Overview of Bait Supply & Demand in Atlantic Canada and Quebec

Submitted to:

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EXECUTIVE SUMMARY

The situation: The supply of domestic fish traditionally used for bait has been declining due to stock reductions resulting in lower total allowable catch and recent moratoriums on some stocks. Further, supply of herring from the USA has declined due to stock reductions. Coupled with the general increase in demand for wild seafood supplies for human consumption, meal production for agriculture and aquaculture use, and pet food has resulted in higher demand of a limited resource. This increasing demand and lower supply situation have resulted in price increases that have further been exacerbated by the current supply chain challenges. Domestic bait supply reductions and significantly higher bait prices is a concern to seafood harvesters.

Methodology: The research completed for this report examines the domestic bait demand and supply situation and provides current information regarding international supply of preferred bait species, other potential bait species, alternative baits, bait use reduction methods, and the process required to certify bait species for importation. Interviews were conducted with stakeholders including harvesting associations, processors, and bait suppliers to better understand concerns and determine how the supply chains for bait species are changing.

Bait demand: It is estimated that bait use for all fisheries in eastern Canada was ~70,000mt in 2020[1]. Given data uncertainties regarding bait use and increased use of bait due to higher catches in some of the major pot fisheries, the upper range estimate of bait demand in 2022 is 100,000 mt.

Exhibit E.1: Bait demand by province 2020 (MT)

Fishery	NS		NB		PEI		QC		NL		Total	
	Landings	Bait used	Landings	Bait used	Landings	Bait used	Landings	Bait used	Landings	Bait used	Landings	Bait used
Lobster	44,594	25,193	21,360	11,419	16,734	8,487	10,310	7,007	4,451	2,524	97,449	54,630
Crab	14,290	1,463	11,621	1,896	3,199	522	12,596	3,176	29,373	4,844	71,079	11,901
Other Crab	239	133	486	270	889	495	637	433	637	354	2,888	1,686
Halibut	4,556	335	112	8	74	5	690	51	862	63	6,294	463
Sword/Tuna	1,627	826	54	8	172	26	25	4	63	8	1,941	871
Groundfish	38,569	38	122	0	78	0	2,527	2	43,151	42	84,447	82
Total	**103,875**	**27,988**	**33,755**	**13,602**	**21,146**	**9,535**	**26,785**	**10,672**	**78,537**	**7,835**	**264,098**	**69,633**

Source: Adapted from various source documents and stakeholder interviews.

Bait supply: There are several competing markets for pelagic bait supplies, and the decision by producers, both nationally and internationally, on how best to utilize their limited supply of pelagic resources will be based on the financial return from these various competing markets. In eastern Canada the markets for pelagic resources traditionally have been for human food, pet food, meal, furrier feed, and bait.

Bait supplies are sourced both domestically and internationally. Atlantic Canadian domestic supply of preferred bait species[2] has decreased 35% from 2011 to 2020, and further reductions were announced recently including a 33% reduction in southwest NS herring, and closure of the Canadian Atlantic

[1] 2020 is most current landings data from DFO.
[2] Whole landings of herring, mackerel, squid, alewife, and silversides.

mackerel and Gulf of St. Lawrence spring herring fisheries. These recent reductions will likely result in landings of these species in 2022 reducing to ~80,000 mt from the 2020 landings of ~96,000 mt. Additional domestic supplies are also provided from undersize fish and racks/heads from redfish, flatfish, groundfish and pelagic species. In total the domestic potential supply available in 2020 is estimated to have been 125,000 mt.

Many of the preferred species used in the Atlantic Canadian fisheries are also harvested by other countries. The total harvest in 2019[3] for the six main species imported to Canada was 4.1 million mt. Not all these preferred supplies are available for import to Canada as species from certain fisheries may contain pathogens that could pose a risk to stocks if introduced as bait (re: section 'CFIA Certification of Imported Bait Species').

The following exhibit illustrates global landings, excluding Canada, of preferred bait species and countries that meet requirements for export to Canada. Limited eligibility of countries to sell herring and chub mackerel reduces the quantity that may be available to Canadian importers. Further, excluding imports from the Russian Federation due to the current embargo, the potential amount of preferred bait species available to Canada is estimated to be 1.4 million mt. Currently, these supplies are either used internally or exported to existing markets, so Canadian importers would have to compete for the supply at prevailing global prices.

Exhibit E.2: Non-domestic landings of preferred species (2019)

Species	Landings (MT)	Top Harvest Countries	Countries Certified to Export to Canada	Foreign Harvest Available for Import
Atlantic Mackerel	864,802	Norway, United Kingdom, Russia,	All	717,056
Chub Mackerel	1,416,568	China, Japan, Chile, Russia	USA and Japan only	454,306
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Redfish	82,951	Russia, Norway, Iceland, USA, Spain	All	44,639
Total	**4,049,213**			**1,426,599**

Note: Russian Federation excluded from 'Foreign Harvest Available for Import'
Source: FAO - FIGIS

Overall, potential sources of traditional baits both domestic and foreign far exceed the demand for the Canadian Atlantic fishery. This is quantified by the fact that all large bait importers stated there are no supply issues except for herring.

Supply and demand summary: **Reconciliation of bait demand and supply:** The following exhibit compares the estimated bait demand to the potential domestic supply plus baits imported to eastern Canada. Bait demand can be met by potential domestic supply; however, the competition for human food, pet food, meal, furrier food, and export bait markets results in much of this local supply being diverted to other markets. The diversion to other markets depends entirely on the economic returns available to the producer and can change significantly on an annual basis.

[3] 2019 is most recent year available from FAO.

Eastern Canada imports of bait are a normal part of the business and in 2020 there was an estimated ~17,000 mt of bait imported. Responses from bait suppliers indicates that imports of bait increased significantly in 2022, which is supported by import data that was ~25,000 mt (47% increase).

Potential domestic supply plus imports is ~142,000 mt, total bait demand is ~70,000 mt, resulting in potential excess supply of ~72,000 mt. Further, there are 1.4 million mt of preferred bait species that are landed in countries approved for bait exports, which at prevailing prices could be purchased to further supplement bait supplies.

Exhibit E.3: Potential bait supply and estimated demand

	Estimated 2020 Bait Volumes (MT)					
	NS	**NB**	**PEI**	**QC**	**NL**	**Total**
Supply - Potential domestic	48,262	30,154	3,260	4,591	38,552	124,817
+ Supply - Actual Imported	11,131	5,837	3	123	113	17,207
Total potential bait supply	59,393	35,991	3,263	4,714	38,665	142,024
Bait demand	27,988	13,602	9,535	10,672	7,835	69,633
Excess supply (shortfall)	31,405	22,388	(6,272)	(5,959)	30,830	72,392

***Conclusion**: Interview results, potential domestic supplies, potential preferred species landed in other countries and eligible for import indicate overall bait demand will continue to be met.*

Alternative baits: Various types of alternative bait supplies are available, Appendix V, and many have been tested by a research team from St. Francis of Xavier, Appendix VI, and many harvesters. There has been no widespread adoption in Canadian fisheries of any of these alternative baits.

There are several categories of these alternative baits including:

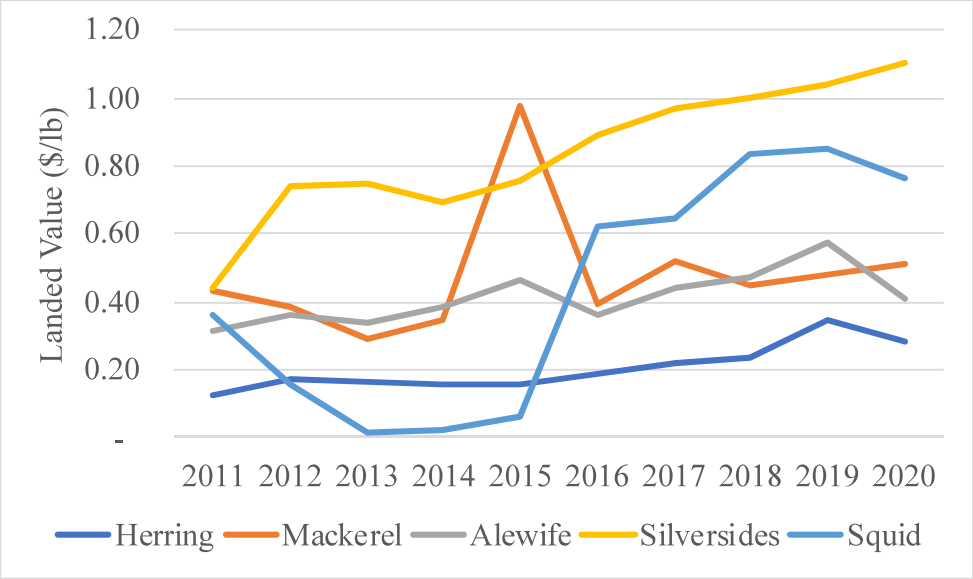
- **Blended baits:** These baits are sourced from local fisheries and blended with binders. They can be offered in several product forms including frozen, shelf stable or refrigerated.
- **Synthetic bait:** This is a non-fish-based product that is synthesized in the laboratory.
- **Acoustic bait:** These are sound emitting devices that can be used as a bait replacement and/or supplement.
- **Non-traditional species:** There are numerous baits that have been tested or adopted for other pot fisheries, including ocean-based and freshwater supplies.
- **Non-seafood alternative:** These are land-based animal products that have been used and tested in numerous shellfish pot fisheries. Further, research conducted using lights and luminescent fishing gear was completed by the Marine Institute with reportedly positive results yet has not been adopted by fishers.

Conclusion: *The broad adoption of alternative baits will likely be driven by increasing costs of preferred bait. However, providing information to harvesters regarding these options, conducting further research on performance of these alternatives, and establishing a research protocol that can be easily adopted by harvesters that test these alternatives would all be of benefit.*

Bait prices: There is no published information regarding bait prices by species and import data of individual bait species has been blended since 2017. As a result, the only indices are trends in bait species shore prices and blended import prices. Imported bait values increased 29% from 2016 to 2021, with an average annual cost increase of 5.8%. In 2021, the average imported cost of bait species was $0.77 per pound, ranging from $0.09 to $6.79. Importers must incur shipping, insurance, storage, financing, and distribution costs prior to selling the bait. Limited responses from stakeholders indicate that prices for whole pelagics and squid ranged from $1.50-$2.00 and racks/heads from $0.60-$0.90.

The landed value of Atlantic Canadian domestic preferred bait species has increased from 2011-2020. Herring has increased 121%, mackerel 20%, alewife 30%, silversides 152% and squid 113%. These increases may be understated as landed value of herring, alewife and squid all declined in 2020 versus 2019, which was likely due to the market uncertainty due to the covid pandemic. Overall, the price increases seen over the period reviewed support the fact that these limited resources are in high demand globally.

Exhibit E.4: Canadian Atlantic preferred bait species landed value ($/lb)



Source: DFO landings

Conclusion*: All bait prices have increased in recent years, with prime bait species now costing up to $2.00 per pound.*

Mitigation measures: Though there are abundant supplies of preferred bait species available, demand from other markets makes continuity of any supply uncertain. To ensure a more stable supply stream and reduce costs there are several measures that may be considered:

- **Herring:** The potential supply of herring available for bait has declined in the entire northwest Atlantic. Whereas the USA is the only CFIA certified supplier of herring, other primary northeast Atlantic supply countries should be engaged by industry/government to determine the willingness of the target country to engage CFIA in starting the certification process.

- **Atlantic producers:** Onshore and offshore producers of preferred and potential bait species should be engaged by industry/government to determine if additional supplies of undersize and racks/heads could be secured under supply contract.

- **Alternative baits:** Several have been tested by fishers and researchers and offer the potential to be a lower cost replacement of traditional bait supplies. Government could support further research of these alternatives and suppliers could be supported through a short-term government subsidy to increase the commercial testing, under defined protocols, of these alternative baits.

- **Ground bait:** Industry should engage bait suppliers to determine if they are willing to make the necessary investment to provide harvesters with ground bait in bags that could be readily used in pots. This has the potential reduce bait demand for lobster by up to 25%.

- **Bait workshop:** DFO has indicated that a bait workshop, or summit, will be held in the fall of 2022. This workshop should include active participation by large bait suppliers, alternative bait producers and CFIA. This will inform harvesters about the current supply situation and bait alternatives, permit direct questioning of participants regarding anticipated prices and supply availability for the 2023 season and certification of other international bait supply streams.

Contents

Glossary

CFIA	Canadian Food Inspection Agency
CPUE	Catch per unit effort
CSAS	Canadian Stock Advisory Secretariat
DFO	Department of Fisheries and Oceans Canada
FAO	Fisheries and Agriculture Organization
IUCN	The International Union for Conservation of Nature
LFA	Lobster fishing area
MSC	Marine Stewardship Council
MT	Metric tons
NOAA	National Oceanic and Atmospheric Administration
StatsCan	Statistics Canada
TAC	Total allowable catch

1.0 BACKGROUND

1.1 Project Objectives

The objectives of this project are to provide the client with an accurate representation of the following:

- Supply and demand of bait for pot and longline fisheries in Atlantic Canada.
- Identification of where bait supplies are sourced locally, regionally, nationally, and internationally.
- Sources of new bait supplies including traditional and non-traditional sources. Further information regarding status of development and availability of artificial/blended supplies.
- The status of stock health, as indicated by third-party certification, of primary bait species regardless of source.
- Challenges identified by bait suppliers and industry stakeholders regarding availability, trade or regulatory challenges, bait processing capacity, cold storage availability and inventory holding costs.

1.2 Methodology

The methodologies that were used to gather information and determine regional and Atlantic fisheries bait demand and supply included:

- Collection and review of information, public and internal, regarding bait use, supply, demand, and effective studies. Sources of information included prior research completed by federal and provincial governments represented in the Bait Working Group, publicly available government sources (e.g., Government of Canada, Trade, DFO, NOAA, USA, CFIA), international agencies (e.g., MSC, FAO), industry stakeholders including bait users, processors, bait suppliers and alternative bait producers.
- Information regarding blended or artificial baits including types, costs, availability, and commercialization status was provided by the producer/supplier and publicly available information.
- Interviews with harvester associations, producers, and bait suppliers to identify bait preferences, sources, availability, and price. A total of 53 companies and organizations were contacted for personal interviews.
- Fishing effort information, trap hauls, by fishery and province was sourced from the Canadian Stock Advisory Secretariat (CSAS), DFO management plans and third-party certification bodies. This effort information coupled with bait use per pot haul was used to determine total estimated bait use. There were some inconsistencies in this documentation that required adjusting some calculations to obtain the best representation.

As possible, the output of bait use calculations was checked against alternative source information and interview results to gauge 'reasonableness' of overall results. The most significant bait use fisheries, lobster, and crab had the best source data. Given most of the bait used is for these fisheries, the overall results are thought to be representative.

- The calculation for bait used for hook and line fisheries was based on the only one available source document that was used to extrapolate across all hook and line fisheries.

2.0 BAIT DEMAND AND SUPPLY

2.1 Bait Demand

Bait use in **2020** in the Atlantic Canadian fishery is estimated to be ~70,000 mt. The bait is used primarily for lobster, 54,630 mt (79%), crab fisheries, 13,587 mt (19%), and longline fisheries 1,416 mt (2%). The following exhibit presents the estimate of bait use for each major species or species category and province in 2020.

Exhibit 2.1: Bait demand by province 2020 (MT)

Fishery	NS		NB		PEI		QC		NL		Total	
	Landings	Bait used	Landings	Bait used	Landings	Bait used	Landings	Bait used	Landings	Bait used	Landings	Bait used
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Total	**103,875**	**27,988**	**33,755**	**13,602**	**21,146**	**9,535**	**26,785**	**10,672**	**78,537**	**7,835**	**264,098**	**69,633**

Source: Adapted from various source documents and stakeholder interviews.

***Conclusion**: Estimated bait demand in 2020 was ~70,000 mt. This bait was used to harvest 264,098 mt of shellfish and finfish. This results in an overall bait demand of approximately 25% of the resources harvested, or a 1:4 bait to harvest ratio.*

This bait demand estimate was prepared using numerous written sources and then qualified through interviews with stakeholders. Many of the written sources were provided by members of the Bait Working Group representing the four DFO regions and five provinces, with the remaining documents sourced from the Canadian Stock Advisory Secretariat (CSAS), Marine Stewardship Council (MSC) assessment documents, and DFO management plans.

Given the various sources of information and that many bait use estimates are based on feedback from a sample of harvesters, there are several uncertainties, including:

- **Lobster:** The information for bait used varied by source, ranging from 1.0 to 1.6 pounds per trap. Some sources did not cite the participation rate of harvesting respondents, whereas others provided range estimates based on uncertainties. The average of range estimates was used.

