

Forage fish in decline: Understanding the usage and management of bait fisheries in the  
Maritimes Region

By

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## **Abstract**

Many commercial fisheries of great socio-economic importance in Canada rely on bait, such as the lobster, crab and groundfish fisheries. In the Fisheries and Oceans Canada (DFO) Maritimes Region, traditional species of bait include pelagic fish such as Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*) and gaspereau (Genus *Alosa*). In recent years, these stocks have declined due to overfishing and high natural mortality, necessitating closures of the Atlantic mackerel bait and commercial fisheries and quota cutbacks for Atlantic herring, resulting in a reduced supply and increased cost of bait in the Maritimes Region. This paper consists of research into the socio-economic and operational characteristics of the bait fishery in the Maritimes Region, industry perspectives on potential management measures, and insight into the perceptions of alternative bait sources. The bait fishery's characteristics were studied through DFO licensing and catch data analysis. The analysis showed that annual bait licence landings are increasing, and recent increases in bait prices may further incentivize the use of bait licences. Additionally, usage depends upon economic factors, a harvester's geographical location, and the characteristics of their commercial fisheries. Perspectives on bait and management measures were gathered through interviews with bait licence holders and fishing associations. Harvesters had concerns about the supply and availability of bait for the 2022 commercial fishing season and heightened concerns for future fishing seasons. Some harvesters cited that fishing their bait licence can reduce financial strains on their fishing operation through economic savings. Interviews supported implementing a minimum gillnet size and a delayed spring opening in the Maritimes Region's bait fishery. This paper's findings will inform DFO regarding how commercial harvesters utilize their bait licenses and provide key recommendations to improve the management of the bait fishery.

## List of Abbreviations

CC	Commercial Communal
COSEWIC	The Committee on the Status of Endangered Wildlife in Canada
C&P	Conservation & Protection
DFO	Department of Fisheries and Oceans Canada
DMC	Dockside Monitoring Company
FIN	Fisher Identification Number
FSC	Food, Social and Ceremonial
HFA	Herring Fishing Area
H/M	Herring Mackerel
ITQ	Individual Transferable Quota
IUCN	International Union for Conservation of Nature
LFA	Lobster Fishing Area
LRP	Limit Reference Point
MARFIS	Maritime Fisheries Information System
MFA	Mackerel Fishing Area
NAFO	Northwest Atlantic Fishery Organization
NS	Nova Scotia
PEI	Prince Edward Island
SARA	Species at Risk Act
SWNB	Southwest New Brunswick
SWNS/BoF	Southwest Nova Scotia/Bay of Fundy
TAC	Total Allowable Catch

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## Chapter One – Introduction

In Canada, marine fisheries are governed by the federal Department of Fisheries and Oceans (DFO). DFO's jurisdiction is divided into seven geographic regions: Pacific, Ontario & Prairie, Quebec, Arctic, Newfoundland & Labrador, Gulf and Maritimes (Figure 1) (Department of Fisheries and Oceans [DFO], 2022I). The Maritimes Region includes 8,600km of coastline stretching from the northern tip of Cape Breton Island to the New Brunswick-Maine border while encompassing the Bay of Fundy.

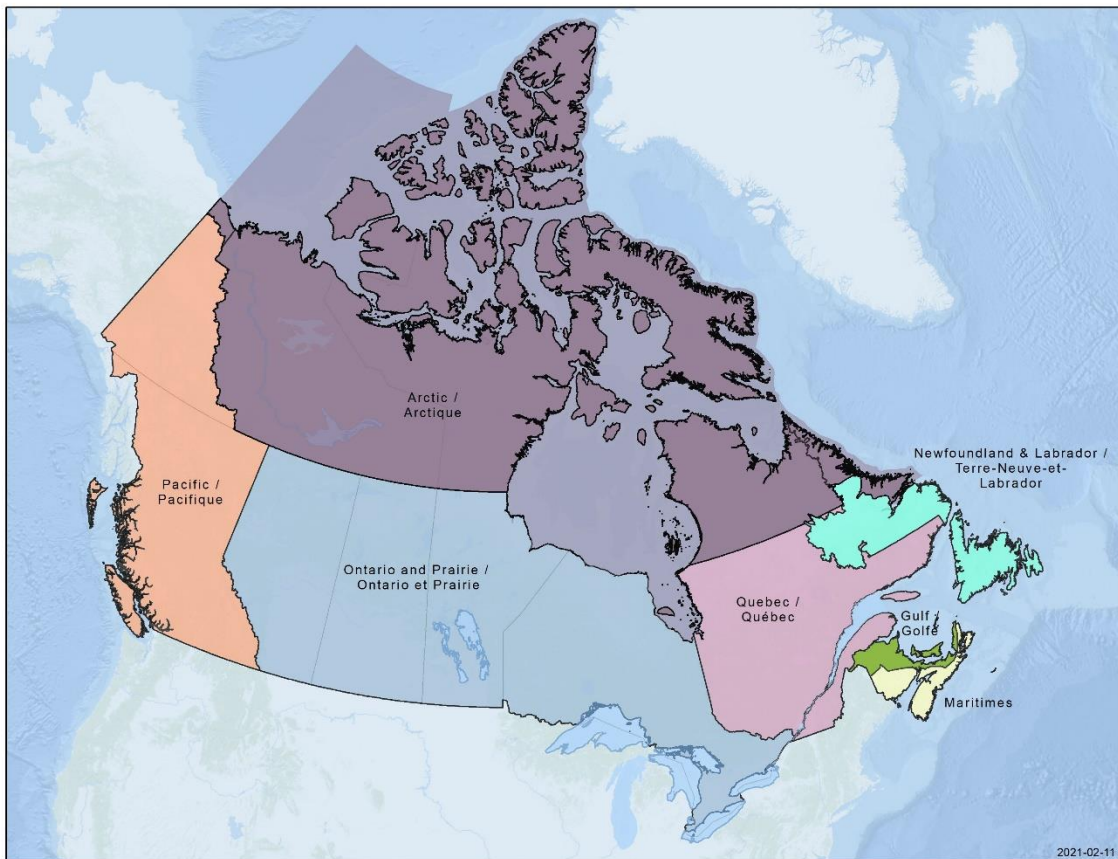


Figure 1. The Department of Fisheries and Oceans seven geographical regions in Canada (DFO, 2022I).

The fishing and seafood industries are an integral part of the Atlantic Canadian economy and cultural identity; the Maritimes Region alone accounts for nearly 40% of Canada's total landed value from its sea fisheries, with 245,639t of marine species worth \$800,000,000 landed in 2020 (DFO, 2021b). While research initiatives and management is typically focused on the larger or more economically valuable species such as lobster, tuna, or groundfish, an often overlooked element of marine ecosystems is the smaller, more

abundant species that are an intrinsic element of trophic dynamics and harvester's fishing operations (Rizzari & Gardner, 2019; Harnish & Willison, 2008). Some of these species, including forage fish, such as Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), and gaspereau (*genus Alosa*) are planktivorous species that play a significant role in transforming zooplankton production into food availability for species found at higher trophic levels (Engelhard et al., 2014). These species are also known as bait fish, a term predominantly used within the fishing industry to describe small-sized fish species typically abundant in marine or freshwater ecosystems. Both recreational and commercial fishers catch bait fishes with the intention of using the fish to attract larger, predatory fish species to traps, hooks, or other fishing gears. Commercial harvesters in the Maritimes Region are given access to herring, mackerel and gaspereau through the issuance of bait licences to allow harvesters to catch their own bait to support their commercial fishing operations.

Despite the crucial role that forage fish species play in marine ecosystems and their importance in daily fishing operations, bait fish stock sizes have decreased in recent years in the Maritimes Region and the mackerel and herring stocks are considered overfished while gaspereau stocks are critically understudied (DFO, 2020a; DFO, 2022b). According to DFO's Sustainable Fisheries Framework, once a stock has reached or fallen below its Limit Reference Point (LPR), it enters the critical zone which triggers the requirement for immediate action that promotes a high probability of the stock recovering within a reasonable timeframe (DFO, 2020a; DFO, 2009). The Maritimes Region main herring stock has been in the critical zone since 2018 while mackerel in Atlantic Canada have been since 2011 (DFO, 2020a; DFO, 2021g). Additionally, an Atlantic Canadian-wide closure of Atlantic mackerel commercial and bait fishing has been implemented as of spring 2022, and there have been recently been significant reductions in the allowable catch for herring in the Maritimes Region (DFO, 2022a).

## 1.1 The Atlantic Mackerel Fishery in the Maritimes Region

### The Species

Atlantic mackerel (*Scomber scombrus*), known as Amalamaq in Mi'kmaq, is a pelagic fish species belonging to the family Scombridae which includes species of tuna, bonito, and other mackerels (Denny et al., 2020). Atlantic mackerel (herein also referred to as mackerel) have a metallic-blue to green dorsal coloration, which transitions to silver and white on the ventral side of the body (DFO, 2016; OCEANA, 2022a). They are a torpedo-shaped species that can reach lengths of 40cm and weigh up to 800g; they additionally do not have a swim bladder (DFO, 2016). Mackerel are a highly migratory species that exhibit schooling behaviour; school size depends upon the level of predation and food availability (Rafferty, 2014; Diaz et al., 2013). Mackerel are found on both sides of the Atlantic Ocean; their western range extends from North Carolina to Labrador, and their eastern range from Morocco to Norway (NOAA, 2022a; DFO, 1982).

Atlantic mackerel are harvested throughout the Maritimes Region in both coastal and offshore areas. In the Maritimes Region (herein also referred to as the Region), mackerel often first appear in Southwestern Nova Scotia in May and arrive in Cape Breton in early June when the water temperature reaches 11-14°C (DFO, 2007). The arrival of mackerel in Cape Breton coincides with the emergence of fiddleheads, dandelions, and strawberries; because of this, the initial mackerel harvest in Cape Breton is sometimes known as “the strawberry run” (Denny et al., 2020). During the summer months, mackerel congregate in the upper 25-30 fathoms of the water column and decrease their depth during the winter months to as deep as 100 fathoms along the continental shelf in search of warmer water temperatures (Rafferty, 2014; Denny et al., 2020). Mackerel have been harvested in Atlantic Canada by Indigenous Nations prior to European contact using techniques such as gillnetting (DFO, 2007; Denny et al., 2020). The Mi'kmaq traditionally harvested Atlantic mackerel as a food source and for use as bait to snare otters, martins, foxes, bears, lynx, and bobcats (Denny et al., 2020). Prior to the closure, mackerel were commonly harvested in Atlantic Canada for sale and food consumption and as bait to support other commercial capture fisheries.

On March 30<sup>th</sup>, 2022, The Minister of Fisheries, Oceans and the Canadian Coast Guard made a decision to implement a closure for all Atlantic mackerel commercial and bait fishing in Atlantic Canada in hopes of limiting fishing pressure and allowing the stock to rebuild (DFO, 2022b; DFO, 2022k). This decision came after the 2021 stock assessment showed a further decline of the stock into the critical zone, and scientific advice indicated the stock was being overfished (DFO, 2021a).

### **Atlantic Mackerel Management**

Prior to the recent commercial and bait closure, DFO managed four distinct mackerel fisheries in the Maritimes Region: commercial (including commercial communal), bait (including communal bait), recreational, and Food, Social and Ceremonial (FSC).

#### *Atlantic Mackerel Commercial Fishery*

Commercial Atlantic mackerel licences are one of the most commonly issued licences in Atlantic Canada; in 2020, DFO issued 7,812 licences to commercial harvesters (DFO, 2022a). Mackerel is harvested using rod and reel, trap nets, handlines, jiggers, tuck seines, purse seines, weirs, and gillnets (Denny et al., 2020; DFO, 2007). The commercial mackerel fishery is broadly classified as two separate fleets, an inshore fleet (vessels less than 65') and an offshore fleet (vessels greater than 65') (DFO, 2007). The commercial management area is broken into 21 Mackerel Fishing Areas (MFAs) to allow for area-specific management and research initiatives. The commercial fishing season for mackerel varies by gear type and MFA. In the Maritimes Region, the trap net, handline, and gillnet fisheries are generally open year-round, with the licence conditions becoming valid on January 1<sup>st</sup> and expiring on December 31<sup>st</sup> of the same calendar year. The landings from these gear types generally take place from mid-June to October (DFO, 2020a). The minimum catch size for mackerel in the commercial fishery is 26.8cm (DFO, 2022d).

