shareholders are The Agricultural Food Research Foundation (33.2 %) and Akvainvest Møre og Romsdal (10 %).* The organization supplies internationally renowned research and solutions that provide competitive advantages along the complete chain of value. NOFIMA has several laboratories and pilot plants, which are used for specific research in the fields of food, fisheries and aquaculture. The facilities make it possible for the industries to carry out experiments and to test production methods.

SINTEF - Foundation for Scientific and Industrial Research. SINTEF , the "Foundation for Scientific and Industrial Research" was established at the Norwegian Institute of Technology (NTH) in Trondheim in 1950 and expanded rapidly in the following years. SINTEF is a broadly based, multidisciplinary research concern that possesses international top-level expertise in technology, medicine and the social sciences, and our aim is to become the most renowned contract research institution in Europe. SINTEF Fisheries and Aquaculture has broad expertise and knowledge in utilizing renewable marine resources. The institute will contribute to find solutions to challenges along the entire marine value chain - from biological basis for marine production through aquaculture and harvesting to processing and distribution.

SINTEF Fisheries and Aquaculture has broad expertise and knowledge in utilizing renewable marine resources. The institute will contribute to find solutions to challenges along the entire marine value chain - from biological basis for marine production through aquaculture and harvesting to processing and distribution. SINTEF also acts as an incubator for new industrial companies. In 2013, they were involved in the commercialization of eighty different SINTEF technologies, through licensing agreements and the establishment of new companies.

Fisheries and Aquaculture provide funding and/or support services in the following area:

- Fisheries Technology: vessel and equipment research, safety in the fishing fleet.
- Aquaculture Technology: aquaculture structures, land-based facilities, management and operation as well as traceability of marine products.
- Process Technology: process technology, processing of marine raw materials to consumer products, feed and ingredients.
- Marine Resources Technology**:** Modeling of marine systems, new species in aquaculture, marine bio prospecting.
- Research Based Consulting: National and international advisory services for companies and public administration.

Denmark

The Danish Technological Institute. The Danish Technological Institute is a self-owned and not-for-profit institution. They develop, apply and disseminate research- and technologically-based knowledge for the Danish and International business sectors. Participating in development projects, which are of use to society in close collaboration with leading research and educational institutions both in Denmark and abroad.

Danish Technological Institute is one of the world's largest private institutes to supply technological services such as consultancy, tests, certification and training for companies and public-sector organizations. The Institute employs experts under the auspices of the eight divisions that define the main parameters for their work.

Key Figures 2013:

- Turnover, million EUR: 145 (181 million USD)
- Danish commercial turnover, million EUR: 100
- R&D activities, million EUR: 64.2
- Performance contracts, million EUR: 14.7

- Employees: 1051

An important task is to ensure that new knowledge and technology quickly can be converted into value for our customers in the form of new or improved products, materials, processes, methods and organizational structures.

Danish Technolgy Group/Association: The Danish Fish Tech Group (DFITG) represents a wide range of Danish suppliers within the international fishing equipment industry. Our members are specialized in e.g. plate freezers, trawl doors, complete propulsion systems, marker buoys and vacuum pumps.

DFITG has been divided into three subgroups each specializing in a specific part of the industry:

- Catch instruments
- Processing industry
- Fish farming

Some notable Danish process equipment suppliers include Fomaco A/S, Interaqua, Cabinplant A/S and Kimpex.

Ireland

Bord Iascaigh Mhara (BIM). Bord Iascaigh Mhara (BIM) helps to develop the Irish Seafood Industry by providing technical expertise, business support, funding, training *and* promoting responsible environmental practice. Our technology experts can advise you on new fishing and fish farming opportunities using technical innovation, and gear modifications and other Technical Conservation Measures (TCMs) and trials.

BIM's mission is to grow a thriving Irish seafood industry; expand the raw material base, add value and develop efficient supply chains that together deliver on the Government's Food Harvest 2020 targets for seafood and create sustainable jobs. BIM's Vision is to create a scaled Irish seafood industry capitalising on the growing opportunities for seafood in global markets and providing sustainable employment in our coastal communities. The Seafood Development Centre (SDC) fosters innovation and assists seafood businesses to develop new products and processes. The technology experts can advise on new fishing and fish farming opportunities using technical innovation, and gear modifications and other Technical Conservation Measures (TCMs) and trials. BIM's business development advisors can help you with product development, improving the efficiency of your processes, adding value through product labelling and setting up food safety systems. BIM also assists with developing skills with training in fishing, fish farming and seafood processing.