  In a limited number of lobster fishing areas (LFAs) trap haul, or catch per unit effort (CPUE), data was not available (LFAs 15-18). In those instances, the effort was based on the traps licensed x number of days in the fishing season x 90% to reflect weather delays, etc.

  Harvester associations interviewed reported bait use was 0.50-0.75 pounds of bait per pound of lobster landed. This anecdotal information aligned well with the calculated bait use range of 0.51-0.68 pounds of bait per pound lobster.

- **Snow crab:** The bait used per trap is reported to range from 14.0-16.7 pounds per trap, except in NL where smaller crab pots are used. The uncertainty lies in the range of accuracy cited in source documents that was +/- 5% to +/-35%. Considering all source data and feedback from stakeholders the estimated range is 15-20 pounds per trap haul with a +/-15% uncertainty.

  NL snow crab traps are much smaller, 3' versus 7' diameter, so less bait is used. These smaller pots, 18% of square footage of a 7' trap, yield a corresponding lower catch per trap haul, ranging from 10%-25% of the larger pots. The most recent CSAS document (Research Document 2021/028) estimated that bait use is 2-3 pounds per pot haul; however, this was based on DFO survey traps which likely uses a standard survey protocol. FFAW feedback indicated that bait to crab ratio ranges from 0.25-0.50:1, which equates to 6-12 pounds of bait per trap haul. Considering this broad range of estimates, 2-12 pounds, a 4 pound per trap haul estimate was used which aligns to other regional snow crab fisheries based on a trap size adjustment.

***Conclusion**: Data uncertainties likely result in bait use accuracy estimates being +20% / -10%.*

Sensitivity analysis: Several sensitivity analyses were completed and measured against the estimated 'Baseline' demand of ~70,000 mt. These sensitivities examine the data uncertainties, potential stock growth of target species, and the use of ground bait in the lobster fishery.

Data uncertainties - As previously stated much of the source data used to determine bait demand is based on limited industry survey or qualified information.

It is more likely that the total bait demand is underestimated, up to 20%, versus overestimated, 10% less. The impact of these data uncertainties on the baseline estimate is provided in the following exhibit and indicates that the upper limit estimate would be 84,000 mt of bait based on 2020 landings.

Exhibit 2.2: Impact of data uncertainties on bait demand

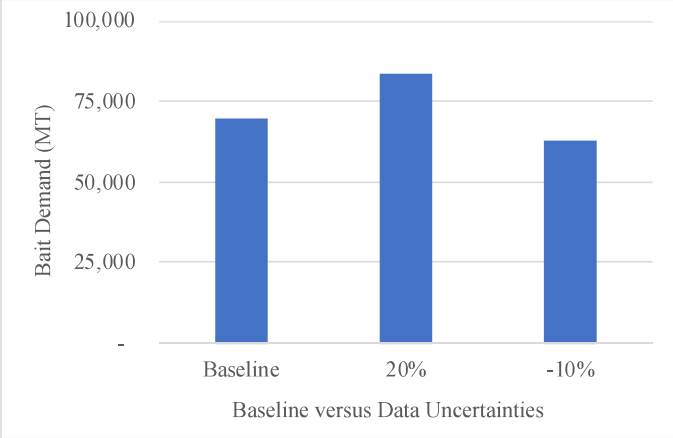
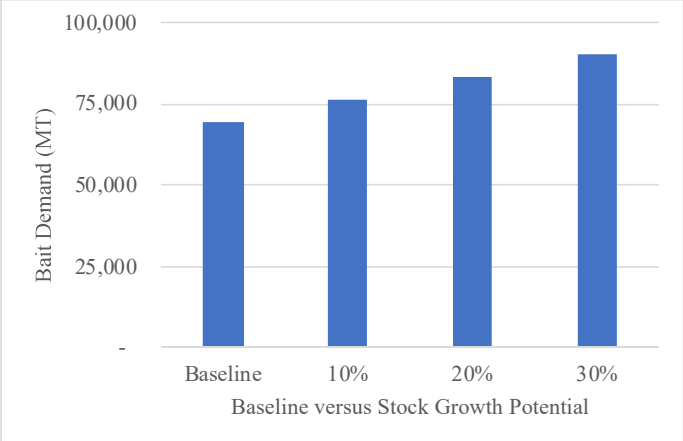


Exhibit 2.3: Impact of target species stock growth

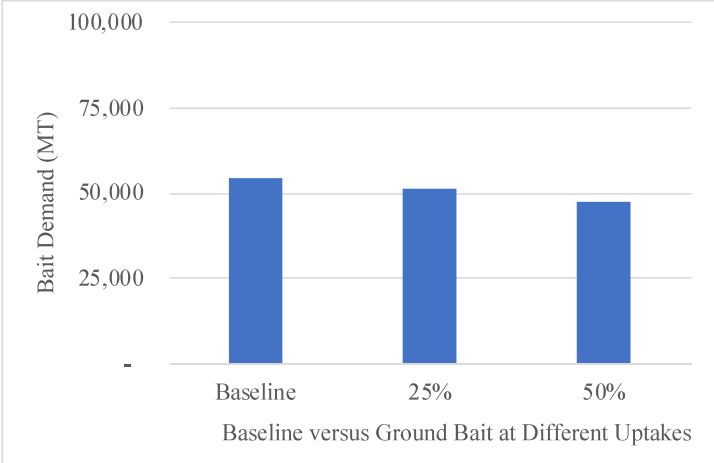


Stock growth – The stock of target fisheries requiring bait can vary significantly over time and recently have with increases in snow crab quotas in the Gulf and NL regions and continued increases of lobster catches in many areas.

The adjacent graph illustrates the impact of 10%-30% stock growth of these target species on bait demand. As illustrated in the adjacent exhibit, bait demand in 2022 was likely closer to the upper limit, 90,000 mt, than the baseline estimate. As access to resources and catch rates change, the amount of bait demanded will also change; however, using the 1:4 bait to catch ratio overall will provide a relatively accurate estimate.

***Conclusion**: Including data uncertainties and stock growth the upper limit of demand for bait is estimated to be 100,000 mt.*

Exhibit 2.4: Impact of adopting ground bait in lobster pots



Ground bait – Research conducted by Merinov indicates that ground bait, of preferred species, in bags performs just as well as traditional means of baiting yet uses 21%-25% less bait.

The adjacent exhibit illustrates the impact on bait demand if 25% and 50% of lobster harvesters were to adopt ground bait. This indicates that bait demand would reduce by 6,800 mt in the lobster fishery if 50% of harvesters used ground bait. The impact of adopting this practice in other fisheries is uncertain, but certainly offers some potential benefit.

Processing of ground bait would require grinding/mincing equipment and additional effort, whether it is completed by the harvester or supplier. Many processors and bait suppliers have industrial mincing or grinding machines to reduce by-product volume. If harvesters were to create demand for this product, it is likely producers and bait suppliers would respond by using existing, or purchasing, equipment to supply the bait in the format requested.

***Conclusion**: Using ground bait versus traditional bait forms could reduce bait demand in the lobster fishery by as much as 25%.*

2.2 Bait Supply

There are several competing markets for pelagic bait supplies, and the decision by producers, both nationally and internationally, on how to utilize their limited supply of pelagic resources will be based on the financial return from these various competing markets. In eastern Canada the markets for pelagic resources traditionally have been for human food, pet food, meal, furrier feed, and bait. The current trends in each of these markets are:

- **Human food:** Pelagic fishes are known to be very healthy due to their high Omega-3 content, and consumers are encouraged to eat oily fish as part of a balanced diet. These fishes are staple products in many parts of the world, and the health benefits of fish oil, much of which is rendered from pelagic fishes, are well known and demand is expected to grow at 6.8% compound annual growth rate until 2028.

- **Pet food:** Many large pet food producers are offering more refrigerated fresh pet foods to encourage better pet health. This includes healthier ingredients that use less binders and cereals and more protein and vegetable products. One recent report indicates that the fish based pet food market will realize a 4.9% compound annual growth rate until 2032.

- **Meal:** Fish meals and oils are key ingredients for feed and agricultural use globally. It is reported that 20 million mt of wild seafood is directed to meal each year, and that as much as 90% of this fish is food grade. These supplies are primarily from fishes including herring, menhaden, anchovy and other bony fish. Given global population growth and the need for these people to eat, regardless of whether it is agriculture or aquaculture products, these limited supplies of fish will continue to be in high demand.

- **Furrier feed:** Information indicates that the furrier industry is in decline and has been for 20 years or more. Fish racks and pelagic fishes were in high demand by furrier growers in the past as the oils in the fish make the furs healthy and more luxuriant. The demand from this sector has declined steadily and will likely continue to decline in the future.

- **Bait:** Small pelagic fishes are the primary preferred bait species for Canadian pot fisheries. Declines in herring stocks and closure of the mackerel fishery have limited domestic availability of these supplies. Coupled with competitive factors for other uses of these pelagic species and the relatively fixed availability of these wild resources, prices have increased significantly in recent years, and are forecast to continue to increase further in 2023.

> ***Conclusion****: Competition for fish products and oily fish specifically is intense and has the potential to disrupt established supply chains for bait.*

Domestic bait supply: The Atlantic Canadian domestic supply of preferred bait species has decreased 35% from 2011 to 2020, and further reductions were announced recently including a 33% reduction in southwest NS herring, closure of Gulf spring herring and closure of all Atlantic Canadian mackerel fisheries. These recent reductions will likely result in landings of these species reducing to near 80,000 mt from the 2020 landings of ~96,000 mt. Though landings may have decreased in 2020 due to the onset of the covid pandemic, it is known that landings have declined further since that time due to stock reductions and fisheries closures.

Given that stock rebuilding strategies are effective it is anticipated that some of these pelagic stocks may recover; however, it is uncertain how long this may take. Regardless, domestic bait supplies have declined significantly and can only be replaced by diversion of these species from other markets for Canadian producers, increased importation of these preferred species, broader use of alternative species such as menhaden, or adoption by harvesters of bait alternatives.

Exhibit 2.5: Canadian Atlantic preferred bait species landings

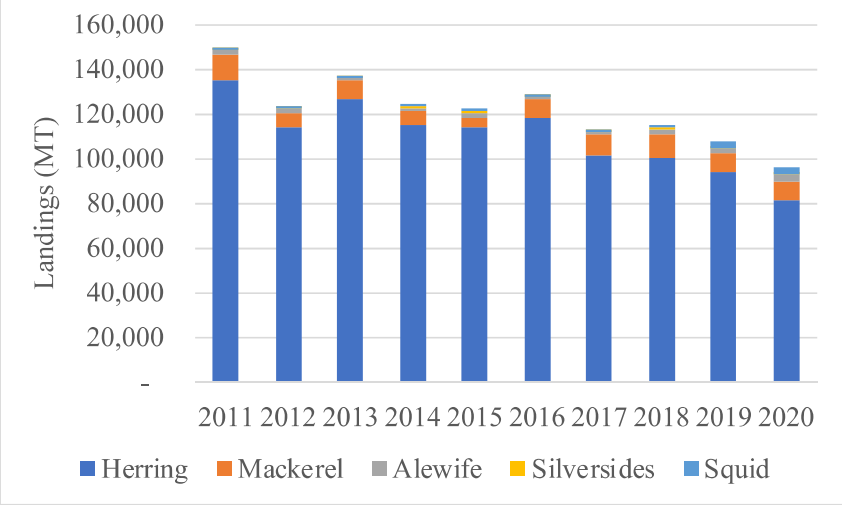


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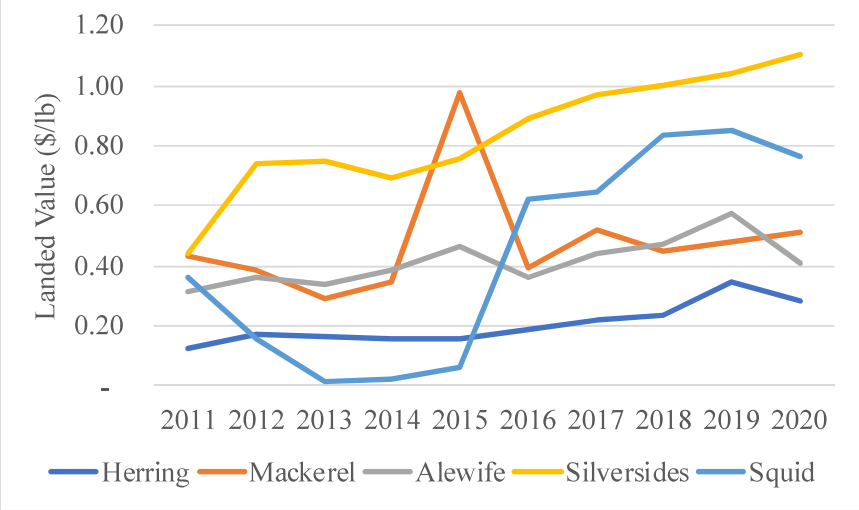
Exhibit 2.6: Canadian Atlantic preferred bait species landed value ($/lb)



Source: DFO landings

***Conclusion**: Domestic allocations and landings of preferred bait species have declined significantly, and prices have increased.*

Foreign supply: Foreign supplies of bait species are normally procured under contract for a specified number of containers, 20 mt per container. The primary suppliers of these baits are paid upon shipping and the value of the shipment is normally insured.

Bait costs have risen considerably in recent years, and the shipping costs to secure these supplies have been increasing regularly due to supply chain issues and the increasing cost of fuel. Interviews with bait suppliers indicate the primary bait species imported and traded include herring, mackerel, redfish, menhaden, and squid. Secondary trade is done with local species including redfish, halibut heads, flounder, silversides, capelin, clams, gaspereau and salmon most of which is sourced from Atlantic Canadian harvests and processors.

Responses from bait suppliers indicate the source countries of most bait imports are the EU, Iceland, Japan, Norway, Spain, United Kingdom, and USA. This is supported by review of bait import data from Statistics Canada.

Non-domestic landings of preferred species: Many of the preferred species used in the Atlantic Canadian fisheries are also harvested by other countries. The total harvest in 2019[4] for the six main species imported to Canada was 4.1 million tonnes per year. Not all these preferred supplies are available for import to Canada as some species from certain fisheries may contain pathogens that could pose a risk to stocks if introduced as bait (re: section 'CFIA Certification of Imported Bait Species').

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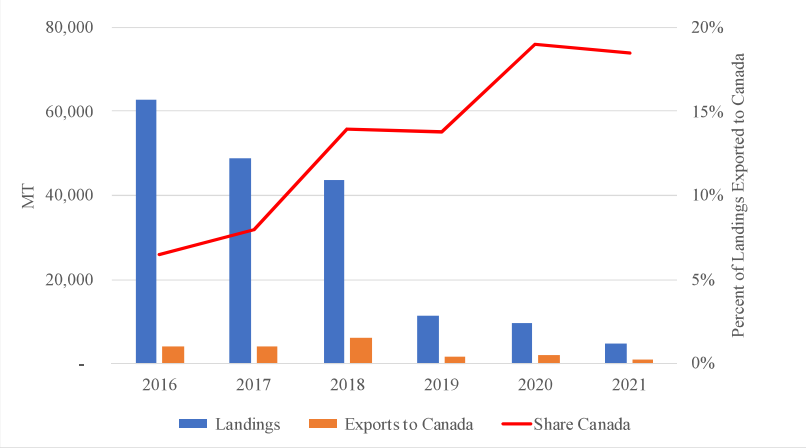
Note: Russian Federation excluded from 'Foreign Harvest Available for Import'
Source: FAO - FIGIS

***Conclusion**: There is up to 1.4 million mt of import eligible preferred bait supplies landed in other countries.*

[4] 2019 is most recent year available from FAO.

More information for each species is provided in Appendix II, including worldwide harvest for 2019 and the top producing countries. Since 2019 there have been some changes in resources available to harvest internationally, of highest concern is the decline of herring availability in the USA that is a traditional supplier of herring bait to Canadian fisheries. This USA herring decline will make herring much more difficult to procure, coupled with Canadian stock declines and the limited options for importation of herring, some harvesters will likely have to change their preferred bait type.