#### *Total Allowable Catch (TAC)*

The commercial Atlantic mackerel fishery is unique in management, among small pelagic fisheries because all mackerel in Atlantic Canada are considered to originate from a single stock, unlike species such as herring, where there are many distinct spawning components

(DFO, 2020a). Harvesting limits are set using an Atlantic Canada-wide total allowable catch (TAC) that is further broken into allocations by fleet and gear type (DFO, 2007). The TAC is fished competitively, meaning licence holders are eligible to fish until the sum of their catches reaches the TAC or the quota allocated to their fleet, as opposed to using individual quotas or allocations. In 2021, the TAC for Atlantic Canada was 4,000t (DFO, 2021a). The Atlantic Canadian-wide TAC has been steadily declining over the past 15 years, decreasing from 75,000t in 2008 to 0t in 2022 (Figure 2).

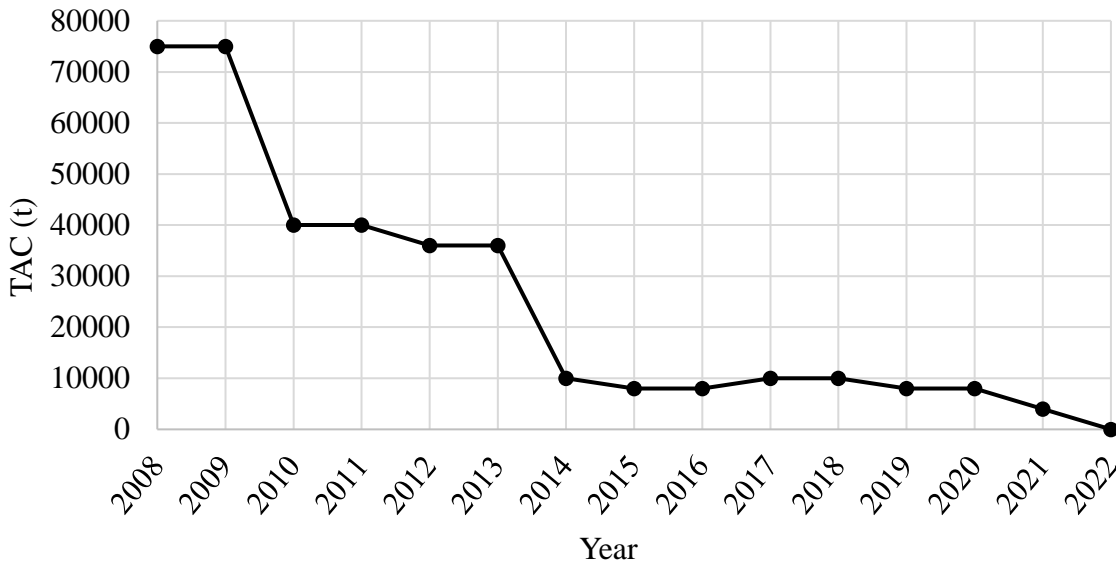


Figure 2. Atlantic mackerel TAC for Atlantic Canada measured in tonnes (t) from 2008-2022.

### *Commercial Monitoring and Reporting Requirements*

In recent years, DFO has implemented stricter monitoring and reporting requirements for commercial mackerel harvesters. Improving fishery statistics will better account for all sources of fish mortality and aid in eliminating unreported catch. Since 2017, DFO has improved data collection throughout Atlantic Canada by introducing additional dockside monitoring programs, increased frequency of logbook reporting and a 100% hail requirement (DFO, 2020a). In 2020, 60% of all commercial landings in Atlantic Canada were estimated to be verified by third-party dockside monitoring companies (DMCs) (DFO, 2020a).

### *Atlantic Mackerel FSC Fishery*

To ensure Indigenous communities are given access to mackerel, a culturally significant resource, DFO issues FSC licences to Indigenous groups in recognition of their collective right to the resource. While FSC licences do not authorize the sale of catch, they are designed to provide Indigenous harvesters with an avenue to catch what is needed for themselves and/or their community for food, social or ceremonial purposes (DFO, 2021d). The licences are issued to Indigenous communities, and the communities may designate harvesters to fish under the collective licence (DFO, 2021d). The FSC fishery remains open during the commercial and bait closure to ensure Indigenous access to the resource.

### *Atlantic Mackerel Recreational Fishery*

Atlantic mackerel is one of the few remaining species that can be recreationally fished in Atlantic Canada without a licence. The only gear type authorized for recreational harvest is angling using hook-and-line (DFO, 2022c). DFO has issued recreational gillnet licences in the past, but the Department is in the process of phasing out this gear type as all existing recreational gillnet licences are non-transferable, and no new licences will be issued to harvesters. The recreational mackerel fishery is popular among both Atlantic Canadians and tourists alike. A Canadian survey from 2015 found that mackerel is the second most commonly caught recreational fish species (includes freshwater and marine fish) in Nova Scotia and PEI (DFO, 2020b). Older surveys indicate that recreational harvesters keep their captured mackerel 88% of the time instead of releasing it (DFO, 2020b). The recreational mackerel fishery has recently undergone changes to provide stricter regulations to further protect the depleted mackerel stock. Historically, the recreational fishery was largely unregulated and operated without a closed season or bag limits. This changed on May 26<sup>th</sup>, 2021, when regulatory amendments were made to provide stricter regulations to further rebuild the stock and minimize recreational fishery misuse. These amendments closed the recreational fishery from January 1<sup>st</sup> to March 31<sup>st</sup>, set a daily recreational catch limit of 20 mackerel per person, and increased the minimum possession size from 263mm to 268mm for both commercial and recreational harvesters. In addition, fishing gear was restricted across all licence types to five fishing lines with a maximum of six hooks per line (DFO, 2021a). Prior to the 2021 amendments, it was not uncommon for some recreational

harvesters to land more than 500lbs of mackerel in a single day (DFO, 2021c). This created issues where commercial harvesters were incentivized to fish “recreationally” instead of using their commercial licences where they are required to report catch. Furthermore, the lack of reporting requirements in the recreational fishery made it difficult to accurately calculate the total removals of mackerel in Atlantic Canada (Van Beveren et al., 2017). The recreational fishery is unaffected by the current Atlantic mackerel moratorium and remains open with the ongoing regulations that were in place pre-commercial closure.

### **Fishery Economics**

The commercial mackerel fishery harvested 7,809t in 2020 at a landed value of \$8.9 million (DFO, 2021b). In 2020, Newfoundland landed 4,015t of mackerel, making up 50% of the 8000t regional-wide TAC at a value of \$2.94 million (DFO, 2021b). PEI landed the second highest weight of mackerel at 1,471t (valued at \$2.98 million), followed by Nova Scotia at 1,315t (\$1.92 million) (DFO, 2021b). In 2020, Quebec landed 662t (\$781,000) while New Brunswick landed just 346t (\$687,000) (DFO, 2021b). The price of mackerel varies by region and year, but it is increasing throughout all regions in Atlantic Canada (DFO, 2020a). Canada exports a small amount of mackerel; the majority of commercial landings are kept within Atlantic Canada due to its importance as bait to support commercial fisheries. In 2020, only 167t or \$388,000 of mackerel was exported from Atlantic Canada; accounting for 2.14% of the total landings by weight (DFO, 2022g).

### **Conservation Status**

The high-demand Atlantic Canadians have placed upon mackerel has resulted in the species being intensively fished (Hamelin et al., 2022). Today, the stock has fallen below the limit reference point (LRP), placing the species in the critical zone and recovery efforts follow the guidelines of a rebuilding plan (DFO, 2020a). As per the Precautionary Approach Framework, once a stock has reached or fallen below the LRP, a rebuilding plan must be put in place that promotes a high probability of the stock recovering and growing above the LRP within a reasonable timeframe (DFO, 2020a; DFO, 2009). Furthermore, a March 2021 stock assessment recorded the lowest spawning stock biomass to date, which further complicates rebuilding efforts (DFO, 2021a). DFO will reassess the stock in 2023

to track the rebuilding plan's progress. COSEWIC has not yet assessed mackerel's conservation status and risk of extinction or extirpation, but it is listed as a high priority candidate for future status assessments (COSEWIC, 2022). The IUCN list the global Atlantic mackerel as decreasing population trend (IUCN, 2022).

## **1.2 The Atlantic Herring Fishery in the Maritimes Region**

### **The Species**

Atlantic herring (*Clupea harengus*), or alanj in Mi'kmaq, is one of the nearly 200 fish species that are part of the family Clupeidae which includes other herrings, shads, sardines and menhadens (FishBase, 2012). Atlantic herring (herein also referred to as herring) is a silver-coloured fish species with a streamlined body, forked tail and protruding lower jaw (OCEANA, 2022b). Herring can reach ages greater than 11 years and commonly grow to lengths exceeding 35cm, maxing out around 40cm (DFO, 2021g). Like mackerel, herring is a pelagic fish species found on both sides of the Atlantic Ocean (DFO, 2021g). Atlantic herring are distributed throughout the North Atlantic Ocean in waters that range from 1-18°C and are found at depths between 0-200m (Government of Newfoundland and Labrador [NL], 2003). Their western range encompasses much of the Northwest Atlantic ranging from Labrador to Cape Hatteras, North Carolina. In the Northeast Atlantic, herring range stretches from Iceland southward to the Bay of Biscay and eastward toward Northern Scandinavia and Russia (DFO, 2021g; FishBase, 2012). Herring are an important component of the food web in the North Atlantic Ocean and are preyed upon by seabirds, sharks, skates, and marine mammals (NOAA, 2022b).

Herring is a highly migratory, schooling species that undergoes both a seasonal and temporal migration. They migrate annually to spawn, overwinter and feed in the summertime, although the timing may vary between spawning stocks (NL, 2003). Herring are thought to return to the same coastal area or offshore bank each year to spawn (DFO, 2021g). Herring are presumed to home to these locations during the spawning season in Atlantic Canada, which extends from April to November, but most herring in the Region are believed to be fall spawners (DFO, 2021g). Further, they overwinter in offshore locations and deeper coastal inlets and return to coastal areas, sheltered bays and sometimes



the open-ocean during the summertime to feed (DFO, 2021g). Herring are filter-feeders that prey upon zooplankton, krill and fish larvae with their main food source being *Calanus finmarchicus* (NOAA, 2022b; DFO, 2021g). Additionally, herring undergo daily temporal migrations where they spend the daytime in deeper waters and rise to the sea surface at night to feed (NL, 2003).

A herring fishery has existed in the Maritimes Region since the 1700s, first operating at the mouth of the Bay of Fundy (DFO, 2021g). Harvest was significantly upscaled in the 1960s with the adoption of purse seines, resulting in the need for large-scale fish processing facilities which became common throughout the Region. In 1968, herring catch reached an all-time high of 500,000t, but the level of harvest was unsustainable, leading to overfishing and a sharp decline in landings by the early 1970s (DFO, 2021g). Today, herring is mainly fished to support commercial and bait fisheries; large amounts of herring are exported annually to the US and Japan, where roe is highly coveted (OCEANA, 2022b).

### **Atlantic Herring Management**

The Atlantic herring fishery in the Maritimes Region has commercial (including commercial communal), bait (including bait communal), recreational and FSC components.