NL Vessel and Harvest Technology

HARVESTING

Company / Enterprise Name

Home Port?

How many vessels does your enterprise operate?

What size is your vessel?

	0 - 34'11"	35' - 64'11"	65' - 99'11"	>100' Offshore
Vessel 1				
Vessel 2				
Vessel 3				
Vessel 4				
Other				

How many crew on each vessel category?
Indicate by categories selected above

What is the age of your vessel(s)?
Indicate by categories selected above.

What species do you fish?

- Groundfish
- Snow Crab
- Shrimp
- Pelagics
- Whelk
- Sea Cucumber
- Lobster
- Clams
- Other:

Does your vessel have a fish finder?

- ◯ Yes
- ◯ No
- ◯ Other: ____________

Does your vessel have net minding technology?

- ◯ Yes
- ◯ No
- ◯ Not Applicable
- ◯ Other: ____________

Does your vessel have a shelter deck?

- ◯ Yes
- ◯ No
- ◯ Other: ____________

Does your vessel have an auto hauler?

- ◯ Yes
- ◯ No
- ◯ Other: ____________

What method(s) is used to cool product?

Check more than one if applicable.

- ☐ Slurry System
- ☐ Ice / Water mix
- ☐ Dry Ice
- ☐ Other: ____________

What type of holding is on-board?

Check more than one if applicable.

- ☐ Refrigerated Dry Hold
- ☐ RSW
- ☐ Insulated Boxes
- ☐ Pan Boxing
- ☐ Bulk
- ☐ Live Holding
- ☐ Other: ____________

Does your vessel have fuel monitoring system?

This system lets you monitor fuel consumption while fishing.

- ◯ Yes
- ◯ No

Does your vessel have any of the following stabilizing / energy efficiency technologies?

Does your vessel have any of the following stabilizing / energy efficiency technologies?

- ☐ Bulbous Bow
- ☐ Stabilizer Fins
- ☐ Anti - Roll Tank

Other types of energy saving technologies or approaches?

Modifications to engine, propellor,etc, 2 stroke vs. 4 stroke engines, etc

Have you invested in any safety related technologies?

- ○ Yes
- ○ No

Describe any safety related technologies and approaches you have invested in.

Have you invested in research and development to improve your gear performance? (how recently)

- ☐ Past 2 years
- ☐ Past 5 years
- ☐ None

Have you invested in new technology?

- ☐ Past 2 years
- ☐ Past 5 years
- ☐ None

If you invested in new or innovative technology, please describe?

Have you recieved funding to assist in R&D or technological innovation?

- ☐ Yes
- ☐ No

Are there factors that limited your ability to invest in new technologies?

Are you aware of new technology that would improve the economics in your sector?

- ◯ Yes
- ◯ No

What new technologies could improve your fishing performance?

What factors will influence your decision to invest in new technology in the future?

- ☐ Improved quality
- ☐ Improved productivity
- ☐ Return on Investment
- ☐ New Species
- ☐ Safety
- ☐ Other:

Do you plan on investing in new technology in the future? (when)

- ◯ Next 2 years
- ◯ Next 5 years
- ◯ No

Would cost shared funding programs influence your decision to invest?

- ◯ Yes
- ◯ No

Add item

After page 1 Continue to next page

Page 2 of 10

Untitled Page

Do you fish groundfish?

- ◯ Yes
- ◯ No

Add item

After page 2 Continue to next page

Page 3 of 10

Page 3 of 10

Groundfish

What species groundfish do you fish?
Check more than one if applicable

- ☐ Cod
- ☐ Haddock
- ☐ Pollock
- ☐ Hake
- ☐ Atlantic Halibut
- ☐ Greenland Halibut (Turbot)
- ☐ Lumpfish
- ☐ Ocean Perch (Redfish)
- ☐ Monkfish
- ☐ Flounder
- ☐ Yellowtail
- ☐ Greysole
- ☐ Skate
- ☐ Other: ______

What types of gear do you use? (check all used)
Check more than one if applicable

- ☐ Hook and Line
- ☐ Gillnet
- ☐ Otter Trawl
- ☐ Other: ______

Does your vessel have a bleed tank?