Exhibit 2.8: USA herring landings and exports to Canada[5]



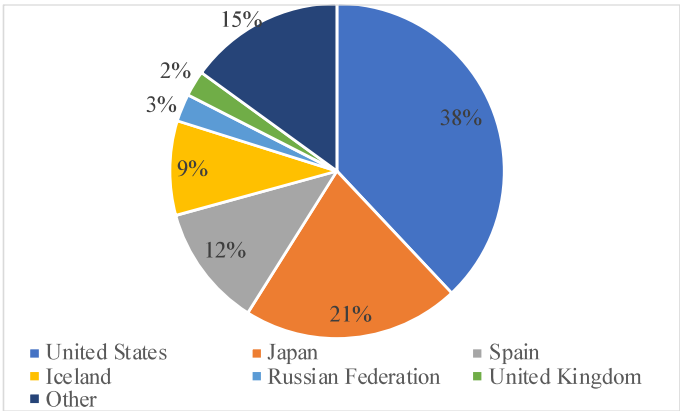
As illustrated in the adjacent exhibit, the declines in Atlantic herring landings in the USA have been very significant, from nearly 63,000mt to less than 5,000mt.

The export of whole fresh/frozen herring to Canada remained in the 5,000mt range until 2019 when landings fell precipitously.

Though the share of landings exported to Canada increased after 2019, the herring supply to Canada from the USA was less than 1,000mt in 2021.

***Conclusion**: Recent declines of herring availability in the USA and Canada will, if it has not already, drastically impact the availability of herring for bait. To source other Atlantic herring, import certification will be required of other countries since the USA is the only certified supply currently.*

Exhibit 2.9: Bait imports to eastern Canada 2019



Since 2017 all bait import data are blended so no definition of species is possible. In 2019 ~22,500mt of bait was imported from 23 separate countries.

The top six supplying countries provided 85% of the bait imported, and the remaining 17 comprised 15%.

The province where bait import is registered is not particularly the province where it is used. The majority is imported to NS and NB; however, it is known to be distributed broadly to other provinces based on need.

The history of bait imports by province is provided in Appendix VIII.

[5] NOAA landings and exports 2016-2021

Supply shortages: Information suggests that bait supplies have been in short supply in a limited number of areas in recent years. Suppliers indicate this is due primarily to unexpected demand in certain areas and the related logistics to having the proper quantities of the desired bait at the right location. Further, they indicate this is not indicative that bait has not been available, as suppliers normally carry over inventories of bait after the traditional fishing season.

Reconciliation of bait demand and supply: The following exhibit compares the estimated bait demand to the potential domestic supply plus baits imported to eastern Canada. Bait demand can be met by potential domestic supply; however, the competition for human food, pet food, meal, furrier food, and export bait markets results in much of this local supply being diverted to other markets. The diversion to other markets depends entirely on the economic returns available to the producer and can change significantly on an annual basis.

Eastern Canada imports of bait are a normal part of the business and in 2020 there was an estimated ~17,000 mt of bait imported. Responses from bait suppliers indicates that imports of bait increased significantly in 2022, which is supported by import data that was ~25,000 mt (47% increase).

Potential domestic supply plus imports is ~142,000 mt, total bait demand is ~70,000 mt, resulting in potential excess supply of ~72,000 mt.

Exhibit 2.10: Potential bait supply and estimated demand

	Estimated 2020 Bait Volumes (MT)					
	NS	**NB**	**PEI**	**QC**	**NL**	**Total**
Supply - Potential domestic	48,262	30,154	3,260	4,591	38,552	124,817
+ Supply - Actual Imported	11,131	5,837	3	123	113	17,207
Total potential bait supply	59,393	35,991	3,263	4,714	38,665	142,024
Bait demand	27,988	13,602	9,535	10,672	7,835	69,633
Excess supply (shortfall)	31,405	22,388	(6,272)	(5,959)	30,830	72,392

***Conclusion**: Interview results, potential domestic supplies, potential preferred species landed in other countries and eligible for import indicate overall bait demand will continue to be met.*

2.3 Sustainability of Preferred Bait Sources

To ensure continuity of supply of bait sources and protect Marine Stewardship Council (MSC) certifications by using sustainably fished bait sources a review of available information for each of the fisheries primary bait species was completed.

Whereas many of the Atlantic Canadian pot and longline fisheries are MSC certified, part of the annual audit and reassessment process is to examine the quantity and source of bait used. If the use of a specific bait species in any MSC fishery is thought to inhibit the recovery of a stock, then a condition is imposed on that MSC fishery. This normally results in the requirement to source alternative bait sources, over time, to maintain MSC certification.

Sustainability is rated by several organizations around the world. For all preferred bait species, the sustainability status of each from MSC, Seachoice and IUCN were determined and are provided in the following exhibit. As illustrated, many of the preferred species, Atlantic mackerel and herring, stock complexes are not currently certified, and in fact several fisheries have voluntarily withdrawn from certification programs in recent years.

Exhibit 2.11: Sustainability of preferred bait species

Species	MSC Website	Seachoice/Seafood Watch	IUCN Redlist
Atlantic Mackerel (Scomber scombrus)	Generally not, but some landings are certified in the UK	This species, fished in FAO areas 27 and 21, is rated as "Not recommended" . This raring does not apply to other mackerel species"	Atlantic Mackerel *Scomber scombrus* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2010. *Scomber scombrus* is listed as Least Concern.
Chub Mackerel (Scomber japonicus)	not specifically mentioned	not specifically mentioned	
Atlantic Herring (Clupea harengus)	Generally not, but some landings are certified in the UK, Norway and Finland	Certified fisheries in the USA, France, Iceland, UK, Norway, Denmark	Atlantic Herring *Clupea harengus* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2009. *Clupea harengus* is listed as Least Concern.
Argentine Short-fin Squid	Certified fishery in the USA	Avoid fisheries in the South West Atlantic	Argentine Squid *Illex argentinus* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2010. *Illex argentinus* is listed as Least Concern.
Northern Short-fin Squid	Certified fishery in the USA	Certified in the USA	Illex illecebrosus has most recently been assessed for *The IUCN Red List of Threatened Species* in 2010. *Illex illecebrosus* is listed as Least Concern.
Redfish (Acadian, Beaked)	Certified fisheries in the USA and Iceland	Certified fisheries in Canada, USA, Austrialia and Iceland	*Sebastes fasciatus* has most recently been assessed for *The IUCN Red List of Threatened Species* in 1996. *Sebastes fasciatus* is listed as Endangered under criteria A1bd. *Beaked Redfish Sebastes mentella has most recently been assessed for The IUCN Red List of Threatened Species in 2009. Sebastes mentella is listed as Least Concern.*

The IUCN Redlist listings for these species are very dated, suggesting that more reliance be placed on the other sources. The Monterey Bay Aquarium is also a source of information, but that site repeats the information available from Seachoice and Seafood Watch.

***Conclusion**: Very few of the preferred bait species used are certified as sustainable.*

2.4 CFIA Certification of Imported Bait Species

CFIA has designated certain bait species as Susceptible Species of Aquatic Animals, which are prohibited from import to Canada unless the source country regulator can demonstrate they are disease/pathogen free. Once designated an import permit, not license, is granted by CFIA to the importer.

Atlantic mackerel (*Scomber scombrus*) and squids (*Illex*) are not listed on Canada's susceptible species of aquatic animals list (SSL), because it is not considered at this time as susceptible to regulated diseases of concern to Canada. Therefore, CFIA does not have any aquatic animal health import requirements for import of these species into Canada. An import permit and export certificate are not required.

Chub Mackerel (*Scomber japonicus*) is on the SSL, and there is a negotiated export certificate with Japan for the import of *S. japonicus* for dead bait. An import permit and official export certificate from the Japanese aquatic animal health competent authority is required for eligibility to export to Canada.

Imports of Atlantic herring (*Clupea harengus*) as bait are approved from the United States (U.S.) only as the CFIA and the U.S. National Oceanic and Atmospheric Administration (NOAA) have a negotiated export certificate in place for this trade. Importers require a CFIA aquatic animal health import permit and official export certification from NOAA for import.

Given that herring is the preferred species in many fisheries, and Atlantic herring is abundant from other Atlantic Ocean bordering countries, it is warranted that the CFIA approval process for any bait species be further discussed.

Bait species certification requirements and process: Certification cannot occur until there are negotiations between the foreign exporting country and CFIA to determine if that exporting country has regulatory controls for the diseases that affect the species to be exported. The outcome of those negotiations is an agreed upon export certificate that is signed by the government of the foreign country and accompanies every shipment exported to Canada.

To begin the process of negotiation, there must be interest from the exporting country as well as sufficient interest in Canada (the importing country) to receive the product(s). There are many steps that must be undertaken during this international discussion and negotiations often take significant time. There is no defined timeline for this process, and even once they are undertaken there is no guarantee of a positive outcome. Many variables outside the CFIA's control in the country of export affect the process and the ability of another country to meet Canada's import requirements. Unfortunately, many countries do not have aquatic animal health programs or processes in place to be able to certify the disease status and other requirements for wild caught aquatic animals.

Currently, there are only two countries that can export these regulated bait species to Canada, Japan, and the USA. All the other countries cannot export susceptible bait to Canada as there is no negotiated export certificate for aquatic animal health purposes. CFIA is negotiating with the European Union (E.U.) to try and develop a harmonized certificate to be used by all Member States for specific species, to be determined, and has approached the Faroe Islands to open negotiations for export of Atlantic herring as bait specifically.

> ***Conclusion**: To gain access to more Atlantic herring bait supplies, it is necessary to identify the sources desired and engage CFIA and the regulatory agency in the supply country to commence discussions to demonstrate no risk of contamination.*

Irradiation: It is known that irradiation can kill pathogens carried by fish, and there are several examples globally where irradiation has been successfully used. This option was reviewed (Appendix VII) using publicly available information and discussed with CFIA.

The CFIA response to the query was as follows:

> *CFIA uses science to make its decisions on the effectiveness of any treatment. The effectiveness of a specific treatment will depend on factors such as the specific pathogen, the product type, and the details (e.g., time, temperature etc.) of the specific treatment.*
>
> *CFIA can look into irradiation if there is confirmation that process can be and is feasible* ***to be used in the exporting country prior to importing products*** *to Canada. Notably, the bait cannot be imported and then treated unless it is accompanied by a negotiated export certificate as described above.*

This response would preclude bait suppliers from importing noncertified bait species, irradiating them locally and selling them as bait.

2.5 Alternative Baits

Various types of alternative bait supplies are available, Appendix V, and many have been tested by a research team from St. Francis of Xavier, Appendix VI, and many harvesters. There are several categories of these alternative baits including:

- **Blended baits:** These baits are sourced from local fisheries and blended with binders. They can be offered in several product forms including frozen, shelf stable or refrigerated.
- **Synthetic bait:** This is a non-fish-based product that is synthesized in the laboratory.
- **Acoustic bait:** These are sound emitting devices that can be used as a bait replacement and/or supplement.
- **Non-traditional species:** There are numerous baits that have been tested or adopted for other pot fisheries, including ocean-based and freshwater supplies.
- **Non-seafood alternative:** These are land-based animal products that have been used and tested in numerous shellfish pot fisheries. Further, research conducted using lights and luminescent fishing gear was completed by the Marine Institute with reportedly positive results yet has not been adopted by fishers.

Blended bait: Blended baits are comprised of local ocean-based fish species combined with a binding agent that permits both stabilization of the product and slow release of fish oils that are essential to maintain a 'bait bloom' in the water.

- Bait Masters Inc.: Located in PEI, Bait Masters has developed and have been commercially selling 'blended' baits for more than 10 years for pot fisheries in PEI, Maine, and New Hampshire.

Product consists of fresh and dehydrated herring and mackerel and fish oils. They combine it with an all-natural binding agent sourced from the EU and all-natural casings sourced in the USA. The blended bait is reported to last 2-3 days longer in the trap than traditional bait, 4-5 days in total. In 2019, their tests yielded catches the same as traditional baits, if not more.

The product is sold in a frozen sausage form and sells for roughly $1.25 per pound to dealers who then re-sell for up to $1.60 to harvesters.

Capacity at present is 1.7 million pounds per year.

- EcoBlock: Produced in NB by McGraw Seafoods, EcoBlock is a blended bait that utilizes local pelagic and groundfish species with a binding agent. Sold locally through International Seafood and Bait, this frozen product has been field tested in both the snow crab and lobster pot fisheries.

  The EcoBlock is sold in frozen format in 40-pound blocks that can easily be broken into 45 individual pieces. These individual pieces are placed in a bag and are reported to last longer than traditional bait, with similar catch results.

  The price of the EcoBlock is reported to be significantly less expensive than traditional bait sources.

  McGraw Seafoods has the capacity to produce up to 5 million pounds of EcoBlock annually and could expand capacity if demand warranted.

- Synergy Seafoods: Located in southwest NS, Synergy is strategically located to provide bait product to local lobster harvesters. Synergy has worked with a synthetic bait producer (Organo Bait) and offers many traditional bait species to harvesters on the eastern seaboard.

  Synergy was offering a biodegradable bagged mix of bait including herring and mackerel, with something a little extra to stabilize the product. Synergy claims that it fishes better then only herring or mackerel and eliminates the need for a hard bait topper. Currently this product is no longer offered; however, Synergy indicated it may be brought back to market in the future.

  Pricing and capacity were not disclosed.

  SuBait Inc.: This bait being developed as a food to attract lobster. Ingredients in the product were not made available other than it uses a lot of current fishery waste and by-products, and other products that are deemed natural and safe. At present, the product needs to be frozen, but the developer is looking at shelf stable options down the road.

  The product is being tested and has been tested throughout Atlantic Canada and is reported to have mixed results. This was tested, and scored very well, in research being conducted by a team at St. Frances Xavier University under the direction of Dr. Russell Wyeth.

  Commercialization of production is being considered soon. The company currently provides samples to harvesters upon request.

- **Wm. R. Murphy Fisheries Ltd:** The Company have been working with a patented non-frozen bait owned by the scientist who developed the process. It has been tested over the last 4 – 5 years and has gained some interest over the past year.

  This product has been tested with both positive and negative results. One of the key components of this bait is that it will use significantly less fish products and tends to last much longer in the trap than traditional baits. One of the earlier tests indicated that sea lice did not like it very much. Combine that with no freezing required, as it is vacuum sealed and must be kept out of sunlight in a cool room, this product is thought to have potential.

  The product is relatively easy to produce but costs are unavailable currently.

- Pacific Net and Twine: Based in BC, this firm sells several bait attractants, primarily oils and blends. The only product that appears suitable for Atlantic Canadian trap fisheries is the "Toplow Commercial Prawn and Crab Bait" that is reported to be produced by Taplow Ventures. Specific information regarding the product was not provided, yet it appears to be a pellet-based feed product.

  The product is sold in 55-pound bags for $97.58 ($1.77 per pound).

- Ace of Baits: Based in BC, this company is no longer producing their blended bait, but does offer licensing opportunities to other firms. The rationale for this business model is reported to be distribution makes the bait too expensive and local production to service specific fisheries could provide a more competitively priced product.

  The product consists mainly of fish by-products from herring and sardines, oils, and a binding agent. This puck style blended bait is available in three sizes that is reported to last from three to nine days fishing. The reported attributes of the product include:

  ✓ Does not require refrigeration. No freezers or coolers required.
  ✓ Outlasts raw baits and keeps fishing until completely gone.
  ✓ Tests shows no attraction of sea lice or sand fleas.
  ✓ Stores easily and stays fresh, allowing you to keep more on the boat for any trip anytime.
  ✓ 100% Natural fish attractant giving consistent, reliable quality.
  ✓ Starts fishing immediately.

  Ace claims that the product can be applied to a hook (Halibut fishery) and some hook and line testing was done by tying a piece of the puck in a small mesh pouch just after the hook and the product performed very well. The product was also tested in Alaska cod traps with good results. No published testing results were available to verify bait performance.

  The company attended the Moncton Fish and Workboat show in March 2022 so some Atlantic Province harvesters may be familiar with the product.

> ***Conclusion****: Several of the blended bait products appear to be viable options to traditional baits and some are reported to have lower price points that traditional bait species.*

Synthetic bait: Synthetic baits are lab manufactured natural bait substitutes. The precise science regarding the synthetic nature of the product is unknown; however, it is likely to be a plant-based oil product that is like pelagic fish oil.

- Organo Bait: Developed by Kepley BioSystems in North Carolina this fully synthetic bait product was developed in 2016. In a 2020 press release, Kepley indicated that this bait was being tested by the Universite Ste. Anne Marine Research Center in partnership with Clare Machine Works and Synergy Seafoods.

  Testing results have been mixed and the product remains under development.

> ***Conclusion****: A synthetic bait may have some potential in the future; however, the cost of scaling up to commercial production and its performance remains uncertain.*

Acoustic baits: Shellfish are known to react to both sound and light. There are at least two firms that are either developing or providing acoustic devices that may be applicable to Atlantic Canadian shellfish fisheries.