#### *Atlantic Herring Commercial Fishery*

In the Maritimes Region, the commercial herring fishery primarily targets four spawning components and a juvenile mixing aggregation. Accordingly, the management area is divided into five management units: Southwest Nova Scotia/Bay of Fundy (SWNS/BoF), offshore Scotian Shelf, Coastal Nova Scotia, George's Bank and Southwest New Brunswick (SWNB) migrant juveniles (DFO, 2021g) (Figure 3). To further manage fishing activity, the management areas are divided into 22 Herring Fishing Areas (HFAs), which follow the same boundaries as the MFAs, with an additional fishing area located in the Upper Bay of Fundy (DFO, 2021g). The herring fishery is managed through various input controls such as a fishing seasons, area closures, temporal closures, size limits and gear

restrictions, as well as output controls such as fleet shares, individual transferable quotas (ITQs) and TACs (DFO, 2021g; DFO, 2014).

The herring fishery has two separate fleets: a mobile fleet (purse seine and mid-water trawl) and a fixed gear fleet. The fixed gear fleet is further broken down into a non-vessel based fixed gear fleet (Weir, shut-off and trap net) and a vessel-based fleet (drift and fixed gillnet). The minimum catch size in the fixed-gear fleet is 26.5cm and it is 18 cm for the mobile fleet (DFO, 2022d). The herring fishery is limited-entry, meaning no new licences will be issued. The total number of licences is limited to the current number, so a harvester can only enter the fishery through acquiring an existing licence (DFO, 2021g). In most years, herring is the Maritimes Region's highest landed species by weight (DFO, 2022g). In 2020, the 1,790 commercial herring licences landed \$28.1 million worth of fish. Herring landings are dominated by the purse seine fleet, which accounts for 90-99% of the total annual catch despite there being less than 10 active licence holders (DFO, 2021g).

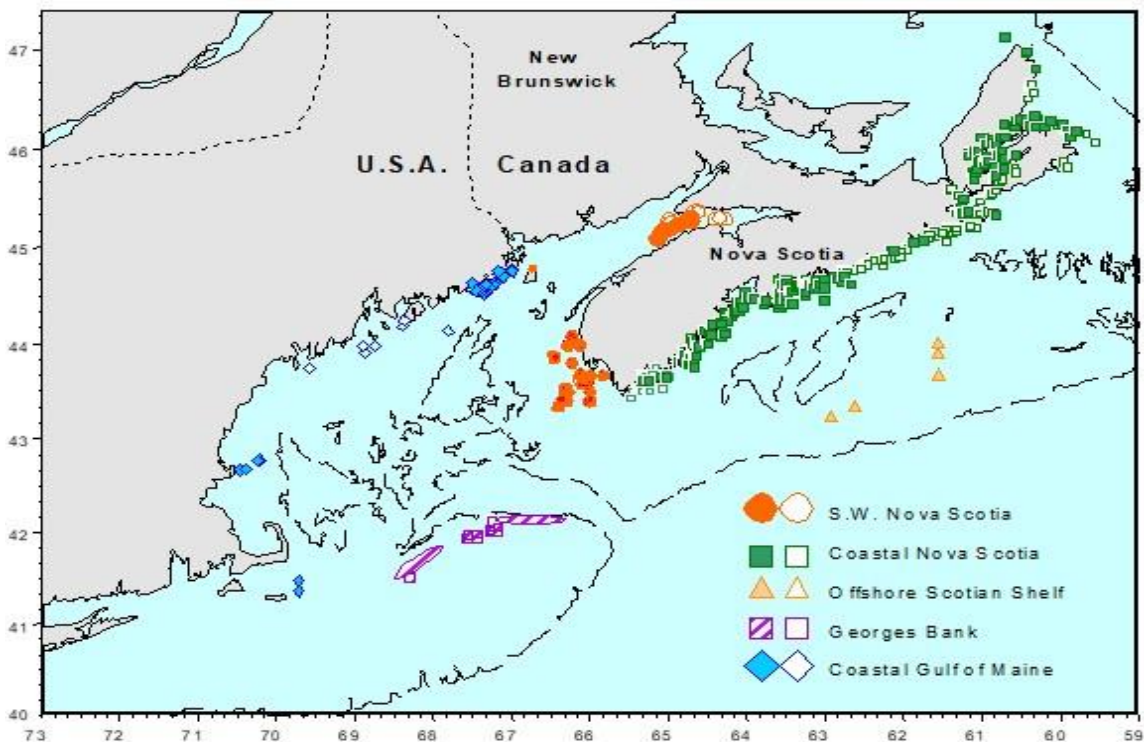


Figure 3. Herring spawning locations and management areas in the Maritimes Region. Open symbols represent locations of reported fishing activity in the 1990s. Filled symbols represent other historical fishing areas. The SWNB migrant juveniles management unit is not shown on the image but it operates in SWNB near Grand Manan and the US border (DFO, 2021g).

### *Coastal Nova Scotia Management Area*

The Coastal NS management area contains locations classified either as quota or non-quota areas. The two quota areas authorize the use of gillnets and they are known as Eastern Shore and Little Hope; their management areas are referred to as “boxes”. In 2022, the Eastern Shore herring gillnet fishery operates under a TAC of 5,699t with fishing authorized from September 15<sup>th</sup> to December 31<sup>st</sup>. The current TAC in the Little Hope gillnet fishery is 8,595t, with harvesters being eligible to fish from August 15<sup>th</sup> to October 31<sup>st</sup> (DFO, 2022e; DFO, 2022f). Coastal harvesters operating outside of the quota areas have year-round access and are authorized to use weirs, gillnets and trap nets; they are also subjected to input controls such as gear restrictions, licensing requirements and area closures (DFO, 2021g). Additionally, a herring fishery historically operated out of the Bras d’Or Lakes, but the fishery has since collapsed and remained closed since 2001 due to conservation concerns (DFO, 2021g).

### *Offshore Management Area*

The offshore fishery operates annually on the Scotian Shelf and other offshore regions from January 1<sup>st</sup> to December 31<sup>st</sup> (Figure 3) The offshore herring fishery is fished competitively and operates with a yearly TAC of 12,000t. Offshore herring are primarily caught in May, June and July (DFO, 2021b). The management area is critically understudied and poorly documented; there are relatively few approaches to evaluating the stock status and TAC outside of commercial catch data.

### *George’s Bank Management Area*

The fishery in George’s Bank is a competitive fishery that operates annually from January 1<sup>st</sup> to December 31<sup>st</sup> (DFO, 2021g). George’s Bank is the only management area with a mid-water trawl fleet. The fleet is tiny, only consisting of one licence as of 2018, and it receives an allocation of 1% of the annual SWNS/BoF TAC (DFO, 2021g). The fleet was approved by DFO in 2004 and has since been used to increase the scientific knowledge surrounding herring in the offshore bank regions (DFO, 2021g). Seiners operating in George’s Bank are regulated through a competitive TAC with a Canadian allocation of

20,000t along with a separate TAC for United States-based vessels; catch typically occurs in the fall for George's Bank (DFO, 2021g).

#### *Southwest Nova Scotia/Bay of Fundy Management Area*

The SWNS/BoF component is the most important herring management area in the Maritime Region. The fishery produces the highest annual catch in the Region and employs over 1000 people while contributing over \$140 million to local economies (DFO, 2022h). Most of the fishing activity takes place on dense summer feeding populations and spawning aggregations; catch is dominated by the purse seine fleet, with smaller landings by weir, gillnet and trap net fishers (DFO, 2014). The herring fishery in SWNS/BoF is managed using a TAC and individual transferable quota (ITQ) approach. Initially, the management area is allocated a TAC, which is divided up to the mobile and fixed gear fleets based on a fixed set of percentage shares (DFO, 2021g). The mid-water trawl is given the first 1% of the TAC, and then the remaining TAC is divided 80/20, with 80% allocated to the mobile fleet and 20% to the fixed gear fleet (weirs, trap nets and gillnets) (DFO, 2022j). The 80% for the purse seine fleet is further broken into individual shares and managed using an ITQ system (DFO, 2022j). The 20% for the fixed gear fleet is fished competitively until the TAC is reached. The SWNS/BoF quota season begins on October 15<sup>th</sup> and runs until October 14<sup>th</sup> of the following calendar year (DFO, 2022j).

The status of the SWNS/BoF spawning stock component has been a concern to DFO for some time, with science advice calling for the implementation of a rebuilding plan since at least 2001. In 2013, a rebuilding plan was finally created to limit removals in hopes of returning the resource to its 2001-2004 population level. Unfortunately, the rebuilding plan has not met all of its objectives, and the spawning stock fell below its LRP in 2018, placing the stock in the critical zone. Additionally, in 2019, the component's overall acoustic spawning stock biomass was found to have decreased by 24% (DFO, 2022j). To promote recovery efforts and to raise the stock status above the limit reference point, DFO has been decreasing fishing effort through steadily reducing the TAC beginning in 2016 (Figure 4). In 2022, the TAC was set at 23,450t, a 33% decrease from the previous year (DFO, 2022j).

The decreased access concerns many harvesters as the area lands the largest quantities of herring which is crucial for supporting the Region’s bait requirement.

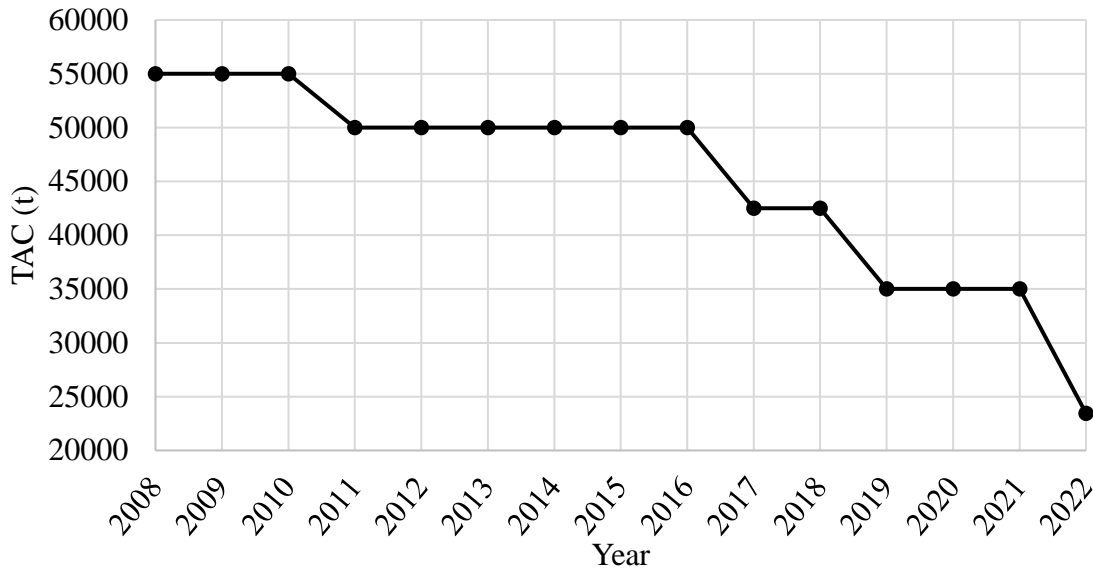


Figure 4. The TAC for the SWNS/BoF herring management area from 2008-2022 measured in tonnes (t).

*SWNB Migrant Juvenile Management Area*

The Southwest New Brunswick (SWNB) migrant juvenile management area uses weirs, trap nets and shut-off gear types to target aggregations of juvenile herring (ages 1-3) in coastal areas near the mouth of the Bay of Fundy (DFO, 2021g). The fish caught in this management area are relatively young, with 90% of the catch aged at 1 or 2 years; these small fish are typically canned and sold as sardines (DFO, 2021g). Despite taking place in the Bay of Fundy, the SWNB migrant juvenile landings are not counted against the SWNS/BoF TAC because it is believed that the fish originates outside of the spawning component. The best available science indicates that these fish are from the Gulf of Maine spawning complex (DFO, 2021g). This fishery is classified as passive since it operates without catch allocations or a TAC. However, it is managed through the number of licences and area closures, with landings being closely monitored through logbooks (DFO, 2021g).