- ◯ Yes
- ◯ No

Add item

After page 3 **Continue to next page**

Page 4 of 10

Snow Crab

Do you fish snow crab?

- ◯ Yes
- ◯ No

Add item

Page 5 of 10

Snow Crab

Have you made pot modifications other than those required by license?

Have you ever tested artificial baits?

- [ ] Yes
- [ ] No

Add item

After page 5 Continue to next page

Page 6 of 10

Shrimp

Do you fish shrimp?

- ◯ Yes
- ◯ No

Add item

After page 6 Continue to next page

Page 7 of 10

Shrimp

Do you use any netting that reduces drag and saves fuel?
Such as knotless twine or low resistance twines.

- [ ] Yes
- [ ] No

Do you use or have you tested semi-pelagic doors?

- ◯ Yes
- ◯ No

Add item

After page 7 Continue to next page

Page 8 of 10

Pelagics

Do you fish Pelagics?

◯ Yes

◯ No

Add item

After page 8 Continue to next page

Page 9 of 10

Pelagics

What pelagic species do you fish?

☐ Capelin

☐ Herring

☐ Mackerel

What type of fishing gear do you use?

☐ Bar Seine

☐ Tuck Seine

☐ Trap

☐ Gillnet

☐ Other:

Add item

After page 9 Continue to next page

Page 10 of 10

Additional Information

Please add any comments below.

Please type comments in the box below.

Add item

APPENDIX VI PROCESSOR SURVEY

Page 1 of 5

NL Processing Technology

PROCESSING

Company Name

Plant Location

What species do you process?

- ☐ Groundfish
- ☐ Snow Crab
- ☐ Shrimp
- ☐ Pelagics
- ☐ Whelk
- ☐ Sea Cucumber
- ☐ Lobster
- ☐ Sea Urchins
- ☐ Clams
- ☐ Salmonids
- ☐ Mussels
- ☐ Other:

Production Type

- ○ Primary
- ○ Secondary
- ○ Both

What certifications does your plant hold?

- ☐ BRC (British Retail Consortium)
- ☐ BAP (Best Aquaculture Practices)
- ☐ MSC Chain of Custody
- ☐ SQF (Safe Quality Foods)
- ☐ ISO 22000
- ☐ Certified Canadian Organic
- ☐ No Certifications
- ☐ Other:

Are you planning on adding any certifications to your plant in the next 2 years?

- [ ] Next 2 years
- [ ] Next 5 years
- [ ] No

Have you invested in research and development?

- [ ] Past 2 years
- [ ] Past 5 years
- [ ] None

Have you adapted new or innovative technology?

- [ ] Past 2 years
- [ ] Past 5 years
- [ ] none

If you implemented new or innovative technology, please describe?

Have you received funding to assist in R&D or technological innovation?

- ( ) Yes
- ( ) No

Are there factors that limit your ability to invest in R&D or new technologies?

What factors will influence your decision to invest in new technology in the future?

- [ ] Improved quality
- [ ] Improved productivity
- [ ] Return on investment
- [ ] Product diversification
- [ ] New Species
- [ ] Other:

Do you plan on investing in new technology in the future?

- ( ) Next 2 years
- ( ) Next 5 years
- ( ) No

Would cost shared funding programs influence your decision to invest?

- ( ) Yes
- ( ) No

What technologies would benefit your production of any species? (Describe)
(Provide details)

Add item

After page 1 Continue to next page

Page 2 of 5

Groundfish

What groundfish species do you process?

- ☐ Cod
- ☐ Haddock
- ☐ Pollock
- ☐ Hake
- ☐ Atlantic Halibut
- ☐ Ocean Perch (Redfish)
- ☐ Greenland Halibut (Turbot)
- ☐ Flounder
- ☐ Yellowtail
- ☐ Greysole
- ☐ Monkfish
- ☐ Skate
- ☐ Lumpfish (roe)
- ☐ Other:

Add item

After page 2 Continue to next page

Page 3 of 5

Pelagics

What pelagic species do you process?