- Livingston Lures: Based in Texas, this firm focuses primarily on sport fishing lures, however, this acoustic device is reported to have been successfully used in several crab fisheries and has been tested in Atlantic Canada over the past 3.5 years with favourable results.

  The technology behind this was first developed and tested back in the 1950's by a Russian and a US scientist. The premise is to mimic the sound of prey or feeding frenzy of the target species. It was initially tested on west coast crab with varying results but showed promise. The product is meant to be used with traditional bait but with much less bait than traditionally used.

  The unit itself is like a small cylinder that would hang with the bait inside the trap. Each unit can be programed with various sounds based on the target species and can be easily changed when needed. The company claims the unit would last many years with regular updates. The unit requires AA batteries and depending on temperature and depth of water, it could last up to 2 weeks before replacing the batteries. They are testing various types of rechargeable batteries now, but do not recommend them currently until testing is complete.

  No independent research publications were available; however, responses from users were favourable. Their recent attendance at regional trade shows indicates their interest in having the product thoroughly tested by harvesters in Atlantic Canada.

  They advertise several units, each is individually programmable, such as the lobster caller.

  The retail price of each unit is US$79.99.

- Acoustic Bait Technologies: Working in conjunction with Dalhousie University, research into this lobster bait replacement has been ongoing for at least three years. It is reported that the biggest challenge is identifying the right acoustics. A prototype is reported to be ready for testing on June 30, 2022. All testing and results will be measured scientifically, and several harvesters are reported to be ready to test this prototype when available.

It is not anticipated that commercial availability of this acoustic product will be available in the short-term.

> ***Conclusion**: Acoustic devices appear to offer good potential for reducing the amount of bait needed while increasing catch performance.*

Non-traditional species use as bait: During consultations several alternative non-traditional bait species were mentioned as having limited testing or potential for use, as follows:

Shrimp: Shrimp had not been previously identified to the Bait Working Group as a potential species to be used as bait. However, the St. Francis Xavier University research group has been using locally caught shrimp in their research and found it to be highly effective. CFIA expressed concern regarding use of imported shrimp due to possible contamination to lobster.

Other shellfish by-product streams, lobster, and crab, have not been tested, though are worthy of consideration given the volumes available from processors,

> ***Conclusion:** Local shrimp, or shrimp heads, have been demonstrated to work effectively and should be available from local producers in eastern Canada.*

- **Atlantic menhaden**: From the same family as herring, this finfish is targeted for commercial meal production and as a bait fish. The most recent stock assessment indicates a biomass of ~4 million mt, and annual harvests of 150,000 mt. The harvest level for commercial meal has reduced since 1990, though bait harvests have increased to the 40,000-50,000 mt range in recent years. This species is reported to be broadly used as bait for the lobster, crab and hook and line fisheries in the U.S., and has limited distribution through Canadian bait suppliers.

  The landed value of menhaden is reported to be in the $0.30 per pound range, increasing in value from $0.20 in the past seven years. Packaged and frozen as bait, the cost of menhaden to harvesters should be in the $0.70-$0.90 range.

> ***Conclusion**: Menhaden offers a viable cost-effective replacement for herring, though long-term performance of menhaden versus herring is unclear.*

- **Green crab**: At first glance, this aquatic invasive species would seem to be a good candidate to offer unrestricted fishing; however, the Department of Fisheries, Forestry and Agriculture, NL has worked in conjunction with DFO NL region for several years to mitigate the spread of green crab. It has been found that green crab populations have negative impacts on the survival of juvenile lobster and eelgrass beds, which are known to be critical nursery areas for juvenile life stages of species such as cod. The strain of green crab in NL is also different from the strain found in the Maritimes and is much more prolific and aggressive. Mitigation efforts in NL have been successful to date. If this species were to be considered for bait purposes, a stringent processing procedure would have to be developed in consultation with DFO and other experts.

The utilization of green crab as a bait type in the fishery poses a high risk of spread to all parts of the island as was the case in the Maritime Provinces.

The Bait Working Group has also been advised by Dr Wyeth that green crab harbours a parasite that can harm lobster. This has been supported through anecdotal evidence provided by one processer in Nova Scotia who reports that green crab causes lobster to be lethargic.

> ***Conclusion:*** *Green crab is an invasive species and consultation with DFO should be completed prior to considering this species for bait use.*

- **Asian carp**: Due to the low cost and high abundance of this species, it would seem to be a good traditional bait alternative; however, it is currently an invasive species near the Great Lakes and thought to be causing extensive damage to the natural ecosystem. Further, meat in frozen form is not permitted to be imported into Canada to be used as bait because thawed meat could also contaminate the environment.

> ***Conclusion:*** *Due to potential for harm, Asian carp should not be considered as a traditional bait alternative*

- **Seal meat**: Seal meat has undergone limited commercial testing. Information indicates that fresh and frozen seal meat did not perform as well as traditional bait species; however, salted seal meat did perform similarly to traditional baits.

  Use of seal meat for bait has support from fishing associations as it would support a commercial hunt for these nuisance species whose populations have continued to grow and are seen as a threat to other commercial species. Industry has requested that the St. Francis Xavier research group include this species in the research. While not against the test for science, the research group feels that using seal meat would cause significant problems in marketing lobster in Europe and therefore questions if it is even useful to test. This marketing issue was also echoed by a representative of the Lobster Council of Canada who expressed the concern that testing seal meat would be a marketing disaster.

> ***Conclusion:*** *Though salted seal meat appears to have potential as a non-traditional bait it may pose a market entry barrier for sale of lobster and crab.*

- **Salmon racks:** Discussions with salmon producers indicated they do not fully utilize by-product from fillet processing and are receptive to discussions regarding sales of heads/racks for bait.

  Estimated annual harvest of whole salmon is 40,000-50,000 mt in Atlantic Canada. Export data indicates on average 5,772 mt of salmon fillets were exported (2016-2020), which equates to ~8,600 mt whole weight, or 19% of landings, and ~2,000 mt of heads/racks.

> ***Conclusion:*** *Salmon producers are receptive to selling some of the available heads/racks (2,000 mt maximum) for use as bait.*

- **Canadian freshwater species:** It is reported that some of the landings of freshwater species have no ready market and may be available for sale as bait fish to Atlantic bait suppliers. The species available were not specified yet are likely carp and suckers.

- **Other supplies:** Producers of capelin and cod in NL were solicited to determine availability of male capelin and cod heads/racks for use as bait. One producer indicated male capelin was being used to a limited degree for bait, whereas other producers indicated that supplies are committed for other uses and will not be available. NL landings of capelin have been ~22,000 mt per year recently and ~50% of these landings (11,000 mt) would be male capelin.

  Conclusion: *There is potential to source male capelin and possibly cod heads/racks*

  Rock crab is a traditional bait species for lobster and a natural prey of lobster. Rock crab in the Gulf of St. Lawrence is captured in a directed fishery (4,000 mt[6]), as bycatch (~300 mt) and under bait license (unknown mt). Information indicates that some of this supply is currently used for bait; however, rock crab is not separated in exported data so no quantifiable quantities can be determined.

Non-seafood alternative bait: Baits from land-based animals have been used to a limited degree in shellfish pot fisheries, and some have been tested in Atlantic Canada.

- **Animals:** During interviews and research, it was indicated non-seafood baits have been used in shellfish trap fisheries including pig ears, and offal (hearts, livers) from chicken processing. Harvesters expressed reluctance to introduce land-based product into the ocean environment due to the potential for contamination. This aligns with similar concerns expressed by the CFIA.

  Conclusion: *Concerns regarding potential contamination of the ocean habitat precludes the use of animal-based bait products.*

Alternative bait supplier view: Several of the suppliers of alternative bait options have expressed frustration over the past several years trying to get harvesters interested to at least test the product. They have been successful in some areas, but it remains a challenge. Regardless, with the availability of preferred local baits declining and increasing cost of available traditional baits, producers indicate there is higher levels of interest from harvesters.

Scientific testing of alternative baits: Feedback from harvester associations indicates that alternative baits have not been adequately tested scientifically. They stated that most testing has been done by harvesters, and testing in some cases is cut short if it is perceived the bait is resulting in lower catches.

Conclusion: *The broad adoption of alternative baits will likely be driven by increasing costs of preferred bait. However, providing information to harvesters regarding these options, conducting further research on performance of these alternatives, and establishing a research protocol that can be easily adopted by harvesters that will test these alternatives would all be of benefit.*

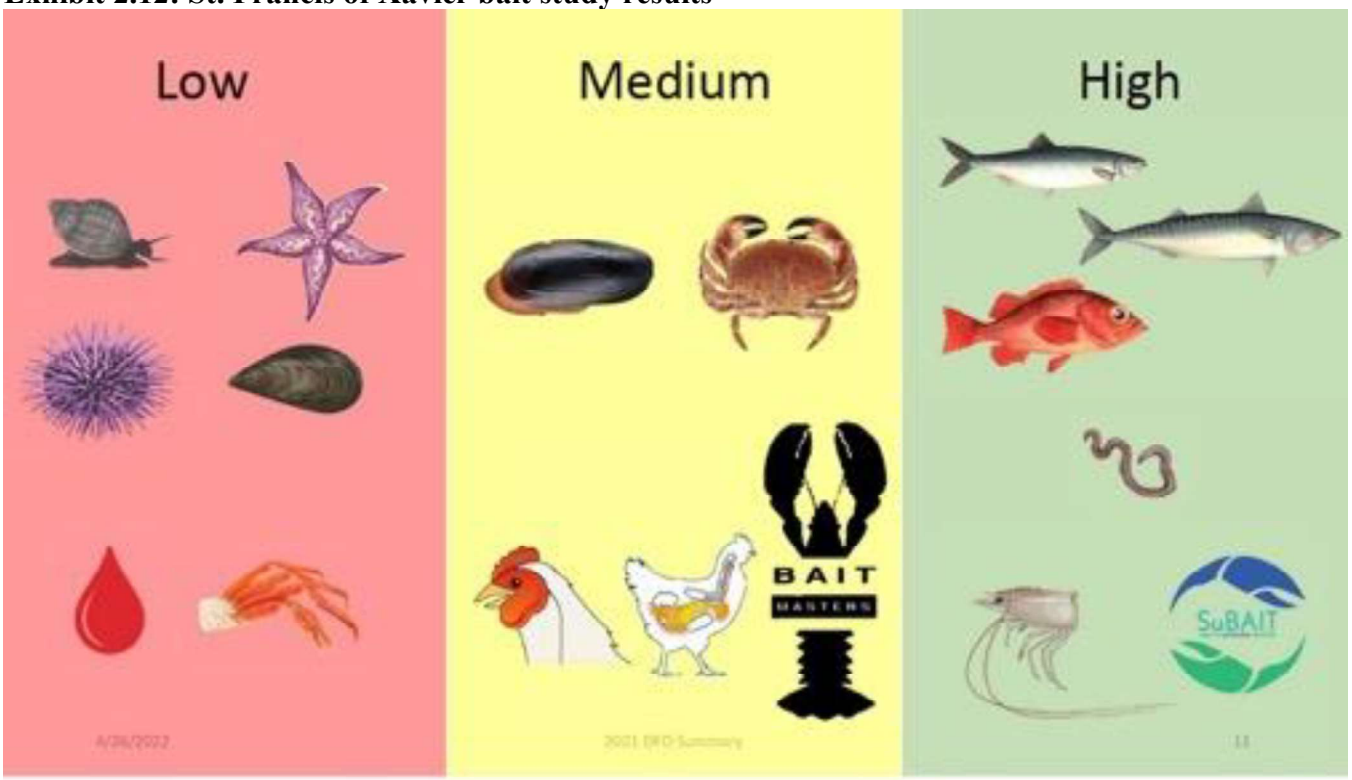
[6] CSAS SAR 2018/044 and RD 2019/007

Further, it is perceived that scientific protocols are not broadly used whereby there is control and experimental traps, and bait use protocols are not documented.

There has been recent scientific study of bait use carried out by Dr Wyeth and his team from St. Francis of Xavier University (Appendix VII). Various bait types, including some blended baits, were tested using a camera system and bait bag to determine how many lobsters entered the field of view (FOV), inferring that the more lobster in the FOV indicates a greater attraction to the bait source. In a recent presentation the study results categorized the various baits tested and ranked them into three categories in terms of efficacy, as illustrated in the following exhibit.

As indicated by interviews, harvesters preferred baits including herring, mackerel and redfish are demonstrated to be the three of the six most effective for attracting lobster. Noticeably absent from study results reported to date are the EcoBlock, ground bait (Merinov), and acoustic devices.

Exhibit 2.12: St. Francis of Xavier bait study results



Conclusion: *Securing support to test the alternative baits not previously tested and expanding the study to include snow crab harvesting with the same protocols and rigor would better inform stakeholders on the potential for commercial use.*

2.6 Options for Bait Use Reduction

Reducing the quantity of bait used in each pot will reduce overall demand for bait if adopted broadly by harvesters. A report completed by Merinov indicates that if any of the preferred bait species for lobster

are ground and bagged rather than using whole or pieces in the pot, the quantity of bait required to realize the same catch rates is reduced 21%- 25%.

Exhibit 2.13: Use of ground bait in the lobster fishery

	Bait Price/lb	Traditional Daily Cost	Daily Cost for Ground Bait		Daily Bait Cost Savings	
			1.6mm Bag	1.27cm double	Low	High
Mackerel	1.00	276	215	208	22%	25%
Herring	0.77	207	164	156	21%	25%
Yellowtail whole	1.27	345	267	260	23%	25%
Turbot rack	0.73	193	153	146	21%	24%

Source: Optimization of traditional baits used in Quebec for lobster and snow crab fishing (2014) - Merinov

There are numerous suppliers of suitable commercial grinders (e.g., Hobart, Baader, etc.) and depending on the application the cost can vary significantly. Broad adoption by harvesters of a grinded bait would likely prompt bait suppliers to acquire commercial size equipment and offer ground bait in blocks or in bags for sale to distributors and harvesters.

Conclusion: *Using ground traditional baits rather than whole or pieces in lobster fishing can reduce bait demand by up to 25%.*

Merinov also completed a study of traditional bait use in snow crab fisheries[7] gathered information regarding species preference and quantities used and examined the bait use and value compared to catch rates through the season. Overwhelmingly, 70%, herring was the preferred species followed by mackerel and squid. It was found that herring and mackerel baits were usually changed out each haul, whereas squid was not. The ratio of bait to snow crab captured varied by crab fishing area, ranging from 7.5 to 29.5 pounds of crab per pound of bait used. It was observed that pot saturation did occur, indicating that a reduction in use of bait when very high catch rates occur would have resulted in the same catch per unit effort.

Conclusion: *Examination of bait quantities to catch ratios and pot saturation would permit defining the maximum quantity of bait required in each crab fishing area, which may result in reduced bait use.*

2.7 Stakeholder Interview Responses

Personal interviews were conducted with a representative number of industry stakeholders (Appendix I) of the Atlantic Canadian seafood industry, including harvesting associations, fish producers and bait suppliers. A total of 53 associations/companies were selected and contacted to schedule discussions. While the list of questions varied slightly between the stakeholder groups the main objective of all interviews

[7] Use of traditional baits in commercial snow crab fisheries (2014)

was to gather information about the supply and demand of bait and awareness and testing of alternative baits. A summary of responses from all participants is provided in Appendix III.

Exhibit 2.14: Interview response rate by stakeholder group

	Interview Participation		
	Target	**Actual**	**Participation**
Fishery associations	17	12	71%
Processors	18	11	61%
Bait supplier	18	15	83%
Total	**53**	**38**	**72%**

There was some commonality in responses from each stakeholder group, as follows:

- **Associations**

  - ✓ All harvester associations expressed grave concerns about the future supply of traditional bait needs. Herring supply is of concern as it is preferred species for member harvesters. Fresh mackerel is another, but it appears adequate supplies of frozen mackerel are available from various sources offering EU, US, and Japanese origin products.

  - ✓ The cost of bait has risen significantly over the past number of years, 45% in some areas, and bait suppliers indicated continued supply chain issues may result in further cost increases of 30% going into 2023. There are significant concerns regarding affordability of bait and access to bait species in the Gulf of St. Lawrence.[8]

  - ✓ It is anticipated that the cost of mackerel will be more than $2.00 per pound in 2023. The price of herring is uncertain. With the closure of mackerel fishery nationally and reduction in availability of herring due to quota reductions, this has put significant pressure on the cost of bait, particularly for those that used to harvest their own bait.