*Commercial Monitoring and Reporting Requirements*

The herring fishery has much stricter dockside monitoring and at-sea observer requirements compared to the mackerel fishery. All fleets in the SWNS/BoF management

area require 100% DMC coverage, and purse seiners are required an at-sea observer to be aboard in 5% of all trips (1 in 20 trips) (DFO, 2021g). Coastal NS fixed gear fisheries operating within the two non-quota areas, Little Hope and Eastern Shore generally require 100% DMC coverage and 10% coverage is required in all other coastal areas (DFO, 2021g). Both the offshore and George's Bank management areas require 100% DMC coverage, with at-sea observer coverage required in every 1 in 20 (5%) offshore fishing trips and every 1 in 6 (16.67%) George's Bank fishing trips (DFO, 2021g).

#### *Atlantic Herring FSC Fishery*

There is very little information published regarding the FSC herring fishery in the Maritimes Region. Each year, DFO and First Nation communities negotiate and review Aboriginal Fisheries Strategy agreements to ensure FSC licences and their conditions are regularly improved and evaluated. Additionally, the review aims to verify that the FSC herring fishery is being managed with respect to *R v Sparrow* and other subsequent decisions made by the Supreme Court of Canada concerning Indigenous People's right to fish for food, social and ceremonial purposes.

#### *Atlantic Herring Recreational Fishery*

The recreational herring fishery receives far less usage and removals than the recreational mackerel fishery. As of 2018, 67 recreational herring gillnet licences were issued in the Maritimes Region (DFO, 2021g). Harvesters are restricted to 30 fathoms of gillnet and mesh sizes between 63.5mm and 83mm. The recreational licence conditions are valid year-round, from January 1<sup>st</sup> to December 31<sup>st</sup>. The licence only authorizes fishing in HFAs 17, 18 (portion outside of the Bras d'Or Lakes), 19, 20, 21 and 22. Recreational harvesters are required to submit a logbook pertaining to their fishing activity, including the timing, location and the amount caught. Additionally, the recreational fishery has reporting requirements regarding species at risk, marine mammals and lost fishing gear.

### **Fishery Economics**

The Maritimes Region lands the most metric tonnage of herring in Atlantic Canada compared to the other three regions. In 2020, the Maritimes Region landed 59,908t, or

72.3% of the total Atlantic Canada herring catch of 81,445t. The 2020 value of the landed herring in the Maritimes Region was \$36.5 million (DFO, 2021b). The second highest landings of 10,969t occurred in the Gulf Region (value of \$9.94 million), followed by 8,449t in the Newfoundland Region (\$2.94 million) and finally 3,119t in the Quebec Region (\$1.52 million) (DFO, 2021b). In 2016, the Atlantic provinces and Quebec exported \$87.9 million worth of herring products, mainly in the forms of roe and smoked herring. The average price of herring has been increasing since 2011 and is expected to continue to rise due to decreasing quotas which limit commercial access to the species. In 2012, the average landed price of herring was \$0.23 per kilogram, and by 2016 it had risen to \$0.39 per kilogram (DFO, 2021g).

### **Conservation Status**

The SWNS/BoF component is currently under a rebuilding plan and has been in the critical zone since 2018 (DFO, 2021g). The origin of fish from the SWNB migrant juvenile aggregation is not fully understood, making it challenging to determine its conservation status. Additionally, DFO conducts few studies on the offshore and George's Bank components and there is limited information on most of coastal NS, outside the Eastern Shore and Little Hope boxes. Individual spawning groups within the coastal component are particularly vulnerable to overfishing due to their relatively small size and proximity to shore. Outside of the SWNS/BoF management component where herring is in the critical zone, the species is relatively understudied, making it difficult to assess its conservation status. COSEWIC has not yet assessed Atlantic herring, but the IUCN listed the species as least concern in 2009, with the global population thought to be increasing (OCEANA, 2022b; IUCN, 2022). Herring, like all forage fish, is a critical component of marine ecosystems, and it is vital that the proper management measures are implemented to rebuild overfished populations.

## **1.3 The Gaspereau Fishery in the Maritimes Region**

### **The Species and Management**

Gaspereau is a colloquial term used to represent two anadromous fish species belonging to the family Clupeidae that are found in Atlantic Canada (DFO, 2021f). The two species

commonly referred to as gaspereau are alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*). The gaspereau fishery contains commercial (including commercial communal), bait (including bait communal), FSC and recreational components. These fisheries are generally managed through input controls such as licensing, gear types, temporal and/or area closures and reporting requirements (DFO, 2021f). As of 2019, the majority of gaspereau stocks in the Maritimes Region remained unassessed (DFO, 2021f). Unpublished DFO data from the Gaspereau River stock indicates the population is in the healthy zone, and the Tuskent River population is thought to be in the critical zone (DFO, 2021f). Gaspereau was initially going to be a major element of this report along with herring and mackerel as it is one of three species that can be captured on bait licences in the Maritimes Region, however, the species is extremely data limited with few active bait fishers. Due to these factors, research was concentrated on herring and mackerel.

#### **1.4 The Bait Fishery in the Region**

##### *Bait Fishery Overview*

To ensure commercial harvesters have access to important bait species such as herring, mackerel and gaspereau, the head of an enterprise who holds a commercial licence to fish using a method that requires bait is eligible to apply for a bait licence. Fish caught under bait licences are for personal use only, exclusively by the bait licence holder; harvesters are prohibited from selling, trading or bartering any fish caught under a bait licence. Before 2002, DFO issued a “pelagic bait licence” to fish for and retain quantities of herring, mackerel, and gaspereau for usage as bait in commercial capture fisheries (DFO, 2021f). However, in 2002, the licence was broken into two separate licences, a herring mackerel (H/M) bait licence and a gaspereau bait licence. The reasoning behind the change is that the regulations of the commercial gaspereau fishery did not conform with the existing licence conditions of the pelagic bait licence, as they gave gaspereau bait fishers increased access to the resource compared to commercial fishers who had to abide by stricter regulations including additional close times (DFO, 2021f). There are currently ten categories of commercial species that make a harvester eligible to apply for a H/M and/or gaspereau bait licence in the Maritimes Region (Table 1).



Table 1. Eligible commercial licences and their gear types that can apply for a bait licence in the Maritimes Region.

Eligible Commercial Licences	Additional Information
Eel ( <i>Anguilla rostrata</i> )	Eel pot licences only
Green crab ( <i>Carcinus maenas</i> )	X
Snow Crab ( <i>Chionoecetes opilio</i> )	X
Crab, Other	Red ( <i>Chaceon quinque-dens</i> ), rock ( <i>Cancer irroratus</i> ) and Jonah crab ( <i>Cancer borealis</i> )
Hagfish ( <i>Myxine glutinosa</i> )	X
Groundfish	Atlantic cod ( <i>Gadus morhua</i> ), haddock ( <i>Melanogrammus aeglefinus</i> ), Atlantic halibut ( <i>Hippoglossus hippoglossus</i> ), dogfish ( <i>Squalus acanthias</i> ), and pollock ( <i>Pollachius virens</i> ) licences that authorize the use of longline and handline only
Lobster ( <i>Homarus americanus</i> )	X
Swordfish ( <i>Xiphias gladius</i> )	Longline swordfish licences only
Tuna	Bluefin ( <i>Thunnus thynnus</i> ), yellowfin ( <i>Thunnus albacares</i> ), bigeye ( <i>Thunnus obesus</i> ), and albacore ( <i>Thunnus alalunga</i> )
Whelk ( <i>Buccinum undatum</i> )	X

### Gaspereau Bait Licence

The gaspereau bait licence conditions only prohibits the catch and retainment of gaspereau; any incidental catch must be immediately returned to the water in a manner which causes the least amount of harm to the species. Gaspereau caught on bait licences is most commonly used in the lobster and snow crab fisheries; smaller amounts of gaspereau are also used as bait by cod, haddock and pollock harvesters (DFO, 2021f). The gaspereau bait fishing season follows all yearly and weekly close times that apply to the commercial fishery. The only gear type that has been authorized for use in the gaspereau bait fishery is gillnets. Harvesters can fish with a maximum of three gillnets, with the total length of the nets not exceeding 90 fathoms (including head rope length). There are also restrictions on mesh size. Harvesters in the Region are prohibited from fishing gillnets using a mesh size that exceeds 89mm, and harvesters fishing in the tidal or inland waters of New Brunswick are prohibited from using a gillnet that has a mesh size of less than 38mm. The gaspereau bait fishery has no hail or observer requirements, but harvesters are required to keep a

logbook of fishing activities. This logbook must be submitted to DFO within 30 days of the season closure to a designated DMC. The logbook must be submitted even if the licence holder did not fish during the season. There are no SARA reporting requirements in the conditions of licence. The gaspereau bait fishery is closed and terminal, meaning no new bait licences will be issued, and all existing licences are non-transferable (DFO, 201f).

### *Herring Mackerel Bait Licence*

The herring mackerel (H/M) bait licence currently only authorizes for the targeting of Atlantic herring due to closure of commercial and bait mackerel fisheries. In previous years, the H/M bait licence specified harvesters could retain quantities of herring and mackerel. Similar to the gaspereau bait licence, all incidental catch must be immediately returned to the ocean. In the Maritimes Region, the herring mackerel bait fishing season begins on January 1<sup>st</sup> and remains open year-round until December 31<sup>st</sup>. Bait harvesters are restricted to a maximum of one fishing trip per calendar day. In 2019, a amendment was made to limit harvesters to a maximum daily mackerel catch of 907kg (or 2,000lbs). In 2022, a similar change was made in respect to herring which restricted daily catch to 1,360kg (or 3,000lbs). Prior to these changes, harvesters could essentially harvest an unlimited amount of herring or mackerel. To aid in enforcement efforts and to persuade illegal fishing, the conditions of licence stipulate it is prohibited to fish herring or mackerel recreationally or commercially while on a bait fishing trip. H/M bait fishers are permitted to use gillnets and handlines in the fishery, but the licence holder is only permitted to possess one of the gear types aboard their boat during a fishing trip. If using a gillnet, a maximum of 90 fathoms (total length including the head rope length) is permitted for use in the fishery; there is no minimum gillnet mesh size, but the maximum mesh size that can be used is 83mm. When fishing using a handline, harvesters can fish with a maximum of two handlines containing no more than 36 hooks in aggregate.

The licence holder/vessel operator is required to hail-out prior to the departure of a bait fishing trip and all harvesters must hail-in to a DMC once a month whether or not fish was landed. Harvesters are required to keep a record of fishing activities of each trip in a DFO-issued logbook and submit the log to a designated DMC within ten days of the end of each

month. Bait fishers must comply with all species at risk and marine mammal reporting requirements and submit a SARA log to a DMC if a species at risk is caught during a bait fishing trip. Likewise, they must additionally report all lethal and non-lethal marine mammal interactions using the DFO Marine Mammal Interaction Form; interactions include bycatch, collisions and all marine mammals entangled in fishing gear. There no at-sea observer coverage required for the H/M bait fishery.

### *2022 Herring-Only Bait Licence*

Due to the 2022 decision to close the commercial and bait mackerel fisheries in Atlantic Canada, the H/M licence conditions have been revised to only authorize the catch and retainment of herring. This decision was made to help ensure harvesters have access to bait to support their commercial licences. The 2022 herring bait licence authorizes a daily catch limit of 1,360kg (or 3,000lbs) on a maximum of one fishing trip per day. The herring-only bait licence operates similar to the dual-species licence that was issued prior to the moratorium with a few minor changes. The usual H/M bait licence conditions prohibit the retention of any incidental catch. However, the modified licence conditions differ as they allow incidentally caught mackerel to be retained and landed as long as the quantity of mackerel does not exceed 10% of the weight of the herring captured and retained during the fishing trip. In addition, the authorization for handlines has been removed leaving gillnets as the only permitted gear type. The same gillnet regulations that applied to past H/M bait licences also apply to the herring-only bait licence. One significant change in the 2022 bait licence is that the fishery has moved away from the monthly hail-in system and instead has adopted a daily hail-in to strengthen enforcement measures and reduce illegal fishing. The new system requires the licence holder or vessel operator to hail-out system and obtain a hail-out reference number prior to departing on a bait fishing trip. Then, the licence holder or vessel operator must hail-in to a DMC at least one hour before returning to port, whether or not any fish were caught and landed. There is currently a dockside monitoring target of 10% coverage for all trips in the Region. However, fishing activity in the Little Hope and Eastern Shore boxes additionally require dockside monitoring for 75% of landings exceeding 907kg to persuade illegal use of the licence.