- ☐ Capelin
- ☐ Herring
- ☐ Mackerel

Add item

After page 3 Continue to next page

Page 4 of 5

By-Product Utilization

Does your plant engage in by-product utilization ?

- ◯ Yes
- ◯ No

From what species do you utilze by-products from?

- ☐ Groundfish
- ☐ Snow Crab
- ☐ Shrimp
- ☐ Pelagics
- ☐ Whelk
- ☐ Sea Cucumber
- ☐ Lobster
- ☐ Sea Urchin
- ☐ Clams
- ☐ Salmonids
- ☐ Mussels
- ☐ Other: ______

What output products result from the by-product utilization?

Add item

After page 4 Continue to next page

Page 5 of 5

Additional Information

Please add any comments below.

Please provide any other detail you feel appropriate.

Add item

Confirmation Page

Your response has been recorded.

☐ Show link to submit another response

APPENDIX VII AQUACULTURE SURVEY

NL Aquaculture Sector - Primary Producers & Key Stakeholders

1. Company Name and Current Address:

   ____
   ____
   ____

2. How many years has your enterprise been involved in the NL Aquaculture sector?

   ____ Years

3. What is the principal species that your enterprise is involved in farming? If more than one species, use 1 to identify the primary species, 2 for the secondary species, 3 for tertiary, etc.

   [ ] Atlantic Salmon
   [ ] Steelhead Trout
   [ ] Atlantic Cod
   [ ] Arctic Char
   [ ] Other Finfish: __________
   [ ] Mussels
   [ ] Scallops
   [ ] Oysters
   [ ] Other Shellfish: __________

4. What is the approximate total annual harvested volume of product? How many producing companies does this represent?

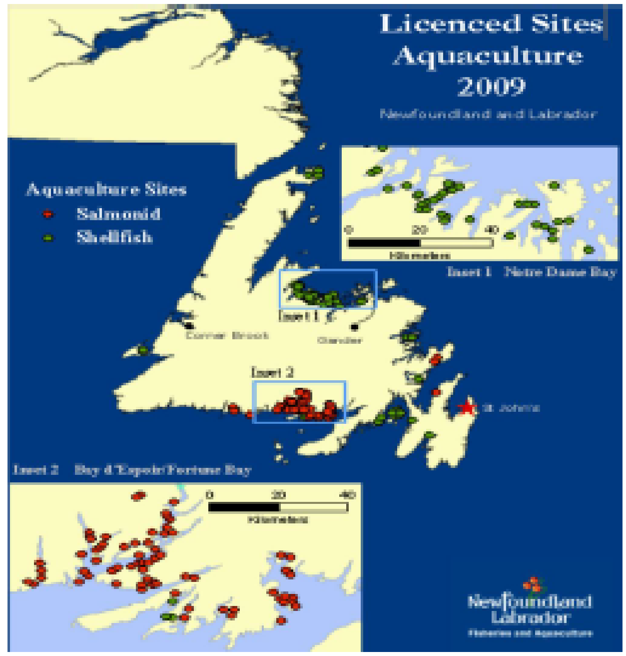
   ______ Volume (mt) ______ Number of Companies
   ______ Volume (mt) ______ Number of Companies
   ______ Volume (mt) ______ Number of Companies

5. What is the approximate total number of employees that this annual harvested volume of product supports?

   _____ Full-time employees
   _____ Part-time employees

6. What area represents the primary location of your production?

   Name of closest community:



7. Using the following 5-point Likert Scale, please indicate the degree of significance of each of the following factors in terms of their constraint on the growth of aquaculture in your primary location. <u>Circle the most appropriate number</u>, e.g. (3)

   [Hint: on a computer, copy & paste the red circle]

Very Insignificant	Insignificant	Neither Significant or Insignificant	Significant	Very Significant
1	2	3	4	5

Potential Constraints to Industry Growth	**Very Insignificant**	**Insignificant**	**Neither Significant or Insignificant**	**Significant**	**Very Significant**
	1	2	3	4	5
Operational Factors					
Storm Damage / Ice Inclement Weather	1	2	3	4	5
Systems / Equipment Failure	1	2	3	4	5
Vandalism / Theft	1	2	3	4	5
Waste Management	1	2	3	4	5