  - ✓ There were four associations whose members had tested alternative baits, and several more are receptive to testing if it is ocean supplied product. Most are apprehensive to use alternative supplies such as land mammal waste. The key criteria for adoption of any alternative bait are that it be, environmentally acceptable,[9] it performs as good as traditional bait and offers cost savings.

  - ✓ Four respondents mentioned compensation should be paid if testing of alternative baits resulted in lower catches.

  - ✓ Four respondents mentioned opening Unit 1 redfish for bait.

  - ✓ Two respondents mentioned that the import restriction on Asian Carp should be lifted.

[8] CBC news June 23.
[9] CBC news June 24.

- **Processors**

  - ✓ Though some processors purchase and freeze and/or import bait species directly, most rely on bait suppliers for most/all their bait supplies. Further, these processors for the most part provide bait as a service to their harvesting supplies, selling bait at cost. The processing sector has no immediate concerns regarding bait supply; however, many were uncertain regarding supply availability of herring in the future.

  - ✓ Processors in the groundfish sector indicated that increasing demand for heads/racks as an alternative source of bait has increased the value of the by-product stream from their operations. Redfish producers indicated that without a bait market for heads/racks and undersize whole, the production of redfish fillets would not be viable.

  - ✓ There was concern over availability of bait in the fall as fresh mackerel is preferred.

  - ✓ Current demand is being met, yet future supply availability seems uncertain.

  - ✓ Mackerel is the preferred species by most processors, following by herring and redfish.

  - ✓ Alternative baits have not been broadly tested. However, demonstrating that the bait works is paramount, and price will be very important.

- **Bait Suppliers**

  - ✓ All large bait importers state there are no supply issues except for herring.

  - ✓ Bait supplier concerns were not on availability of baits but on logistics and increasing costs. Most indicated they have been sourcing supplies globally for a long time, though some had previously relied exclusively on domestic supplies and had only recently began importing. The biggest challenge identified was receiving bait in a timely manner due to logistics challenges. This is reflected in the higher shipping costs, reported to have increased from $5,000 to more than $20,000 per container, being incurred since the onset of the pandemic.

  - ✓ Bait suppliers indicated that the primary sources of bait are:

    - Mackerel – Iceland, Norway, EU, Japan, USA, and local.

    - Herring – Local and USA.

    - Redfish heads/frames and small whole – Iceland, Norway, (Russia -no more), other EU sources, and local.

    - Gaspereau (alewife)– Local

    - Silversides – PEI

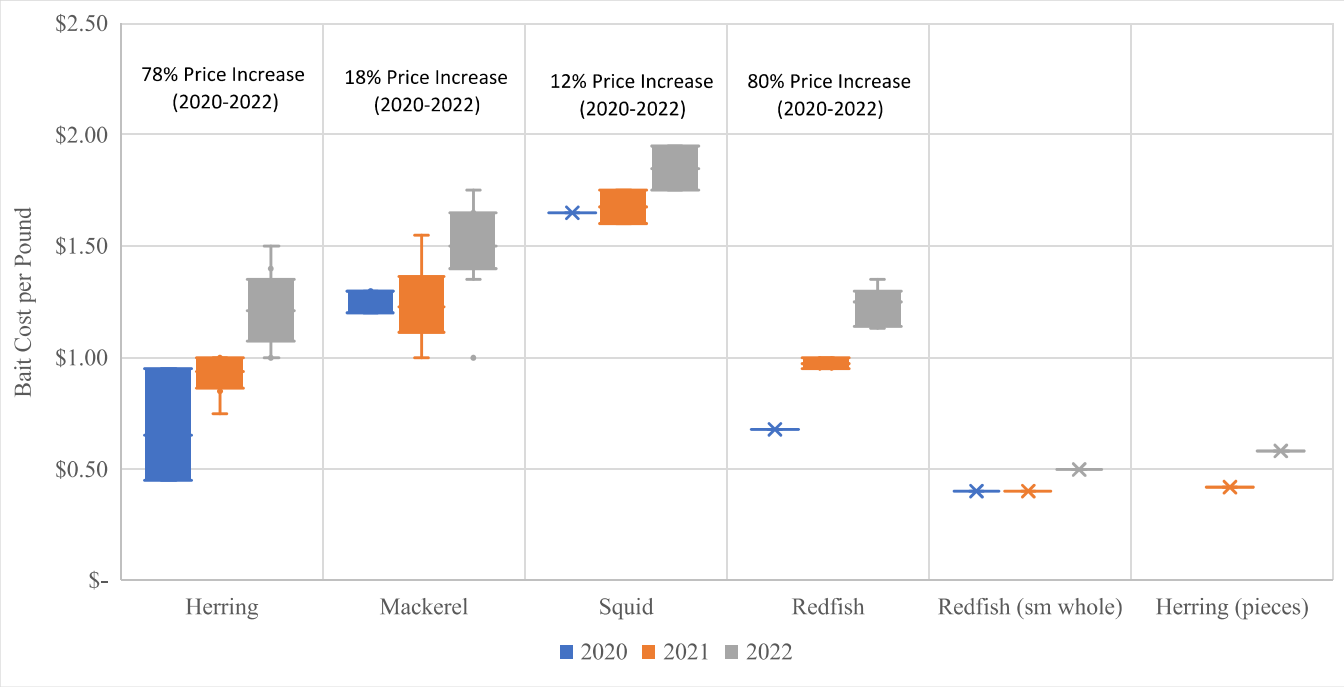
- Allowable trap bycatch based on area license – Sculpin, rock crab, green crab.

2.8 Bait Prices

Bait prices vary by species, supplier, area and bait source (e.g., imported, domestic, size, fresh or frozen etc.), though all responses indicated that bait prices have steadily increased in recent years. Further, given current inflationary pressures and supply chain costs, bait prices are anticipated to increase further in 2023.

Examination of preferred bait species indicate that prices of bait supplies primarily from domestic sources increased significantly in the past two years whereas species sourced from international supplies had more modest price increases. Based on the average annual prices cited by respondent's herring prices increased 78% and redfish 80% in the past two years, mackerel and squid have increased 15% and 12% respectively.

Exhibit 2.15: Harvester bait prices



Source: Interview responses

> ***Conclusion:*** *Due to limited supply the price of domestic bait species has increased more rapidly that broadly available imported supplies.*

3.0 LOGISTICS

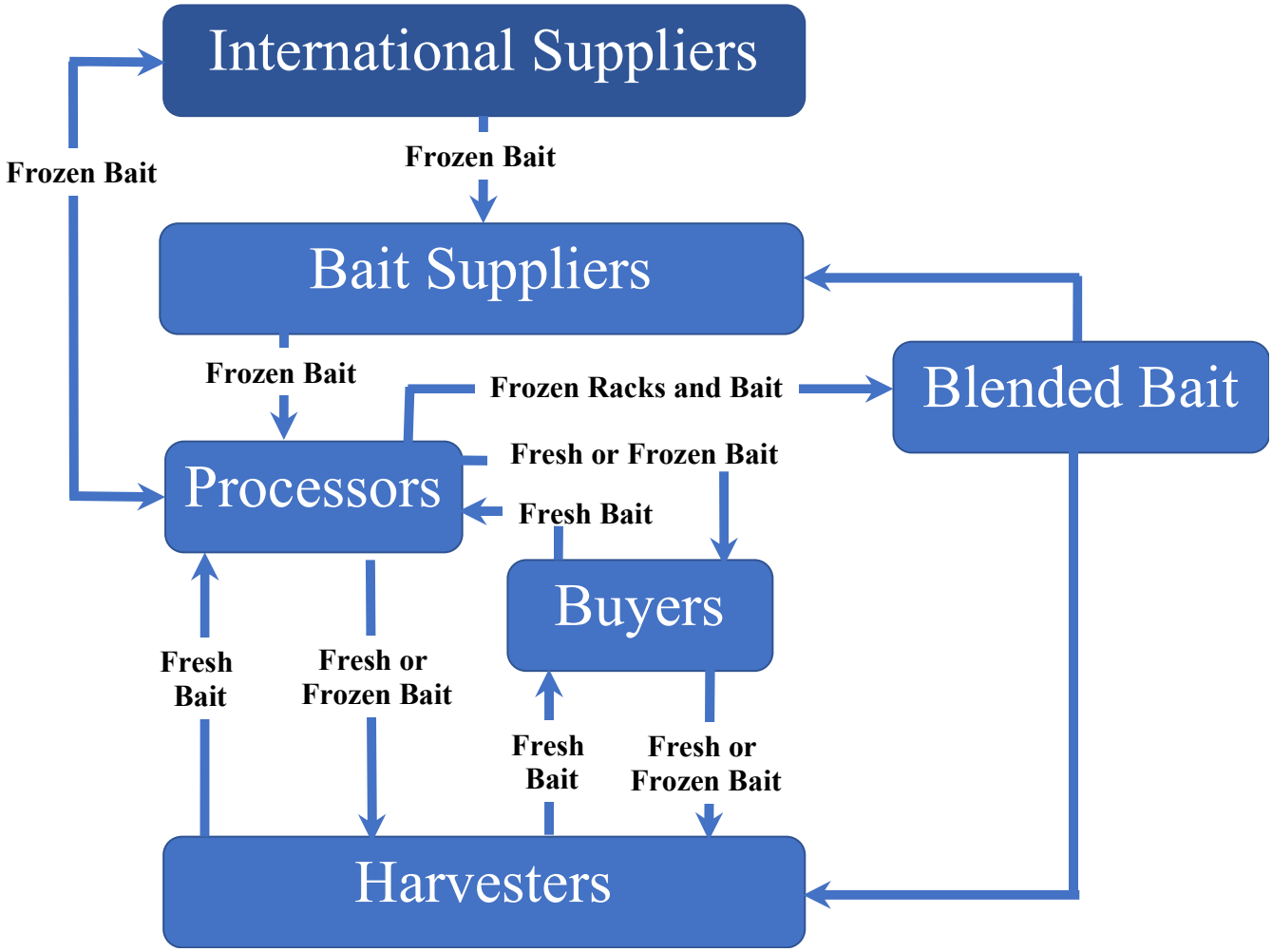
3.1 Procurement and Distribution

In the simplest terms, bait is procured domestically by producers, harvested and frozen by commercially licensed pelagic or bait fishers, and imported by large bait suppliers and producers. It can be more complex as some producers import bait, and there is trade amongst the various stakeholders. The procurement and distribution of bait works very effectively, as providing bait to harvesters is an essential service provided by the buyer/processor.

Given the shortfall of domestic bait supplies, an increasing amount of bait is secured through both traditional and new international supply channels. With current supply chain issues, the ease of importing bait has been disrupted, requiring importers to plan much further ahead, and incur higher transport, holding and financing costs.

The following exhibit illustrates how domestic and international bait supplies are traded.

Exhibit 3.1: Flowchart of bait movement



3.2 Cold Storage

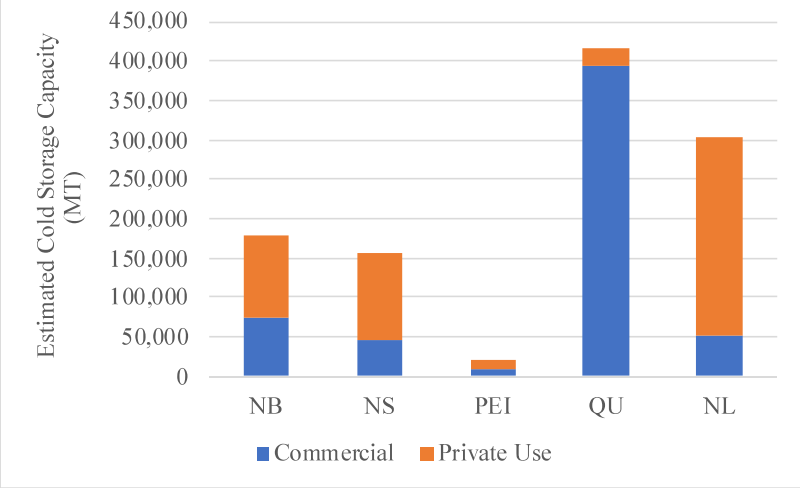
Cold storage capacity: The demand for cold storage will increase with the higher quantities of imported baits that will be required to replace the lower volumes of available domestic herring and mackerel. Further, the longer lead times to procure imported bait supplies due to current supply chain challenges will require longer term storage. It is reported that orders for bait supplies from Asia are being placed now for next season, and that order lead times for eastern North Atlantic supplies have increased. The sentiment is that the supply chain issues should be resolved over the next 1-2 years, reducing the excessive order lead times currently being experienced.

Those interviewed did not express any concerns regarding access to cold storage. However, most interviews were conducted prior to the current buildup of frozen crab and lobster products, that has resulted in the near full cold storage capacity along the eastern seaboard. The duration of cold storage demand from these shellfish holdings is uncertain though it is reported that market prices appear to be stabilizing, albeit at lower levels, which should increase movement of these inventories. Consumer uncertainty regarding inflation has certainly dampened demand for luxury food products, and the concern is that a long-term recession may result in significant seafood inventory carryover into 2023, which may limit cold storage availability.

If long-term need for cold storage capacity is required, the private sector should respond[10] to meet this demand. The growing need for cold storage capacity to service consumers changing buying habits are well understood[11] and some estimate that up to 100 million square feet of additional cold storage will be required in North America. Commercial cold storage operators, retailers and investors should respond to this need making the required investments.

Though comprehensive information regarding cold storage capacity is not known for all jurisdictions adjacent to the Canadian Atlantic fishery, an estimate of commercial and private use facilities based on jurisdictional population and landings respectively was completed. It is estimated there is total capacity of approximately 1 million mt, split relatively evenly between commercial and private use operators.

Exhibit 3.2: Estimated cold storage capacity



Source: Adapted from BWG source documents

[10] Construction of new 219,000 square foot cold storage.
[11] Datex

***Conclusion**: Demand for cold storage will increase due to anticipated increases in bait imports. This demand increase should occur from December to March as bait inventories build. Traditionally, this is the lowest period of cold storage use for the seafood industry.*

Cold storage fees: The costs for using commercial cold storage facilities are reported to have remained stable in recent years. The fees charged for use of commercial cold storage facilities include three components, a fee to place the product in, a fee to remove the product, and a monthly storage fee. Other fees may be charged for special requests by the client (sample removal, product testing, space reservation, etc.). The in/out and monthly fee is reported to range from $0.010-$0.015 per pound, plus $0.010 -$0.015 for storage fee per month, meaning that if a product is stored for one month, it would attract a $0.030-$0.045 fee, a two month storage period would cost $0.040-$0.070, etc.

***Conclusion**: Commercial cold storage fees have remained relatively unchanged in recent years; however, inflation and fuel costs will likely result in fee increases in the short-term.*

Cold storage costs: Due to supply chain issues, bait importers indicated that they are ordering bait many more months in advance than they traditionally did. This will impact the costs of cold storage as much of this inventory will likely have to be held for an additional 1-4 months. Coupled with anticipated cost increases to cold storage fees, 10% estimate, the total incremental cost impact per pound of bait imported will likely increase $0.05-$0.07 per pound due to these supply chain challenges.

***Conclusion**: Commercial cold storage costs will likely increase $0.05-$0.07 per pound due to longer holding times to address supply chain issues and anticipated inflationary fee increases.*

3.3 Financing Cost

All costs associated with importation and distribution of imported baits have increased including the trade value, transport cost, and cold storage costs. Given almost all imported baits are purchased in advance of the peak fishing seasons, all these costs must be financed whether through charter bank loans or the opportunity cost incurred by using internal cash reserves. The anticipated incremental financing cost due to supply chain issues is estimated to be $0.025 per pound based on a $1.50 cost delivered, a four-month public storage holding time and a 4.7% prime interest rate . Further, indications are that the cost of financing will increase more in 2022.

***Conclusion**: Financing costs will increase due to bait supply shortages and likely increase the cost of bait $0.025 per pound or more.*

APPENDIX I CONTACTS

Appendix AI.1: Stakeholder contacts: The following number of contacts were made with each sector.