## **1.5 Understanding Key Issues in the Bait Fishery**

### **Management Challenges Affecting Bait Fisheries in the Maritimes Region**

#### *Bait Usage and Demand is Not Fully Understood*

There is an incomplete understanding of bait usage and demand in the Maritimes Region. Areas of uncertainty include how much bait is required annually, how the demand for bait varies throughout the year and by area, how willing harvesters are to move away from traditional bait sources, how heavily harvesters rely on their bait licences and what concerns industry may have related to bait. Additionally, harvesters opinions on synthetic baits, meaning blended baits that contain a reduced amount of natural-origin fish through the incorporation of filler product, is also not well understood. A better understanding of potential mitigation measures and the bait requirements of harvesters in the Region would better inform the management of bait fisheries to ensure it balances the current rebuilding efforts of forage fish stocks with the value they provide to other regional fisheries.

#### *Relatively Lax Regulations and Approaches to Management*

The H/M and gaspereau bait fisheries in the Maritimes Region operate with less restrictive management measures giving harvesters increased access to the resource compared to bait fisheries in the Gulf, Quebec and Newfoundland Regions. While the Maritimes Region does require a greater amount of bait compared to the other Atlantic Regions, due to its long fishing seasons and high amounts of fishing activity, it is still crucial that removals occur at a sustainable rate. Harvesters in the Maritimes Region are given increased access to bait fish through the absence of a fishing season or daily closures. For example, bait licence conditions in the Maritimes Region are valid year-round and operate without daily or weekly closures. In contrast, bait licences in the Gulf Region are valid from August 1<sup>st</sup> to December 31<sup>st</sup>, and the fishery is closed daily between noon Friday and noon Sunday to limit fishing effort.

The Maritimes Region has fewer restrictions regarding the use of gillnets compared to the other three Atlantic Canadian Regions. Bait fishers in the Maritimes Region are allowed to fish with 90 total fathoms of gillnet with no restriction on minimum mesh size. In comparison, harvesters in the Gulf and Quebec Region are restricted to 50 fathoms and bait

fishers in Newfoundland are authorized 40 fathoms. The Quebec and the Gulf Region further restrict gillnet use with a maximum net height of 150 meshes and requirements on minimum mesh size that change throughout the fishing season as the expected size of bait fish increases. From January 1<sup>st</sup> to June 30<sup>th</sup>, the minimum mesh size in Quebec and the Gulf Region is 57.1mm, and from July 1<sup>st</sup> to December 31<sup>st</sup>, it is 66.7mm. The absence of a minimum mesh size in the Maritimes Region is concerning as they are implemented to ensure a satisfactory amount of juveniles escape to reach maturity and replenish the spawning stocks. With both herring and mackerel stocks being in the critical zone for some time, it is surprising how loosely the Region's bait fisheries are managed compared to the approaches used in the other Atlantic Canadian regions. .

### *Regulation Enforcement*

Bait licences and their regulations are difficult for Conservation & Protection (C&P) Officers to enforce and have resulted in compliance issues in the H/M and gaspereau bait fisheries. The overlap of the commercial, bait and recreational fishing seasons creates an avenue for harvesters to falsely claim they are fishing under a bait licence instead of a commercial one to gain favourable regulations or reporting requirements (DFO, 2021c). A bait licence holder could also easily ignore the required hail-out and begin what is essentially a mackerel bait fishing trip under the pretense that they are recreationally fishing. Since recreational mackerel fishing does not require any DMC coverage or reporting requirements, there is a low risk to the harvester that they will get caught if they overfish the daily limit of 20 fish per day. While it is illegal to concurrently fish H/M recreationally or commercially on a bait fishing trip, once the fish are landed and moved throughout the supply chain, it becomes challenging for C&P to distinguish between legally and illegally obtained fish (NIC, 2016). The lax monitoring requirements in the bait fishery are worrisome and hinder efforts to detect non-compliance and gather relevant data on illegal fishing to reduce unreported sales and misuse of licences. The lack of monitoring can also lead to overfishing, affecting all Canadians and the economy through the loss of millions in tax revenue and future socio-economic benefits associated with sustainable harvest (House of Commons, 2020).

### *Misreported, Nonreported and Illegal Fishing*

Misreported, and nonreported fishing refers to fishing activities that are not reported or intentionally misreported in disregard of the known applicable laws and regulations (NIC, 2016). There is believed to be a long history of reporting issues in the Maritimes Region's bait fisheries where licence holders do not oblige to licence conditions by under or misreporting landings. While DFO has recently restricted landings in the H/M bait fishery, the gaspereau bait fishery still operates without any catch limits. While a catch limits have many management and conservation benefits, they may also incentivize harvesters to underreport their catch if it falls outside the allowable limits. Misreported, and nonreported catch is a significant impediment to adequate data collection for the bait fisheries as it can result in the total removals of the species being underestimated, affecting the analytical models used to assess fish stocks. Additionally, with the current concerns related to herring, mackerel and gaspereau stock sizes, it is crucial that DFO receives reliable data on all removals to accurately assess fishing mortality and so rebuilding efforts can be monitored and adapted as needed. Regarding mackerel, DFO Science estimates somewhere between 2,000-5,000t of underreported catch in Atlantic Canada each year (House of Commons, 2020).

Illegal fishing refers to activities that contravene existing fishery laws, regulations or the reporting requirements (NIC, 2016). Illegal fishing for bait is a concern for all three bait species in the Region. Illegal fishers are likely to not abide by licence conditions such as completion of logbooks, size limits, bycatch restrictions, daily quotas or species at risk/marine mammal reporting requirements. The current management of bait fisheries allows for a high degree of illegal fishing through the relatively lax regulations. In the gaspereau fishery, some areas have recently seen a significant increase in reports of illegal fishing such as fishing during closed times, fishing in fishways or fish ladders, and using non-authorized gear types or fishing without a licence (DFO, 2021f). Additionally, while the daily catch restrictions in the H/M fishery may help limit the illegal use of the bait licence, harvesters have still willingly reported landings which greatly exceed the trip-based catch limit. It is crucial that all removals be accounted for to allow for effective

management and to ensure decisions do not hinder rebuilding efforts or lead to detrimental outcomes.

## **Research Challenges Affecting Bait Fish in the Maritimes Region**

### *Assessing Mortality*

Fish mortality is a key parameter of fishery population dynamics used to describe the loss of fish in a stock due to death. Fish mortality is challenging to assess for forage fish (Saraux et al., 2020), especially when there is uncertainty in the total removals due to misreported or illegal fishing activities. The effect of misreported and illegal fishing has already been discussed, but there is also mortality related uncertainty that can be attributed to discarding and high-grading. Discarding is a significant issue for fish caught using handlines and gillnets (DFO, 2007) and it occurs when harvesters catch undersized fish that cannot be retained, causing them to be released back into the ocean. Discarding also arises when harvesters catch and discard fish in a poor or unfavourable physical condition in a process known as high grading in hopes of selectively harvesting a more desired quality of fish (DFO, 2007). Discarding concerns fisheries managers because released fish are at a high risk of being severely injured, stressed or killed due to the interaction (Hamelin et al., 2022). Stress or injury caused by capture or handling can leave a fish unable to forage for or digest food, resulting in starvation (NOAA, 2019). Additionally, discarded fish are more likely to be preyed upon due to being released near predators at the sea surface, isolation from their school, or weakened defense mechanisms caused by injury (NOAA, 2019). Mortality associated with discards and high-grading are challenging to assess, but it must be considered to better account for all sources of mortality.

### *Bait Fish Stocks are Challenging to Study*

Forage fish, such as herring, and mackerel, is complicated to study due to their biological and behaviour characteristics such as their migratory nature, resulting in high levels of uncertainty when studying the species and their stock dynamics. Specifically, the migratory patterns of herring and mackerel are not fully understood (Studholme et al., 1999; Jansen & Gislason, 2013), leading to uncertainties about the exact location and timing of spawning. Additionally, there is an incomplete understanding of the spawning location of

herring from the SWNB migrant juvenile population. As a result, DFO does not monitor landings since they operate under the assumption that the fish are of United States origin instead of originating from the SWNS/BoF spawning complex. Uncertainty surrounding the science makes it difficult for DFO to adequately protect the species and ensure that harvest rates occur sustainably.

Mackerel is also challenging to study since they lack a swim bladder, which results in inaccurate acoustic sampling (OCEANA, 2022a). Acoustic surveys are widely regarded as the most accurate sampling method to study dense populations of fast-moving, schooling fish, and they are the primary method for studying herring in the Region. However, this approach cannot be used to research mackerel since they produce minimal amounts of backscatter when acoustically sampled (OCEANA, 2022a). Mackerel's absent swim bladder makes acoustic surveys challenging because the swim bladder is responsible for 90-95% of the acoustic backscatter signal (Korneliussen, 2010). With acoustic sampling inadequate for mackerel, DFO Science must use egg abundance data from bottom trawl surveys and commercial catch data as the primary methodologies for assessing stock status and setting commercial fishing limits (DFO, 2007). Egg abundances are often regarded as unreliable when surveying pelagic species such as mackerel, where it is thought to produce highly variable results on a year-to-year basis due to numerous factors, such as changes in water temperature, varying levels of predation and variability in spawning depth (DFO, 2007). The difficulty in studying highly migratory, schooling fish cannot be understated, and surveying methods must continuously be adapted to increase the quality of data surrounding forage fish.

### **1.6 The Management Problem**

As the availability of bait species in the Maritimes Region decreases due to fishery closures and quota reductions, it is unknown how the commercial fishing sector will be affected. The quantity and species of bait used in commercial fisheries are not typically reported in fisheries statistics (Harnish & Willison, 2008), and there is little information regarding how individual harvesters choose to use their bait licences, leaving the fishery to be relatively understudied (Van Beveren et al., 2017). Estimates on bait usage in Atlantic Canada for



2019 concluded that the \$200,000,000 worth of lobster landed required 380,000,000lbs of bait to catch (Schleit, 2021; Harnish & Willson, 2008). A greater understanding of bait and bait licence usage in the Maritimes Region is required to enable adaptive management to effectively balance the bait needs of commercial harvesters with rebuilding efforts of forage fish stocks.

### **1.7 Research Objectives and Questions**

This report will fill some of the knowledge gaps regarding how harvesters utilize bait and their bait licences, including where, when and how much bait fishing occurs, harvester's level of concern related to the supply of bait, and provide recommendations on how to improve the management of the bait fisheries in the Maritimes Region. In the context of this paper, traditional bait species refers to herring, mackerel and gaspereau and alternative bait refers to bait outside of these species. The report will address three overarching research question:

- 1. What are the characteristics of the bait fishery in the Maritimes Region?*
- 2. What are industry's views on bait, the bait fishery & alternative sources of bait?*
- 3. What are industry's perspectives on potential management amendments?*

## **Chapter Two – Methodology**

Characteristics of the bait fishery in the Maritimes Region were explored through the analysis of fishing and licensing data to learn where and when bait fishing is occurring in the Region and how much bait is landed by species. In order to investigate industry's views on bait, the bait fishery and alternative bait sources and their perspectives on potential management amendments, a telephone survey was conducted with bait licence holders and leaders of fishing association who represent bait fishers. The list of interview questions that was emailed to interview participants can be found in Appendix 1.