Potential Constraints to Industry Growth	Very Insignificant	Insignificant	Neither Significant or Insignificant	Significant	Very Significant
Biological Factors					
Disease	1	2	3	4	5
Predation	1	2	3	4	5
Toxic Algal Blooms	1	2	3	4	5
Pollution (Source:)	1	2	3	4	5
Business Factors					
Access to Financing (investment, working capital, etc.)	1	2	3	4	5
Cost of Production – fob the marketplace	1	2	3	4	5
Competition / Price Cutting	1	2	3	4	5
Access to Technologies	1	2	3	4	5
Access to Services	1	2	3	4	5
Access to Markets	1	2	3	4	5
Access to Labour	1	2	3	4	5
Government Factors					
Access to Leases / Tenures	1	2	3	4	5
Ability to Obtain Aquaculture Licence	1	2	3	4	5
Canadian Shellfish Sanitation Program	1	2	3	4	5
Conflicting Fisheries / Aquaculture Policy	1	2	3	4	5

8. Looking back at your responses to Question 7 in the table above, for any factor that you have identified a score of 4 or 5, please provide a brief description outlining why this is a significant issue and, potentially, what can be done about it.

If you prefer, we can call you to discuss the answer(s) to Question 8.

Name:

Phone No.

9. Is most of the production from your enterprise sold in North America?

[ ] Yes [ ] No

10. Are there current barriers to accessing the market?

[ ] Yes [ ] No

If Yes, please describe them:

11. Does your enterprise have a 3rd party certification program in place?

[ ] Yes [ ] No

If Yes, which one? (e.g. Global Aquaculture Alliance BAP, Aquaculture Stewardship Council, Canadian Organic Aquaculture Standards, etc.)

12. Are you planning to add any certifications to your operations in the foreseeable future?

[ ] Next 2 years

[ ] Next 3-5 years

[ ] No

If Yes, which one? (e.g. Global Aquaculture Alliance BAP, Aquaculture Stewardship Council, Canadian Organic Aquaculture Standards, etc.)

13. Has your company invested in research and development to improve productivity or to assess new technologies?

[ ] Past 2 years

[ ] Past 3-5 years

[ ] None

14. Has your company introduced new or innovative technologies?

[ ] Past 2 years

[ ] Past 3-5 years

[ ] None

15. Has your company received funding to assist in R&D or technological innovation from the Province?

[ ] Yes [ ] No

16. Are there factors that limit your company's investment in R&D or new technologies?

[ ] Yes [ ] No

If Yes, please describe them briefly:

17. What factors will influence the decision to invest in new technology in the future?

[ ] Improved quality

[ ] Improved productivity

[ ] Return on investment

[ ] Product Diversification

[ ] New Species

[ ] Other: ______

18. Would cost-shared funding programs influence your decision to invest?

[ ] Yes [ ] No

19. Is your company using the best available technologies for the full life cycle of production? Specifically for:

a. Juvenile production & supply (i.e. fingerlings, smolts, spat);

[ ] Yes [ ] No

b. Growout systems (e.g. physical location, technologies, efficiencies, etc.);

[ ] Yes [ ] No

c. Nutrition & feeding (e.g. diets, feed ordering & delivery, storage, daily allocation);

[ ] Yes [ ] No

d. Performance of stock (e.g. growth rates, survival, feed conversion, etc.);

[ ] Yes [ ] No

e. Inventory management systems (e.g. programs that assist with record keeping and forecasting)

[ ] Yes [ ] No

f. Fish health management (e.g. on-farm diagnostic and procedures, veterinary support and infrastructure);

[ ] Yes [ ] No

g. Harvesting practices and infrastructure;

[ ] Yes [ ] No

h. Maintenance practices and procedures;

[ ] Yes [ ] No

i. Environmental monitoring and reporting.

[ ] Yes [ ] No

20. In considering the answers in Question 18, are there technologies available elsewhere that you do not have access to at the moment? If there are, please describe the nature of the technology, where it is being used, and how it could benefit your operations and/or the entire sector.

If you prefer, we can call you to discuss the answer(s) to Question 20.

Name:

Phone No.