- **Harvesting associations 17**
- **Processors 18**
- **Bait suppliers 18**

APPENDIX II INTERNATIONAL SUPPLIES

Exhibit AII.1: Atlantic mackerel international potential supplies

Rank	Country of Origin	2019 Landings (MT)	% of Total	Known Supplier to Canada	Certified
1	Norway	159,104	18%	Yes	No
2	United Kingdom	152,143	18%	Yes	Yes -7%
3	Russian Federation	147,746	17%	No	No
4	Iceland	128,084	15%	Yes	No
5	Faroe Islands	63,224	7%	Yes	No
6	Ireland	53,490	6%	Yes	Yes
Sub-Total		703,791	81%		
	Other EU countries	121,888	14%	Yes	No
	USA	30,473	4%	Yes	No
	Canada	4,192	<1%	Yes	No
	All other countries	8,649	1%	NA	NA
World Total		868,994	100%		

Source: FAO, StatsCan trade data, MSC

Exhibit AII.2: Atlantic herring international potential supplies

Rank	Country of Origin	2019 Landings	% of Total	Known Supplier	Certified
1	Norway	561,299	36%	No	Yes - 21%
2	Denmark	125,712	8%	No	No
3	Faroe Islands	117,563	8%	No	No
4	Russian Federation	113,327	7%	No	No
5	Finland	113,113	7%	No	Yes -90%
6	Sweden	94,182	6%	No	No
7	Netherlands	83,799	5%	No	No
8	United Kingdom	75,456	5%	No	Yes 5%
Sub-Total		1,284,451	82%		
Other EU countries		186,410	12%	N o	NA
Canada		73,514	5%	Yes	No
USA		11,213	1%	Yes	No
All other countries		3,433	<1%	No	NA
World Total		1,559,021	100%		

Source: FAO, StatsCan trade data, MSC

Exhibit AII.3: Pacific mackerel/chub mackerel international potential supplies

Rank	Country of Origin	2019 Landings (MT)	% of Total	Known Supplier to Canada	Certified
1	China	479,156	34%	Unknown	No
2	Japan	450,441	32%	Yes	No
3	Korea, Republic of	101,142	7%	Unknown	No
4	Chile	88,241	6%	Unknown	No
5	Russian Federation	84,272	6%	Unknown	No
6	Taiwan (China)	62,308	4%	Unknown	No
Sub-Total		1,265,560	89%		
Other countries		151,008	11%		
World Total		1,416,568	100%		

Source: FAO, StatsCan trade data, MSC

Exhibit AII.4: Northern short-fin squid international potential supplies

Rank	Country of Origin	2019 Landings (MT)	% of Total	Known Supplier to Canada	Certified
1	USA	26,398	93%	Yes	Yes
2	Spain	1,840	6%	Yes	No
3	Faroe Islands	122	<1%	Yes	No
4	Portugal	58	<1%	No	No
5	Ireland	57	<1%	Yes	No
6	Canada	30	<1%	NA	No
7	Germany	3	<1%	No	No
8	Russian Federation	1	<1%	No	No
World Total		28,509	100%		

Source: FAO, StatsCan trade data, MSC

Exhibit AII.5: Argentine short-fin squid international potential supplies

Rank	Country of Origin	2019 Landings (MT)	% of Total	Known Supplier to Canada	Certified
1	Argentina	96,265	56%	Yes	No
2	Taiwan (China)	34,000	20%	Yes	No
3	China	20,880	12%	Yes	No
4	Korea, Republic of	14,263	8%	No	No
5	Spain	2,749	2%	Yes	No
6	Vanuatu	1,507	1%	No	No
7	Uruguay	1,007	1%	Yes	No
8	Falkland Is.(Malvinas)	233	<1%	Yes	No
9	United Kingdom	2	<1%	No	No
Total		170,906	100%		

Source: FAO, StatsCan trade data, MSC

Exhibit AII.6: Atlantic redfish international potential supplies

Rank	Country of Origin	2019 Landings (MT)	% of Total	Known Supplier to Canada	Certified
1	Russian Federation	38,312	46%	Yes	No
2	Norway	24,603	30%	Yes	No
3	Iceland	8,679	10%	Yes	Yes
4	USA	5,320	6%	Yes	No
5	Spain	1,994	2%	Yes	No
6	Lithuania	1,609	2%	No	No
7	Portugal	1,096	1%	No	No
8	Greenland	615	1%	No	No
9	Poland	471	1%	No	No
10	Netherlands	243	<1%	No	No
11	United Kingdom	7	<1%	Unknown	No
12	Denmark	3	<1%	Unknown	No
Total		82,952	100%		

Source: FAO, StatsCan trade data, MSC

APPENDIX III INTERVIEW RESPONSES

Exhibit AIII.1: Fishery association interview response summary

	Bait				Species Use Ranking									Alternative Baits				
Fishery	Current Availability	Future Availability	Annual Use (MT)	What are Supply Sources	Herring	Mackerel	Squid	Red	Black Back	Gaspereau	Silverside	Menhaden	Other	Tested	Type	Results	Price Point	Research
Lobster	Good	Uncertain		Barry Group &	1	2		3						No				
Crab	Good	Uncertain	5,000	QuinSea			1						Sculpin	No				
Lobster	Good	Uncertain		Cap Pele Bait	2	1		4		3	5		Rock Crab	Yes		Unknown		
Lobster	Good	Uncertain		Buyer	1	2		3						Yes	Clam/salmon/rock fish/pig hide	Varies	Important	Required
Lobster	Good	Good		Buyer	3	2		1						Yes	Freshwater, salt seal			None done
Lobster	Uncertain	Uncertain		Murphy/Comeau	1	2		3					Gfish cutting	No				
Lobster/Crab	Uncertain	Uncertain		Int'l, Cap Pele	3	1		2					Bycatch	No				
Lobster	Good	Uncertain		Buyer		1		2						No				
Crab	Good	Uncertain		Buyer		2	1							No				
Lobster	Uncertain	Uncertain		Local & NS	1	2								No				
Lobster	Good			Buyer		1		2						No				
Lobster	Good	Uncertain		Buyer		1		2					Bycatch	Yes	Cowhide	Poorly		None done
Crab	Good	Uncertain		Buyer	1									No				
Crab	Good	Uncertain		Int'l, Buyer	1		2							No				

Exhibit AIII.2: Processor interview response summary

Bait					Species Use Ranking									Alternative Baits			
Current Availability	Future Availability	Annual Use (MT)	Do you Freeze Bait	What are Supply Sources	Herring	Mackerel	Squid	Red	Black Back	Gaspereau	Silverside	Menhaden	Other	Tested	Results	Price Point	Research
Good	Good	250	No	Local	1	2								No			
Good	Uncertain	200	No		1									Yes			
Good	Uncertain		No			1		2	3					No			
Good	Uncertain		No	Cape Pele Bait	2	1		4		3	5			No			
Good		700	No		4	1		2				3		No		Important	Required
Good			No	Scandanavia	2	1		3						Yes	Clam was good	Important	
Good	Good		Yes - Racks	Own supply										No			
Good	Good	1200	Yes	Herring	1								2 - Capelin	Yes	Male capelin was ok.	Important	

Exhibit AIII.3: Bait supplier interview response summary

	Bait					Alternative Baits				
Species	Current Availability	Future Availability	Annual Use (MT)	What are Supply Sources	Buy and Freeze Bait	Tested	Type	Results	Price Point	Research
Herring	Challenging	Concerned		Atl. Canada	Yes	Yes	Nano Tech	Mixed	Must be lower	Required
Mackerel	Good	Good		All over	No					
Redfish	Good	Good		Local	Yes					
Squid	Good	Good		Int'tl	No					
Herring	Good	Uncertain		Atl. Canada	No	No				Required
Mackerel	Good	Good		Europe/Iceland	No					
Redfish	Good	Good		Europe/Iceland	No					
Squid	Good	Good		Argentia, US, Canada	No					
Mackerel	Good	Uncertain		Scandanavia, EU, Japan	No	No			Must be lower	
Redfish				Cap Pele	No					
Herring	Uncertain	Uncertain	150 mt	To Quinlans	No	Yes	Master Bait	Uncertain	Must be lower	
Herring	Good				Yes	No				
Mackerel	Good	Good		Oversees	No					
Redfish	Good	Good		Europe/Iceland	No					
Herring	Uncertain	Uncertain		Local		Yes	McGraw	Not positive		
Mackerel	Uncertain	Good		Local		Yes	Bullet Tuna	OK		
Squid	Good	Good								
Redfish	Good	Good								
Blackback	Good	Good								
Herring	Good	Good		Local		No				
Mackerel	Good	Good	10,000 mt	Int'l						
Redfish	Good	Good	total	Int'l/Local						
Squid	Good	Good		Int'l						
Herring	Limited	Limited		Local	Sell fresh only	No				
Herring			4,000 mt	Local	Yes, but sell fresh too.	Yes	Herring meal/oil	Poor		
Herring	Uncertain	Uncertain		Local	Yes	No				
Mackerel	Good	Good		Spanish	No					
Mackerel	Good	Good		Other	No					
Redfish	Good	Good		Europe/Iceland/local	Yes					
Herring				Local	Yes	No				
Mackerel				Int'l						
Redfish				Int'l/Local	Yes					
Salmon				Local	Yes					
Herring					Yes					
Mackerel					No					
Redfish					Yes					
Squid					No					
Blackback					Yes					
Other					Yes					
Herring	Good	Good			No	No				
Mackerel					No					
Redfish WR/Heads				Overall, 50% Imported	No					
Halibut heads					No					
Groundfish cuttings					No					
Herring	Good	Good			No	Yes				
Mackerel Menhaden Flounder Redfish WR Groundfish byproducts Capelin			16,800mt total	In total, 63% imported from Iceland, Norway, Scotland, Spain, Japna, USA and others			McGraw Seafoods Mix and Light	Harvesters not impressed		
Herring Mackerel Groundfish Cuttings				All local		Yes	McGraw Seafoods Mix and Light	Excellent	$0.75 / lb	

APPENDIX IV DOMESTIC BAIT/RACK LANDINGS

Exhibit AIV.1: Bait species and rack bait species domestic landings

	2016			2017			2018			2019			2020		
	Landings	Value	$/lb	Landings	Value	$/lb	Landings	Value	$/lb	Landings	Value	$/lb	Landings	Value	$/lb
Herring	118,492	48,459	0.19	100,822	49,562	0.22	100,179	52,612	0.24	93,902	72,406	0.35	81,445	50,922	0.28
Mackerel	7,746	6,768	0.40	9,479	10,820	0.52	11,061	10,996	0.45	8,734	9,233	0.48	7,809	8,850	0.51
Alewife	1,326	1,052	0.36	1,676	1,642	0.44	2,113	2,203	0.47	1,850	2,329	0.57	3,150	2,835	0.41
Silversides	199	391	0.89	178	382	0.97	199	441	1.00	159	365	1.04	167	406	1.10
Squid	152	208	0.62	365	519	0.65	1,275	2,350	0.84	2,748	5,136	0.85	3,530	5,939	0.76
Subtotal	127,914	56,878	0.20	112,521	62,926	0.25	114,826	68,602	0.27	107,392	89,470	0.38	96,100	68,952	0.33
Domestic rack bait species - Whole weight															
Cod	18,213	27,786	0.69	22,743	34,609	0.69	18,247	27,745	0.69	15,861	27,158	0.78	14,004	23,317	0.76
Haddock	15,871	24,914	0.71	19,015	26,838	0.64	17,333	18,724	0.49	19,331	22,313	0.52	17,033	20,261	0.54
Redfish	10,043	13,329	0.60	12,522	16,201	0.59	12,422	15,717	0.57	14,966	17,888	0.54	12,072	22,572	0.85
Salmon	58,422	541,764	4.21	53,767	536,487	4.53	51,281	534,117	4.72	43,925	405,533	4.19	36,421	276,923	3.45
Carp	779	626	0.36	802	642	0.36	600	478	0.36	607	476	0.36	545	618	0.51
Subotal	103,328	608,419	2.67	108,850	614,776	2.56	99,884	596,781	2.71	94,691	473,367	2.27	80,075	343,690	1.95
Rack Weight	51,664			54,425			49,942			47,345			40,037		
Total Max.	179,578			166,946			164,768			154,738			136,138		

Source: Adapted from DFO seafisheries landings, DFO aquaculture landings, NL DFA salmon landings

APPENDIX V ALTERNATIVE BAITS

Exhibit AV.1: Profile of alternative bait products

	Bait Masters	EcoBlock	Synergy Seafoods	SuBait	Wm.R. Murphy Fisheries	Pacific Net and Twine	Ace of Baits	Organo Bait	Lobster Caller, Crab Caller	Acoustic baiting
Link:	https://baitmastersinc.com	https://internationalseafood.co/bait-products	https://kepleybiosystems.com	http://subait.ca	https://www.novascotiaseafoodalliance.ca	1-604-703-0129	https://www.aceofbaits.com	https://kepleybiosystems.com	https://www.livingstonlures.com	
Producer:	Bait Masters Inc.	McGraw Seafoods	Synergy Seafoods	SuBait	Wm.R. Murphy Fisheries Ltd	Toplow Feeds	Ace of Baits	Kepley Biosystems	Livinston Lures	In development
Seller:	Bait Masters Inc.	International Seafood and Bait	Synergy Seafoods	SuBait	Wm.R. Murphy Fisheries Ltd	Pacific Net and Twine	Ace of Baits	Synergy Seafoods	Livinston Lures	In development
Location:	PEI	NB		NS	NS	BC	BC	US	US	NS
Product form:	Frozen sausage	Frozen - 40 lb block	Salted in biodegradeable bag	Frozen	Vacuum packed shelf stable	Bagged pellets	Individual pucks, 3 sizes, vacuum packed	Individual pucks dried	Acoustic device	Acoustic device
Bait type:	Blended local products	Blended local products	Salted local products	Blended local fish byproducts	Not specified	Pelletized local products	Blended local product	Lab synthesized	Sound	Sound
Current capacity:	1.7 million lbs annually	5.0 million lbs annually	Not specified	Lab production only for testing from deveoplers garage	In development	Not specified	No longer producing	Not specified	unkown but no limited	In development
Maximum capacity:	N/A	Could double production	Not specified	Lab production only for testing from deveoplers garage	In development	Not specified	Not specified	Not specified	unkown but no limited	In development
Source:	Fresh and dehydrated herring, / mackerel and fish oils	Local byproducts (herring, mackerel, haddock,etc.)	Herring and mackerel	Seafood -by -products from local processors and other approved ingredients	Fish products including oils and binding agents	Not specified	Herring, sardines and oils	Hygroscopic complements, binders, and solvent	Sound	Sound
Price/lb:	$1.25 per lb to dealers	$0.75-$1.00 to dealers	Not specified	Not specified	Not specified	$1.77 per pound	Product will be sold by what they refer to as a puck which is vacuum sealed and does not have to be frozen	Not specified	US$79 per unit	In development
Status:	Product is sold in frozen sausage form with varied results but over all apears to be favorable from what they are seeing.	Commercially tested lobster/crab with excellent results.	Not specified	Product has to be frozen and is still in testing mode. Some were positive and others no so good.	Prodcut does not need to be frozen and has had mixed results in tests thus far.	Primarily for recreational fishing, no further information provided	Looking for companys to contract for production based on him receiving royalities.	In development	Has been tested in Alaska, Eastern US, and Altantic Canada with very favourable results being reported over the last 3-4 years.	In development

APPENDIX VI IRRADIATION

Briefing Note
Irradiation to Kill Pathogens in Fish

Date: May 10, 2022
Prepared by: Pisces Consulting Limited

What is irradiation? During the irradiation process, food is exposed to an ionizing energy source. Three different types of ionizing radiation may be used: gamma rays, electron beams and x-rays. The length of time the food is exposed to the ionizing radiation and the energy level of exposure determine the dose of irradiation. The doses used for food irradiation do not result in the food becoming radioactive.

Internationally, there are 150 irradiation facilities in over 40 countries.

Nordion gamma irradiation system is the most used technology in the world comprising 120 of the ~200 large scale irradiators used commercially.

Economics of irradiation : Irradiation is a capital-intensive technology requiring a substantial initial investment, ranging from $1m-$3m, or more. IN the case of large research or contract irradiation facilities, major capital costs include a radiation source (cobalt-60), hardware (irradiator, totes and conveyors, control systems and other auxiliary equipment, land, radiation shield, and warehouse. Operating costs include salaries, utilities, maintenance, taxes/insurance, cobalt-60 replenishment, general utilities, and miscellaneous operating costs[12].

[12] Kunstadt et al., USDA 1989

Broken down, irradiation costs range from US $10 to $15 per ton for a low-dose application, up to US $100 to $250 per ton for a high-dose application. These costs are competitive with alternative treatments such as canning, freezing, pasteurization, refrigeration, and fumigation. In some cases, irradiation can be considerably less expensive. For disinfestation of fruit in Thailand and the United States, for example, it has been estimated that the cost of irradiation would be only 10%-20% of the cost of vapor-heat treatment. The cost to build a commercial food irradiation plant is in the range of US $4 million to $10 million, depending on its size, processing capacity (respectively 15 to 250 + million pounds per year throughput capacity), and other factors.