### **2.1 Bait Fishing Data Analysis**

The characteristics of the bait fishery were analyzed using unpublished DFO fishing and licensing data from the Maritime Fishery Information System (MARFIS) to investigate where, when and how much bait fishing occurs in the Region. MARFIS is a DFO database

used in the Maritimes Region to capture catch-and-effort data and licensing information. The study period was from 2018-2021; earlier years were not investigated due to limited data availability and the 2022 season was already underway at the time of this study so the data could not yet be analyzed. The catch data originates from harvester's fishing logbooks and, in some circumstances, is verified through dockside monitoring companies. The logbook and dockside monitoring data is added to MARFIS by DFO Science and the database is updated in real-time once the logbooks have been received. The data on MARFIS was accessed using Impromptu, an analytical data base tool used to quickly export data from MARFIS and FOIP (Fishery Officer Intranet Portal), a similar tool that is used by fishery officers for licensing information. Once the data was pulled from the database, it was compiled in Microsoft Excel to allow for additional analysis and the calculation of summary statistics. Supplementary information regarding the current management approaches and fishery characteristics were researched using a review of DFO management plans, regulations, forage fish rebuilding plans and licence conditions. Additionally, data were compiled with respect to the *Privacy Act* to ensure that fishing data could not be traced back to any specific individuals. These precautions followed the "Rule of Five," an internal DFO policy which stipulates that catch data cannot be made public if fewer than five licence holders are fishing a particular stock. Due to this policy and privacy concerns, bait landings and licensing data for gaspereau were not analyzed, since less than five active gaspereau bait licences operated in 2021 in the Maritimes Region. Additionally, the catch and licensing data for commercial communal licences were also not analyzed due to sensitivity and privacy concerns with releasing Indigenous fishery statistics without the consent of First Nation communities.

## **2.2 Industry Interviews**

Industry's views on bait, the bait fishery & alternative bait sources and perspectives on potential management amendments was answered using a telephone survey with the bait fishing sector (hereafter referred to as "industry"). The interviews consisted of 16 participants who are considered key stakeholders of bait fisheries in the Maritimes Region. The participants consisted of a mix of bait licence holders, active bait fishers and fishing associations or management board representatives. In total, nine bait licence holders were

interviewed, five fishing association representatives who also held a bait licence, and two fishing association representatives who did not hold a bait licence themselves. These last two interviewees were asked to respond to the questions in a manner they believed best captured the opinions or beliefs of the harvesters they represent. The interviews could not be recorded due to internal DFO policies related to confidentiality and the *Privacy Act*.

Interview participants were invited via email to participate in an opt-in survey concerning bait and bait fishery management in the Maritimes Region. Invitees were selected using a snowball sampling methodology, also known as chain-referral sampling, that began with reaching out to fishing associations or management boards in the Maritimes Region. These associations were contacted based on a recommendation from a Senior DFO Fisheries Management Advisor who managed a fishery in which licence holders are eligible to apply for bait licences. Additionally, the recommendation was based upon an association's likeliness to participate in the research. Fishing associations were also selected to ensure they would cover a broad regional distribution of harvesters in the Region to minimize localized sampling biases and to adequately capture any diversity in bait and bait licence usage among harvesters. The snowball sampling methodology was selected due to its inherent advantages for conducting research in conflict environments where there may be systematic distrust or conflict between the researcher and the participants (Cohen & Arieli, 2011). Additionally, the methodology helps overcome challenges associated with outdated harvester contact information, legal or political constraints, and difficulties in enlisting the participation/cooperation of interviewees (Cohen & Arieli, 2011).

The fishing associations were initially provided information regarding the research and project rationale, a copy of the consent form (See Appendix 2) and a list of the interview questions (See Appendix 1). Additionally, the fishing associations were asked to recommend 3-5 of their harvesters that they felt would be willing to be interviewed as part of this study. The harvesters were initially contacted through the information provided by their fishing associations and were sent the same background information that was sent to the associations/management boards. In total, 24 fishing associations or management boards were contacted, ten returned emails and seven agreed to participate and recommend

harvesters. Some of the recommended participants were not contacted as they did not hold a bait licence or because they fished in an geographical area where an adequate amount of interviews had already been conducted. Individuals that were recommended but did not hold a bait licence were likely mistakenly identified as a bait fisher due to past activity in the fishery. It was emphasized that interview participants were allowed to withdraw from the interview processes at any point up until September 1<sup>st</sup>. After this date, all data was put into an aggregate form, making it impossible to know what set of responses belonged to a specific participant. One interviewee withdrew shortly after the start of their interview, and their data was entirely removed from the study.

The consent form was explained orally to each participant before the onset of their interview. The interview began once any questions from the interviewee were answered and verbal consent was received. The interview was divided into two broad categories, spanning 48 questions. However, some participants were asked fewer questions depending on their previous responses and their level of bait fishing activity. The first half covered industry's views and opinions on bait, bait licences and alternative bait sources. The second portion covered industry perspectives on management plans and stakeholder engagement. The interviews took 35-105 minutes to complete and were conducted either over the telephone or through Microsoft Teams, depending upon the interviewee's preference. The interviews were transcribed by hand to capture quantitative and qualitative responses, including recommendations/suggestions, the general opinion/perspective of the interviewee, rank-based answers, and the selection of the most applicable term. Immediately after each interview, the hand written notes were annotated and typed up to aid in analysis. A significant concern of using this methodology was the difficulty of ensuring that the transcribed responses accurately captured the participants' opinions and perspectives on the subject matter. This potential issue was minimized by asking interviewees for clarification or to repeat any of their responses that provided an unclear answer. Additionally, the general view or opinion of the interviewee was verbally repeated back to the participant at the end of each question to give harvesters a chance to make corrections to how their response was interpreted.

The transcribed interviews were inputted into Excel so each interview question and its corresponding responses could be individually organized and analyzed. The data was organized to remove transitional words, and elements of the conversations that were not relevant to the research to streamline analysis. The resulting datasets were analyzed to search for patterns or themes, and identify relationships within and among responses. Thematic coding involved reviewing response content from each interview and flagging responses according to pre and inductively determined categories. The categorical data derived from the thematic coding exercise was used to determine the proportions or percentage of responses of a question falling into a particular category which allowed for calculation of summary statistics (e.g., totals, averages, proportions of different views/opinions). Microsoft Excel and Power BI were used to create the graphs and tables for showing interview results.

Commercial communal bait licence holders were not interviewed as part of this research, but remain key rightsholders in the bait fisheries. These licence holders were not contacted as part of this study as DFO has dedicated Indigenous engagement procedures intended to be led by senior staff or staff with specialized training in rightsholder relations. The differential rights to fishery access held by the various Indigenous groups in the Maritimes Region meant this dimension of the bait fishery was beyond the scope of this study.

### **2.3 Sources of Bias and Limitations**

The snowball sampling methodology and the study's opt-in nature have inherent biases associated with their use. Opt-in surveys create potential sources of non-response bias, which occurs when there is a systematic difference in the views or opinions held by the sampled participants compared to the unsampled population (Sedgwick, 2013; Lewandowski & Specht, 2014). For example, harvesters who wished to participate in the survey may represent a specific subset of bait licence holders with differences in sociodemography or their behaviours/attitudes towards DFO and fishery management relative to those who chose not to participate (Sedgwick, 2013). The chain-referral methodology can also oversample a particular network of participants since harvesters are likelier to recommend a friend or someone they know well to participate in the interview

process (Cohen & Arieli, 2011). Additionally, since this methodology depends on a referral, individuals who are more social or well-connected in the fishing industry may be more likely to be recruited compared to an independent fisher (Cohen & Arieli, 2011).

In addition, the working relationship between DFO and individual harvesters could be strained due to perceived mismanagement of bait stocks or other management decisions resulting in a reduced desire to participate in DFO-associated initiatives. In the context of this study, 58% of the fishing associations contacted did not reply to the initial or the follow-up invitation. This mistrust among harvesters, scientists, academics and fisheries managers in Atlantic Canada can be traced back decades to the Atlantic cod stock collapse and moratorium in 1992 (Neis et al., 1999; Hamelin et al., 2022; Hutchings, 2022). The mistrust may also reduce the likeliness of a fishing association agreeing to participate due to their desire to distance themselves from the Department or as an act of solidarity to stand with the harvesters they represent. Past personal working experiences with student interns or Dalhousie University may also impact harvesters' willingness to opt-in to the study. Finally, snowball sampling does not allow for the ability to make statistical inferences from the sampled population to the true population or the calculation of sampling error due to the absence of random sampling (Simkus, 2022).

Despite these potential biases and limitations, the interviews provided diverse and insightful knowledge that was an integral part of the research and formulation of recommendations. Studies have shown that it is possible to increase the representativity of snowball sampling with sufficient planning of the sampling process, creating goals and using quota sampling (Cohen & Arieli, 2011). Some of the biases and limitations of snowball sampling and opt-in surveys were mitigated by ensuring fishing associations represented a diverse regional distribution of bait licence holders and by limiting the number of interviewees who strictly held lobster licences to ensure fisheries with fewer licence holders were still represented.

## Chapter Three – Analysis of Bait Licence and Landings Data

### 3.1 Bait Fishers and Licences in the Maritimes Region

#### *Current Number of Bait Licence Holders in the Maritimes Region*

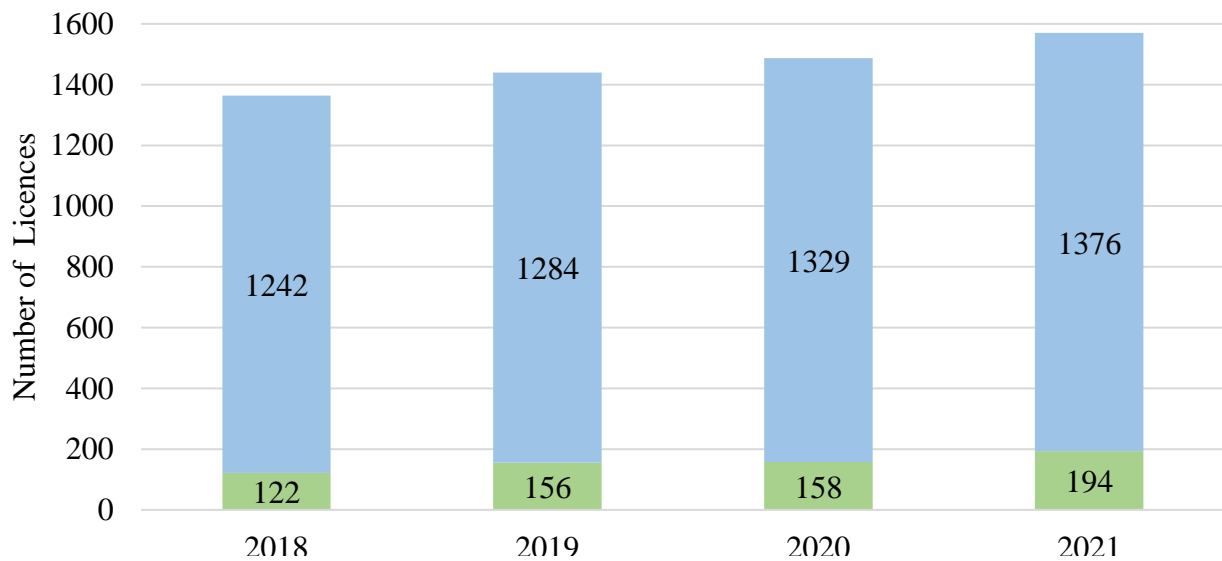
At the end of 2021, 1376 commercial harvesters in the Maritimes Region held a H/M bait licence, and 338 harvesters held a gaspereau bait licence (Table 2). In 2021, 14.1% of all H/M bait licences and 0.6% of all gaspereau bait licence holders were considered active, meaning they submitted landings during the calendar year. As of 2021, 43 commercial communal H/M bait licences and five commercial communal gaspereau licences were held by Indigenous communities in the Maritimes Region (Table 2).

*Table 2. The number of bait licences and active bait fishers in 2021 in the Maritimes Region. The percentage of active commercial communal (CC) was withheld due to privacy concerns.*

Licence Type	H/M Bait	CC H/M Bait	Gaspereau Bait	Gaspereau CC Bait
# of Licences	1376	43	338	5
% Active	14	<i>x</i>	1	<i>x</i>

#### *Bait Licence Holders from 2018-2021 in the Maritimes Region*

The total number of bait licences and active licences has increased every year in the Maritimes Region since 2018 (Figure 5). In 2021, the total number of licences had risen



*Figure 5. The total number of H/M bait licences and active licences in the Maritimes Region in 2021.*

by 10.8% compared to the 2018 total, and over the four-year study period, the number of active licences increased by 59.0%.