In most cases, low-dose applications can be used to deal with phytosanitary issues, but high doses are used to sterilize. With 2,000 pounds in a ton, these numbers indicate a cost of from half a cent to ¾ of a cent per pound for low-dose application and from five cents a pound to 12.5 cents a pound.

Contracting with an off-site company was profitable for throughput rates of 150 and 200 million pounds per year. Specific costs estimates were $0.04, 0.02, 0.015, and 0.01 per pound for 50, 100, 150, and 200 million pounds annually, respectively for the X-ray system. The Cobalt-60 system resulted in cost estimates of $0.02, 0.015, 0.01, and 0.008 per pound for 50, 100, 150, and 200 million pounds annually, respectively. Contracting services resulted in costs of $0.06 per pound for 50 and 100 million pounds annually and $0.05 per pound for 150 and 200 pounds annually. The cost of $0.06 per pound for contracted services resulted in negative revenue values based on the present business simulation model.

With different methods, we have different prices ranging between $.008 cents per pound and $.06 cents per pound, depending on the type of irradiation and the volume.

Adjusting for CPI (1.48) since the time of this publication would result in estimated costs of up to $0.09 for the preferred option.

Sadex Corporation is one of the largest third-party contractors for irradiation of food products.

EU approved facilities for treatment of food with ionising radiation comprise 24 separate facilities in 13 countries. Many of these countries are harvesters and processors of herrings and mackerels.

Canada FAQ regarding food irradiation indicates:

The products currently approved for irradiation in Canada include potatoes, onions, wheat, flour, whole wheat flour, whole and ground spices, and dehydrated seasoning preparations. Of these, irradiation of spices is the most common.

- Health Canada is responsible for setting standards for irradiated foods. Canadian standards are found in the *Food and Drug Regulations* and consist of a list of foods which may be irradiated, the permitted sources of ionizing radiation and the permitted absorbed doses of radiation allowed.

- The **Canadian Food Inspection Agency** (CFIA) is responsible for all enforcement and compliance issues relating to irradiated foods. It administers the regulations relating to the labelling of irradiated products under the *Food and Drugs Act* and the *Consumer Packaging and Labelling Act*.

- The **Radiation Protection Bureau** (RPB) of Health Canada is responsible promoting and protecting the health of Canadians by assessing and managing the risks posed by radiation exposure in living, working and recreational environments. They operate a centralized dose record system which contains the occupational radiation dose records of all monitored radiation workers in Canada. Dose records for monitored workers involved in the food irradiation process would be included in this dose registry. This dose record information helps the relevant regulatory authority to control occupational exposure to ionizing radiation in the workplace and to evaluate dose trends and statistics.

- The **Canadian Nuclear Safety Commission** (CNSC) (formerly the Atomic Energy Control Board or AECB) regulates the use of nuclear energy and materials in accordance with Canada's international commitments on the peaceful use of nuclear energy. Food irradiation facilities must comply with these regulations. The CNSC functions as a tribunal, making independent decisions on the licensing of nuclear-related activities in Canada; establishing regulations and setting regulatory policy direction on matters relating to health, safety, security, and the environment.

These labelling regulations require that all irradiated food, both prepackaged and non-prepackaged, be labelled with the radura symbol, an internationally recognized irradiation symbol, and an explanatory statement such as "treated with radiation", "treated by irradiation", "irradiated", or a written statement with the same meaning. The radura symbol and the irradiation statement must be prominently displayed near each other on the principal display panel (main panel) of the label of a prepackaged food or, in the case of non-prepackaged foods, on a sign displayed immediately next to the food at its point of sale.

What is the process for approval in Canada? Petitioners submit new applications for food irradiation to Health Canada for scientific review. The organization applying for approval submits scientific data that is evaluated by a team of scientists with expertise in the areas of nutrition, microbiology, chemistry, and toxicology, who evaluate the impact of irradiation on food safety and nutritional quality.

If any part of the information provided is incomplete, the department would request further information or studies; if this information is not provided, the submission would be rejected. The submissions are not recommended for approval until the scientific evaluators are satisfied that the application addresses all regulatory requirements, the science is complete, and the irradiated food product is safe to consume.

Once the scientists in the Food Directorate of Health Canada's Health Products and Food Branch have completed the scientific evaluation, the results are considered by their senior management team. If accepted, it is proposed as an amendment to the regulation. All proposed regulatory amendments are reviewed by the Special Committee of Council, a Cabinet committee. If accepted, the proposals are published in *Canada Gazette*, Part I, to allow stakeholders and the public an opportunity to comment.

All comments received during the *Canada Gazette*; Part I consultation are then considered by Health Canada. Only when any concerns or issues of a scientific nature are fully addressed does Health Canada recommend the amendment to the Cabinet committee for final approval. The final regulation is then signed by the Governor in Council and is published in *Canada Gazette*, Part II. At this time, the food products are considered approved for treatment by irradiation if producers choose to use that method.

Portable irradiation facility: The University of Tennessee completed an design and financial appraisal of constructing and operating a mobile food irradiation facility (2009). The facility consists of a tractor trailer, one portable linear accelerator, and a diesel generator. An electron beam, or linear accelerator, was selected for use due to the ability to turn off the system and the better capability to shield an electron and is the better choice for portability.

able 1 - Comparing E-beams to other types of irradiators

	Advantages	Disadvantages
Electron Beam	Machine can be turned on/off Cost-efficient In-line capability Compact Produces higher, uniform doses	Poor penetration depth Limited energy range
Gamma	Broad energy range Able to penetrate dense material	Source cannot be turned off Requires excess shielding Requires frequent source disposal/replacement Consumer perception Expensive
X-rays	Can be turned off Higher penetration Broad energy range	Inefficient (< 0.1%) Requires cooling system

The conveyor belt system runs the length of the trailer in two sections. At the irradiation point, an electron permeable window will be used to allow penetration to the product. Once the food has been processed, it exits the trailer via the second section of conveyor belt where it can be removed and further processed.

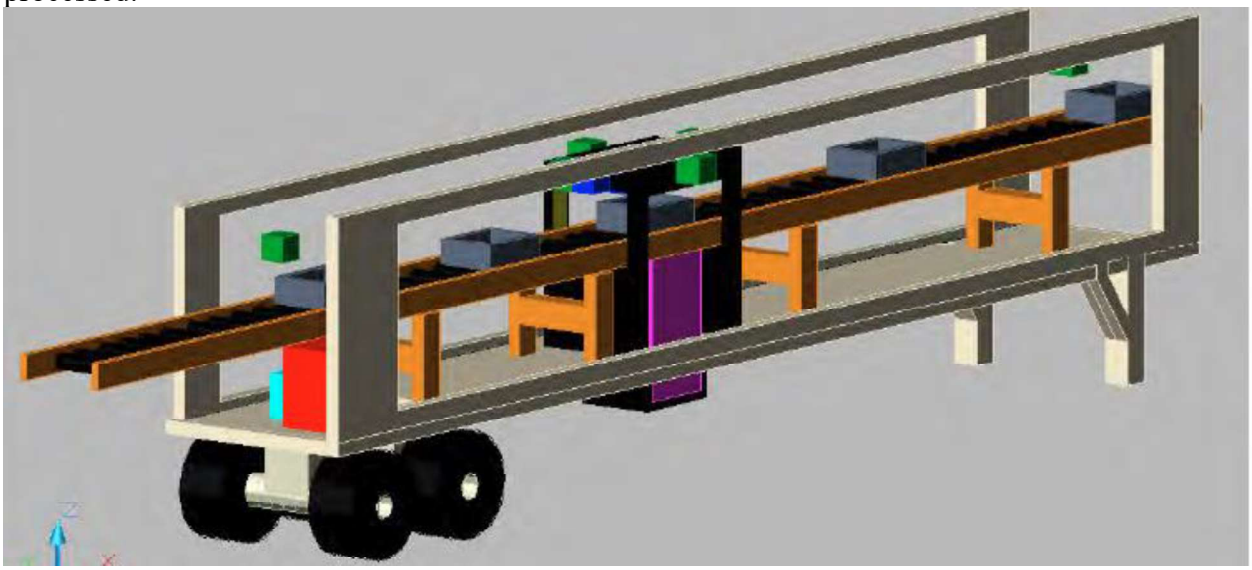


Table 2 - Cost estimate

Equipment	Cost
Trailer	$40,000
Semi-Truck	$135,900
L&W Portac	$900,000
Generator	$27,000
Shielding	$51,200
Radiation Monitoring system	$10,000
Conveyor System	$12,000
Total	$1,176,100

Using the CPI from 2009 to 2022, 1.34, and current exchange rate, 0.78, indicates the capital cost would be $2.1 million.

Exhibit AVII.1: SFX field study of bait use

DEVELOPMENT & USE OF FIELD BEHAVIOURAL ASSAYS OF LOBSTER RESPONSES TO DIFFERENT BAIT TYPES

Dr. Russell Wyeth

Students
L. Grace Walls
Rachel Webber
Michelle Hodgson
Laura Brady
Lia Blackett
Max Speiss
Gavin Hiltz

ST. FRANCIS XAVIER UNIVERSITY

4/26/2022

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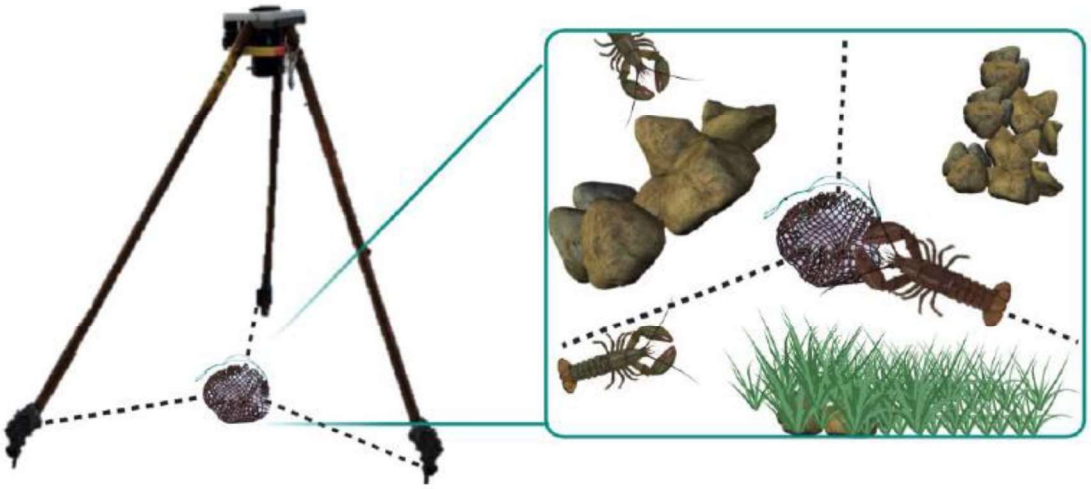
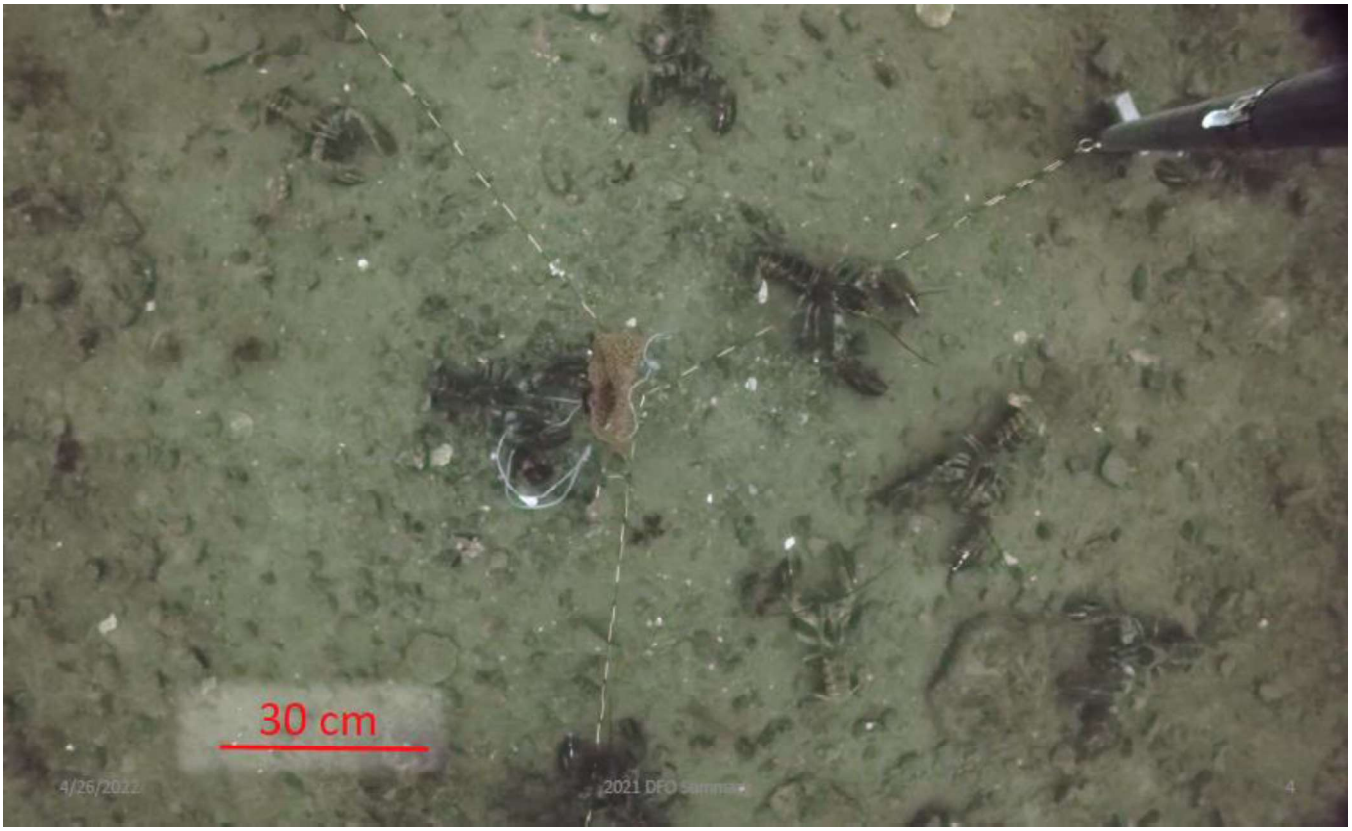
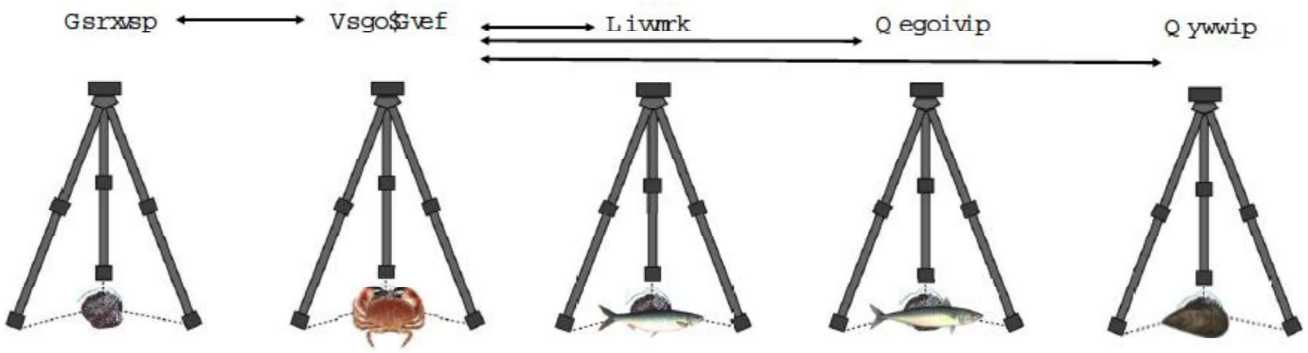
Baited Underwater Video Tripod Setup