### **3.2 Quantities and Value of Bait Harvested in the Maritimes Region from 2018-2021**

#### *Annual Bait Licence Landings in the Maritimes Region*

From 2018-2021, the average total annual weight landed on the H/M bait licence in the Maritimes Region was 388t (Table 3). The landings have increased each year from 2018-2021 and increased by 64.3% over the four-year study period. In 2021, the total catch for the Maritimes Region exceeded 1,000,000lbs or 483t (Table 3). The total value of the fish captured using the H/M bait licence from 2018-2021 was \$2,436,499, and in 2021, the landings alone were valued at \$966,107. Value was automatically assigned to each landing by the MARFIS database system and was based off the market price for each species at the date of the landing.

*Table 3. Annual Atlantic herring and mackerel bait licence landings in the Maritimes Region from 2018-2021 measured in metric tonnes (t).*

Year	H/M Landings (t)
2018	294
2019	374
2020	401
2021	483
Average	388

#### *Annual Herring Bait Licence Landings*

Herring bait landings fluctuated from 2018-2021, peaking in 2020 with a catch of 127t (Table 4). The average annual herring catch over the study period was 64t per year. The total herring catch increased by 150% when comparing the 2021 to the 2018 landings.



*Table 4. Annual Atlantic herring bait landings in the Maritimes Region from 2018-2021 measured in metric tonnes (t).*

Year	Landings (t)
2018	32
2019	19
2020	127
2021	80
Average	64

#### *Annual Mackerel Bait Licence Landings*

Atlantic mackerel bait licence landings peaked in 2021 with a catch of 403t (Table 5). There was a 53.8% increase in mackerel landings in 2021 compared to 2018. The average annual mackerel catch over the four-year study period was 324t (Table 5).

*Table 5. Annual mackerel bait landings in the Maritimes Region from 2018-2021 measured in metric tonnes (t).*

Year	Landings (t)
2018	262
2019	355
2020	274
2021	403
Average	324

#### *Comparison of Herring & Mackerel Bait Landings in the Maritimes Region*

Harvesters landed more mackerel than herring in every fishing season from 2018-2021 (Figure 6). In 2019, harvesters caught a relatively high amount of mackerel compared to herring on their bait licences. However, in 2020, the trend was not as dramatic, with harvesters landing an increased proportion of herring on their bait licences compared to the other years of the study period (Table 4).

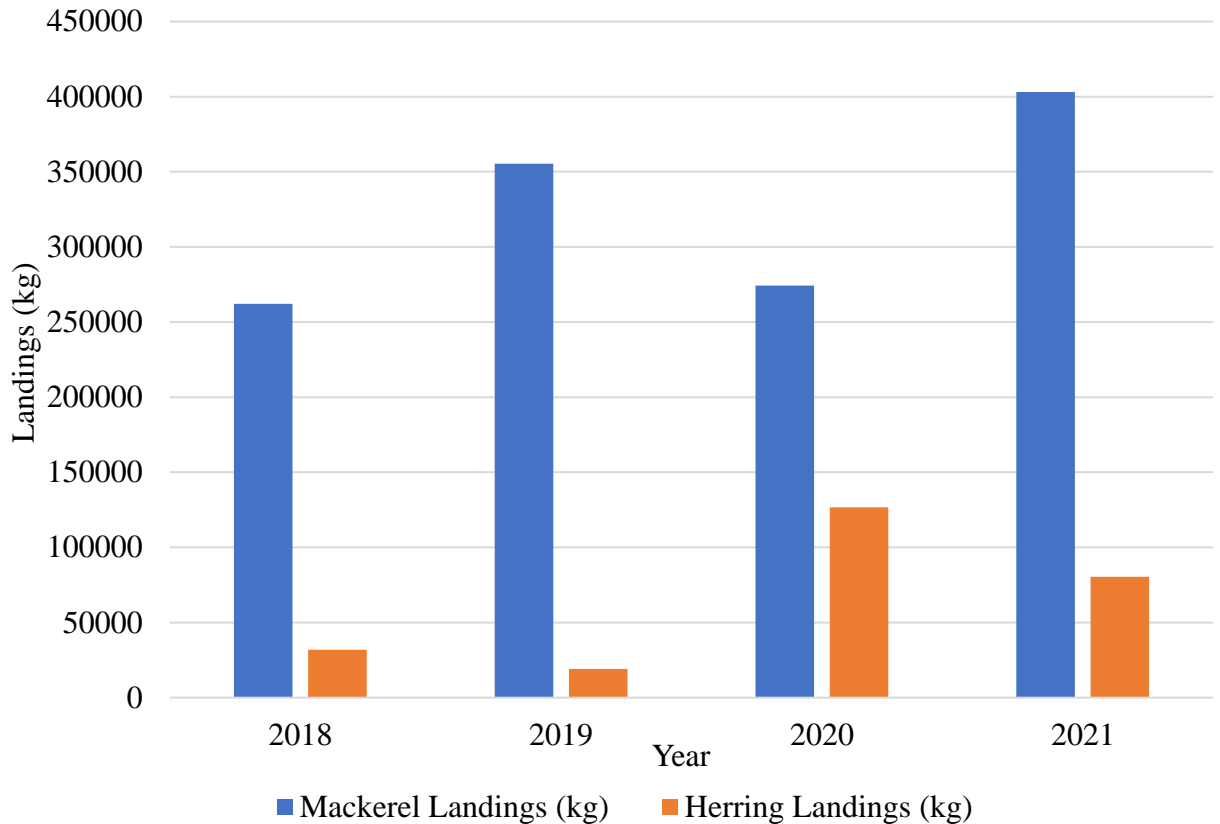


Figure 6. Comparison of the total annual landed weight in kilograms by species captured on H/M bait licences in the Maritimes Region from 2018-2021.

### 3.3 Location of Bait Fishing in the Maritimes Region

#### *Location of Bait Landings in the Maritimes Region*

The most active bait fishers are located in NAFO sub-area 4Xm (68 licences), with the ports of Sambro and Lunenburg containing large amounts of active bait fishers. The sub-area with the next largest amount of active bait fishers was 4Xo (36 licences), followed by 4Wk (28 licences) (Figure 7). Sub-areas 4Vn (26 licences) and 4Wd (25 licences) also contain a significant number of active bait fishers, and there is low bait fishing activity in sub-areas 4Xq (6 licences) and 4Xr (5 licences) (Figure 7). Location was based upon the home port associated with each licence holder's Fisher Identification Number (FIN). A map of NAFO sub-areas is located in Appendix 3.

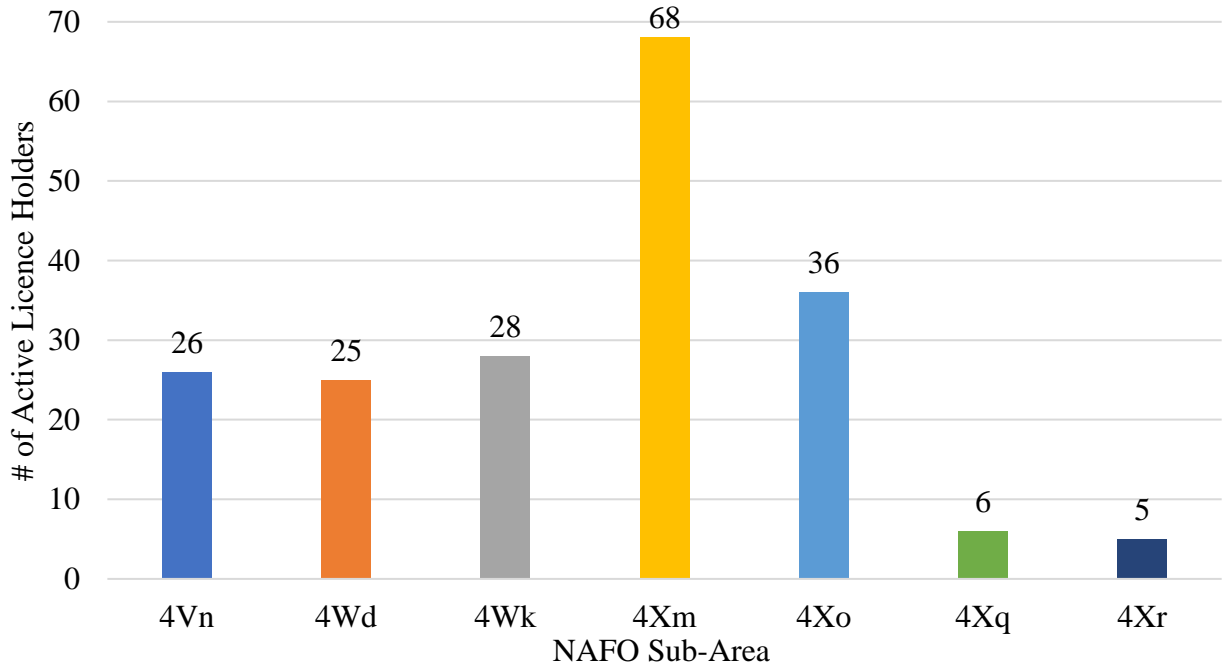


Figure 7. Location (NAFO Sub-Area) of the 194 active H/M bait fishers in the Maritimes Region during the 2021 fishing season.

In addition to having the most active licences (35% of all active licences), ports located in 4Xm landed the largest portion of the Region’s total annual bait landings with 43% of the catch (Figure 8). The sub-area with the next largest portion of the catch was 4Xo (23%), followed by 4Wk (15%) (Figure 8). These three sub-areas comprise much of the Coastal Nova Scotia herring management area, where there are well-established spring and fall gillnet fisheries.

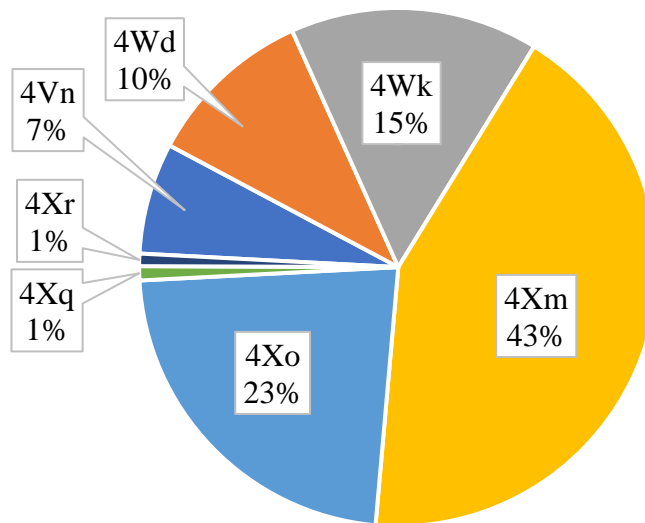


Figure 8. Percentage of the total annual landed weight by NAFO Sub-Area in the Maritimes Region in 2021.

*Location of Mackerel Caught on Bait Licences in the Maritimes Region*

Outside of the Bay of Fundy (4Xr) and Yarmouth area (4Xq), mackerel is commonly landed throughout the Maritimes Region (Figure 9). The largest quantities of mackerel from 2018-2021 were landed in 4Xm, with this sub-area accounting for 44.4% of the total landed weight (Figure 9). The sub-areas with the next largest amount of landed mackerel were 4Wk (15.3% of total landed weight) followed by 4Wd (12.8% of total landed weight).