30 cm
4/26/2022
2021 DFO Summit
4


FOV= 9
30 cm
4/26/2022
2021 DFO Summit
5

Averaging ~ 360 Hours of Video Data Per Set



Data Summary

2019: pilot experiments developing video system

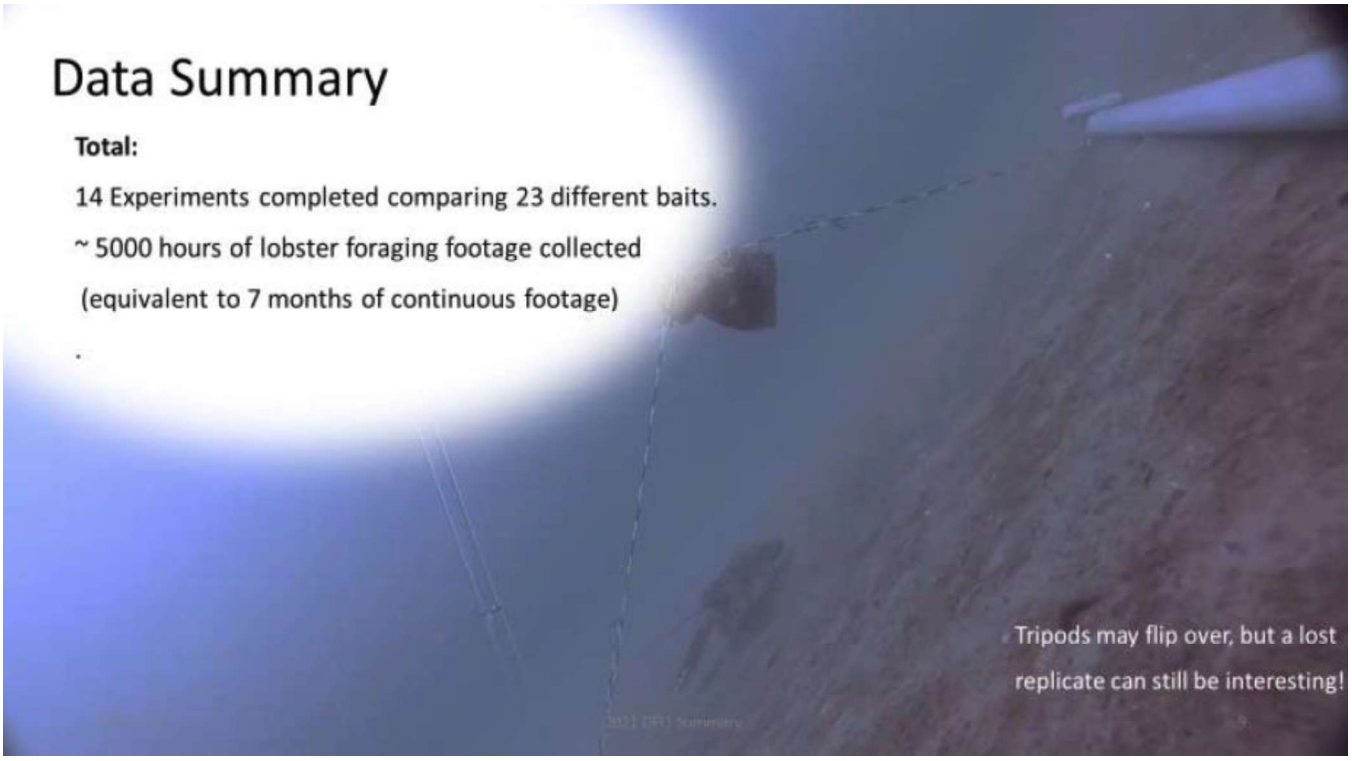
2020: 6 Experiments completed testing 13 baits.

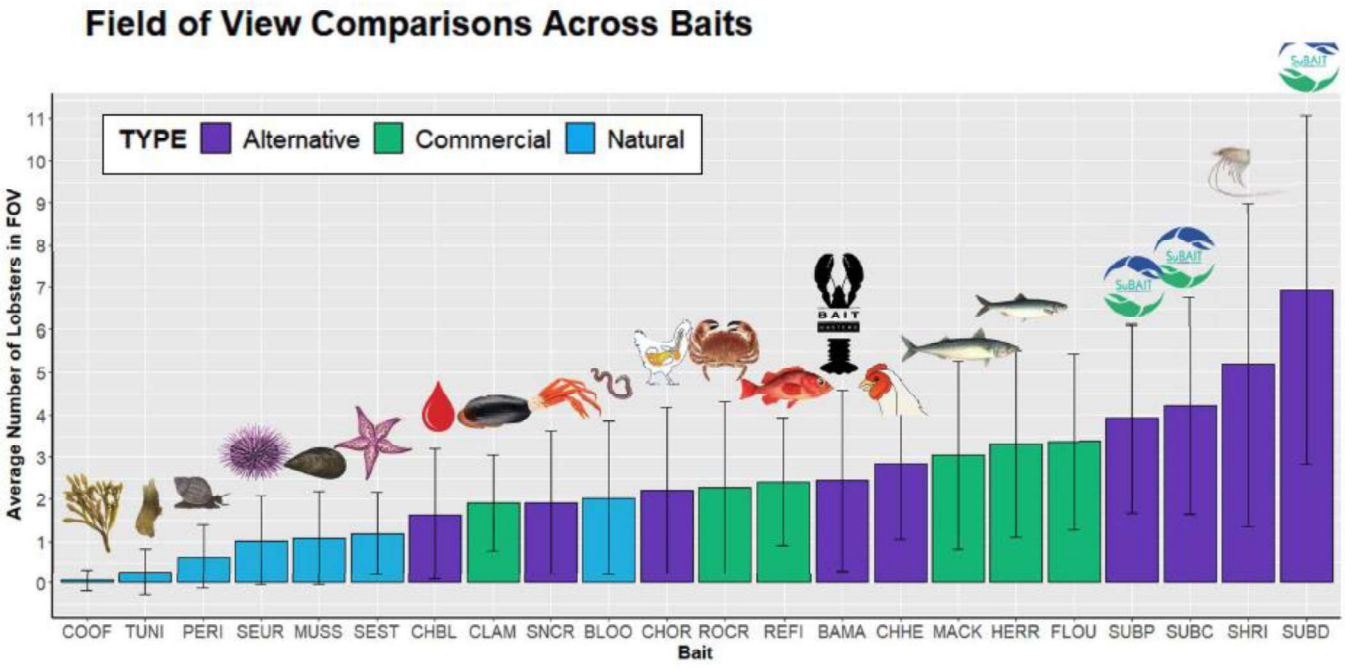
~2259 hours of lobster foraging footage.

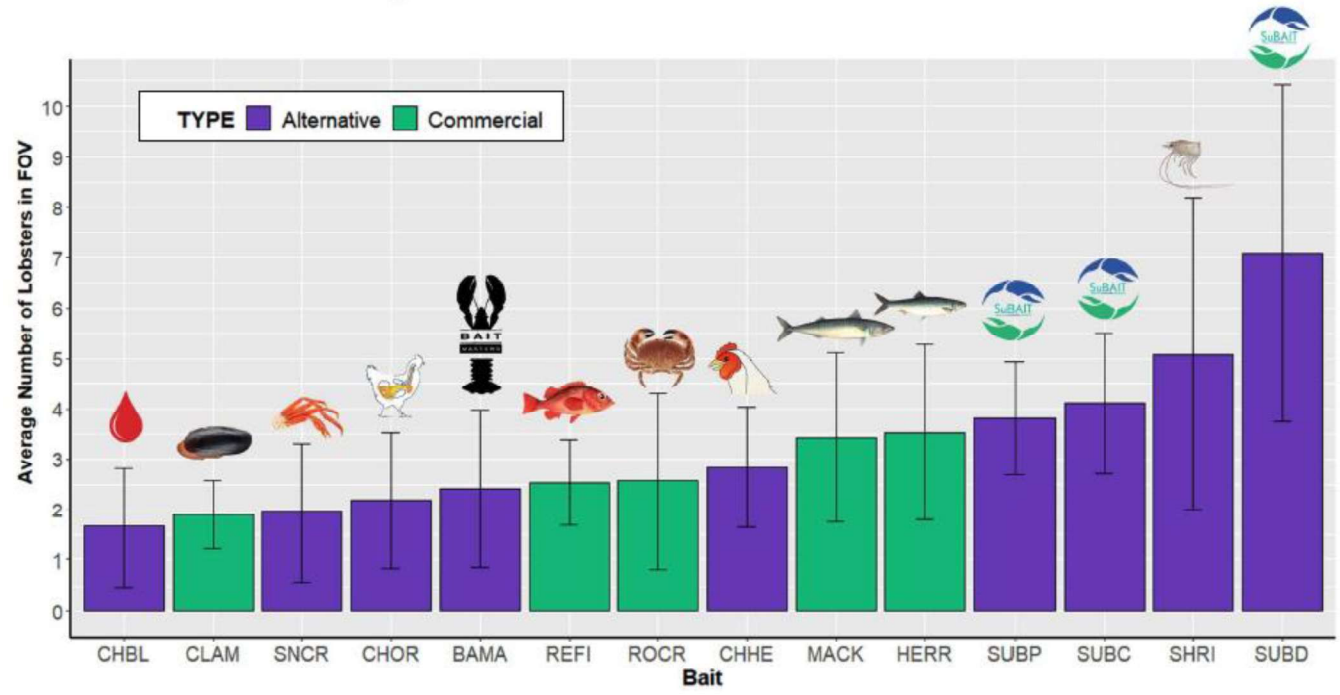
2021: 8 Experiments completed testing 20 baits.

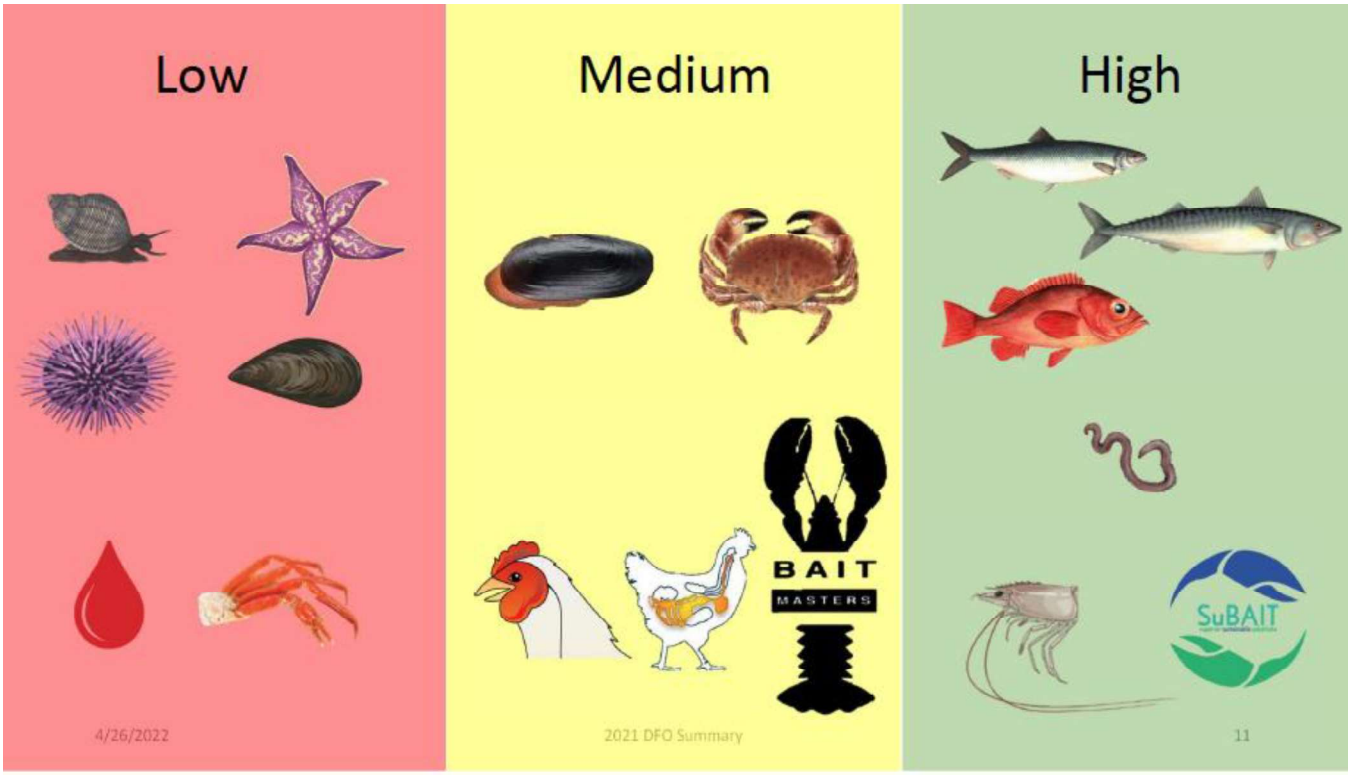
~ 2535 hours of lobster foraging footage.

Tripods may flip over, but a lost replicate can still be interesting!


Data Summary
Total:
14 Experiments completed comparing 23 different baits.
~ 5000 hours of lobster foraging footage collected
(equivalent to 7 months of continuous footage)
.
Tripods may flip over, but a lost
replicate can still be interesting!


Field of View Comparisons Across Baits
TYPE
Alternative
Commercial
Natural
Average Number of Lobsters in FOV
0
1
2
3
4
5
6
7
8
9
10
11
COOF
TUNI
PERI
SEUR
MUSS
SEST
CHBL
CLAM
SNCR
BLOO
CHOR
ROCR
REFI
BAMA
CHHE
MACK
HERR
FLOU
SUBP
SUBC
SHRI
SUBD
Bait


Field of View Comparisons Across Baits
TYPE
Alternative
Commercial
Average Number of Lobsters in FOV
0
1
2
3
4
5
6
7
8
9
10
CHBL
CLAM
SNCR
CHOR
BAMA
REFI
ROCR
CHHE
MACK
HERR
SUBP
SUBC
SHRI
SUBD
Bait


Low
Medium
High
BAIT
MASTERS
SuBAIT
4/26/2022
2021 DFO Summary
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APPENDIX VIII BAIT IMPORTS

Exhibit AVIII.1: Bait imports by province 2010-2020

Herring Bait (0511910011) Imports											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
New Brunswick	3,195	5,818	6,709	1,088	542	1,206	5,388	-	-	-	-
Newfoundland and Labrador	-	-	-	-	-	-	-	-	-	-	-
Nova Scotia	-	0	518	59	-	-	-	-	-	-	-
Quebec	57	80	1	0	-	3	2	-	-	-	-
Prince Edward Island	-	-	-	-	-	-	-	-	-	-	-
Sub Total	**3,253**	**5,898**	**7,228**	**1,147**	**542**	**1,209**	**5,390**	-	-	-	-
Mackerel Bait (0511910012) Imports											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
New Brunswick	2,029	483	1,624	578	403	454	1,440	-	-	-	-
Newfoundland and Labrador	-	25	-	-	164	-	-	-	-	-	-
Nova Scotia	92	725	4,778	1,839	562	3,053	6,850	-	-	-	-
Quebec	-	-	58	0	-	-	248	-	-	-	-
Prince Edward Island	-	-	-	-	-	-	-	-	-	-	-
Sub Total	**2,121**	**1,233**	**6,460**	**2,417**	**1,129**	**3,507**	**8,537**	-	-	-	-
Squid Bait (0511910013) Imports											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
New Brunswick	650	2,102	616	422	363	325	742	-	-	-	-
Newfoundland and Labrador	5,249	324	5,113	1,608	3,120	4,235	83	-	-	-	-
Nova Scotia	138	4,091	1,314	851	266	250	3,509	-	-	-	-
Quebec	0		0		0	1	1	-	-	-	-
Prince Edward Island	-	-	-	-	-	-	-	-	-	-	-
Sub Total	**6,037**	**6,517**	**7,043**	**2,881**	**3,748**	**4,811**	**4,335**	-	-	-	-
Fish Nes Bait (0511910019) Imports											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
New Brunswick	2,925	1,951	1,472	1,409	676	351	932	-	-	-	-
Newfoundland and Labrador	-	-	-	108	-	0	-	-	-	-	-
Nova Scotia	72	842	943	378	1,972	3,401	4,272	-	-	-	-
Quebec	26	237	294	0	19	488	211	-	-	-	-
Prince Edward Island	-	-	0	-	0	-	-	-	-	-	-
Sub Total	**3,022**	**3,030**	**2,708**	**1,896**	**2,667**	**4,240**	**5,415**	-	-	-	-
Misc Products Bait (0511910010) Imports											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
New Brunswick	-	-	-	-	-	-	-	6,885	5,703	7,655	5,837
Newfoundland and Labrador	-	-	-	-	-	-	-	720	943	1,149	113
Nova Scotia	-	-	-	-	-	-	-	16,521	12,872	13,735	11,131
Quebec	-	-	-	-	-	-	-	60	43	94	123
Prince Edward Island	-	-	-	-	-	-	-	-	2	0	3
Sub Total	-	-	-	-	-	-	-	24,186	19,563	22,634	17,207
Total	**14,433**	**16,678**	**23,439**	**8,340**	**8,085**	**13,768**	**23,677**	**24,186**	**19,563**	**22,634**	**17,207**

Source: DFO NL