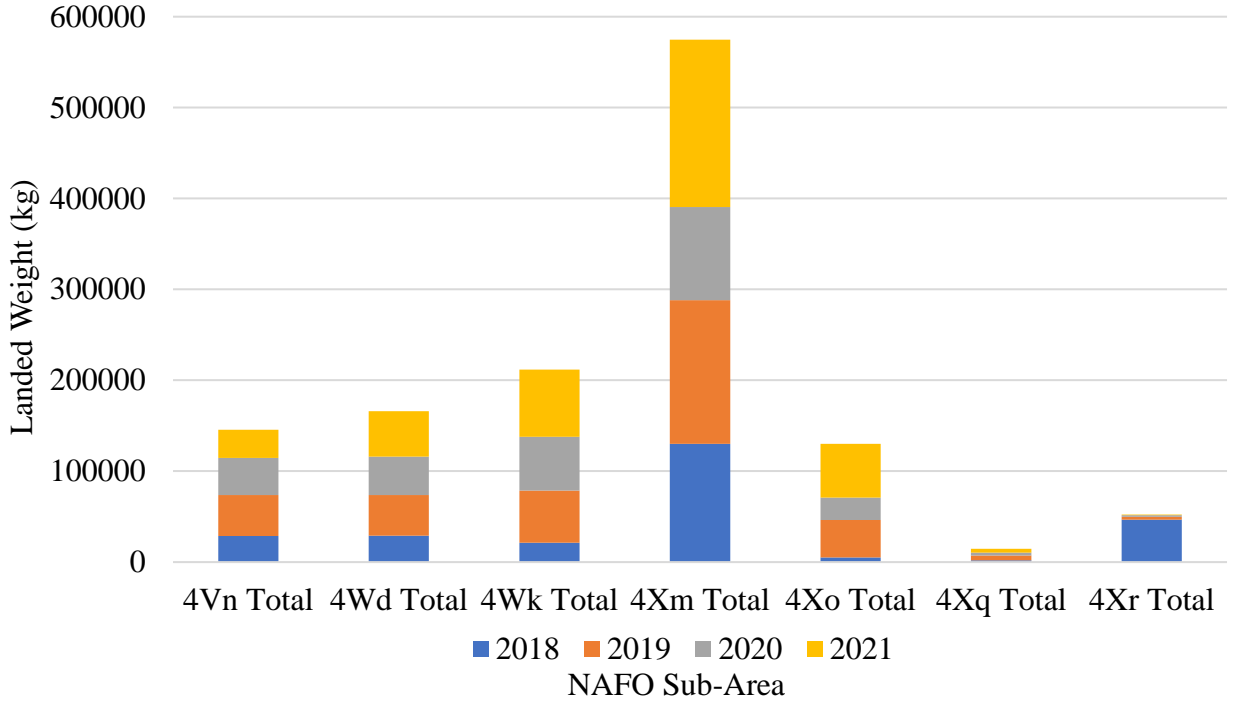


Figure 9. Mackerel weight (kg) caught on H/M bait licences in the Maritimes Region by NAFO sub-area from 2018-2021.

*Location of Herring Caught on Bait Licences in the Maritimes Region*

From 2018-2021, 61.4% of the total herring landings were landed from NAFO sub-area 4Xo (Figure 10). The sub-area with the second highest percentage of total landed weight was 4Xm (20.3%), followed by 4Vn (8.7%) (Figure 10). The herring landings appear to be more concentrated towards the Southwestern and Northeastern ends of Nova Scotia compared to the mackerel landings, where the largest landings were observed along the Eastern coast of Nova Scotia stretching from Lunenburg County (4Xm) to Guysborough County (4Wd). The smallest herring landings were concentrated in 4Wd (0.85% of the total landed weight), but interestingly, this sub-area landed the third-highest portion of mackerel over the same time period.

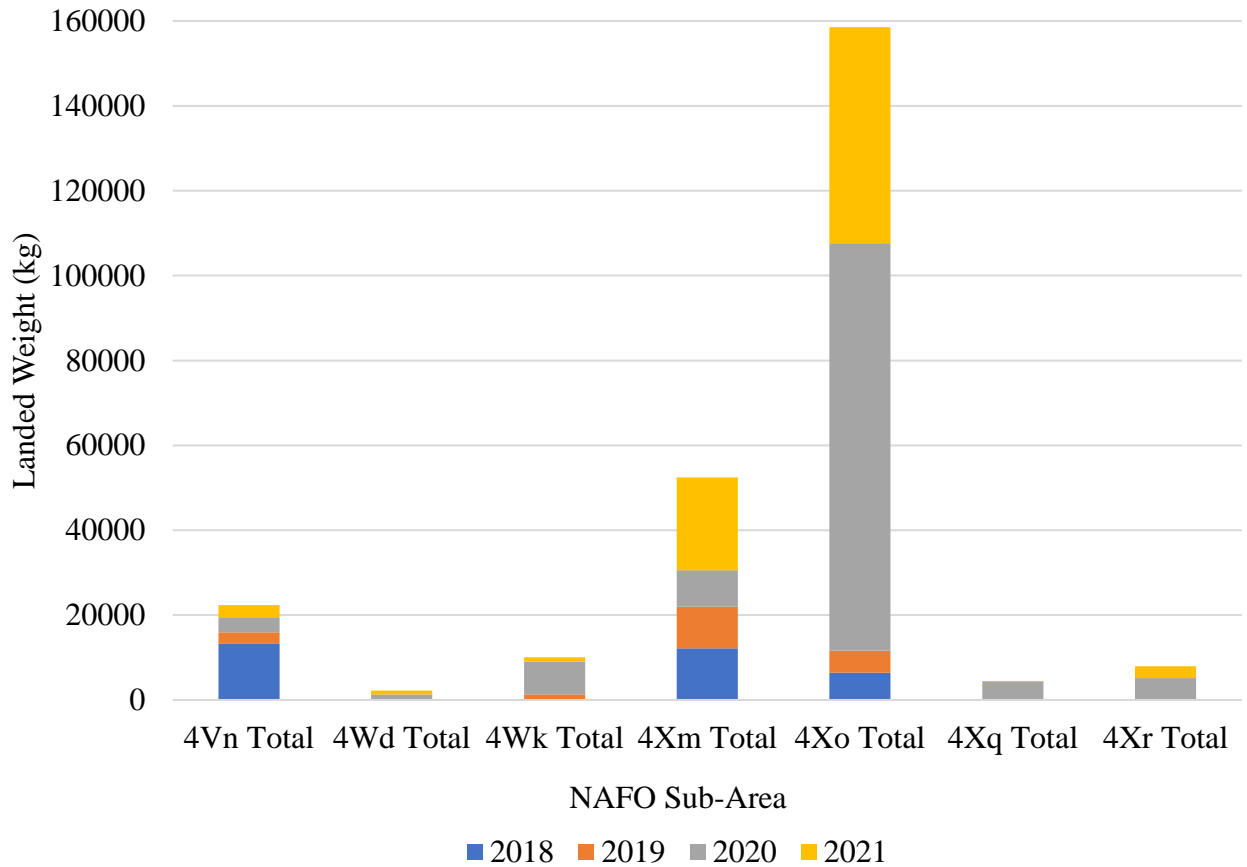


Figure 10. Herring weight (kg) caught on H/M bait licences in the Maritimes Region by NAFO sub-area from 2018-2021.

### 3.4 Timing of Bait Fishing in the Maritimes Region

#### *Timing of Mackerel Bait Fishing in the Maritimes Region*

The month with the largest average weight of mackerel bait licence landings from 2018-2021 was September which accounted for 36.6% of the Region's total landed weight (Figure 11). The month with the second highest quantity of mackerel landed was August (31.6% of the total landed weight), followed by October (8.7%). The majority of the mackerel landings took place from July 1<sup>st</sup> to October 31<sup>st</sup>, with these four months accounting for 85.3% of the total catch (Figure 11). No mackerel catch was reported in February, March, April or December from 2018-2021, highlighting the lack of mackerel bait fishing during the winter and early spring. However, on one occasion in January 2020, a small mackerel catch of 54 kg was reported.

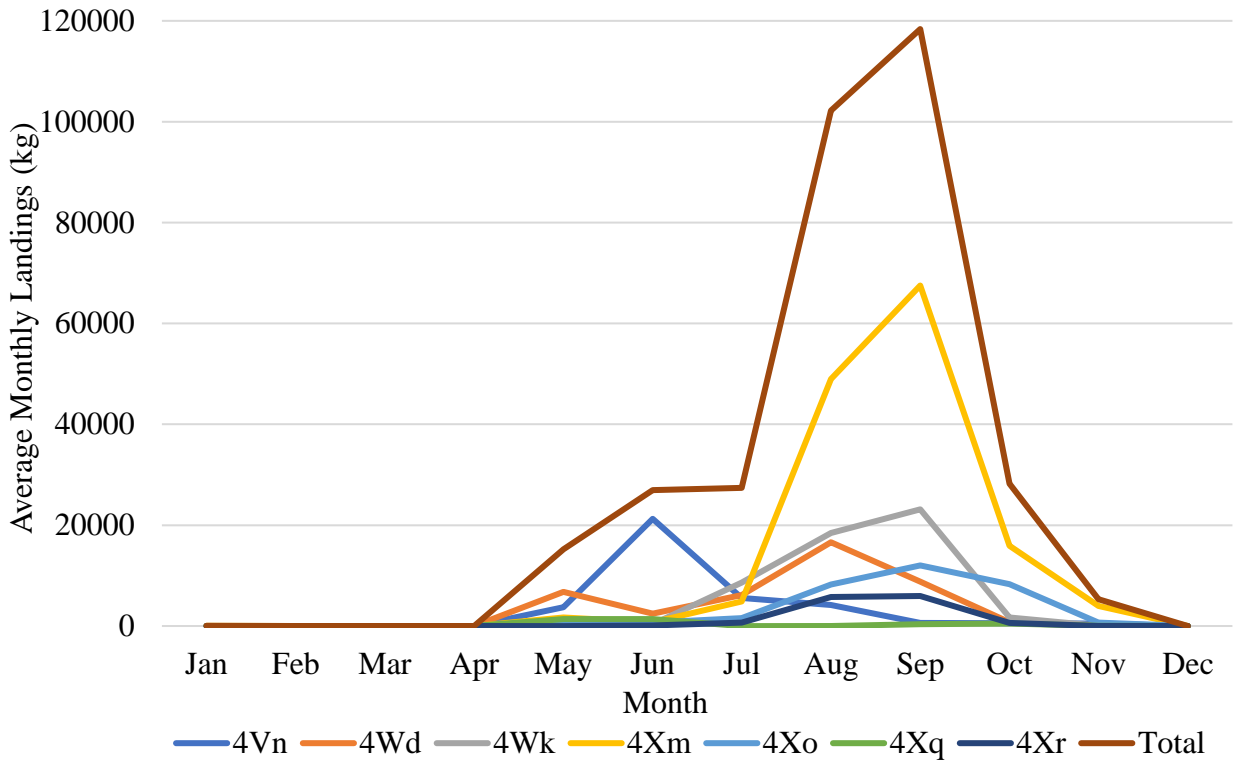


Figure 11. Average monthly landed weight (kg) of mackerel captured on H/M bait licences in the Maritimes Region from 2018-2021. Also shown is the total mackerel bait landings in the Maritimes Region from 2018-2021.

When monthly landings data was further broken down by NAFO sub-area, the pattern of high bait landings from July to October was also observed in most sub-areas outside of 4Vn, where landings peak in June (Figure 11). Mackerel bait licence landings appear to peak once a year in each sub-area, except for 4Wd, where landings spike in May and August each year (Figure 11).

#### *Timing of Herring Bait Fishing in the Maritimes Region*

Similarly to mackerel, the highest average monthly herring landings over the study period were observed in September (27.8% of the total landed weight) (Figure 12). The month with the next highest percentage share of the total landings was August (23.5%), followed by October (21.5%) (Figure 12). Similar to the mackerel landings, herring landings are not evenly distributed throughout the fishing season and are concentrated in the summer and early fall. From 2018-2021, 84.0% of all mackerel landings occurred between July 1<sup>st</sup> and October 31<sup>st</sup>. No herring bait landings were reported in the Maritimes Region from

December to April, highlighting the species is not fished for bait during the late fall and winter months.

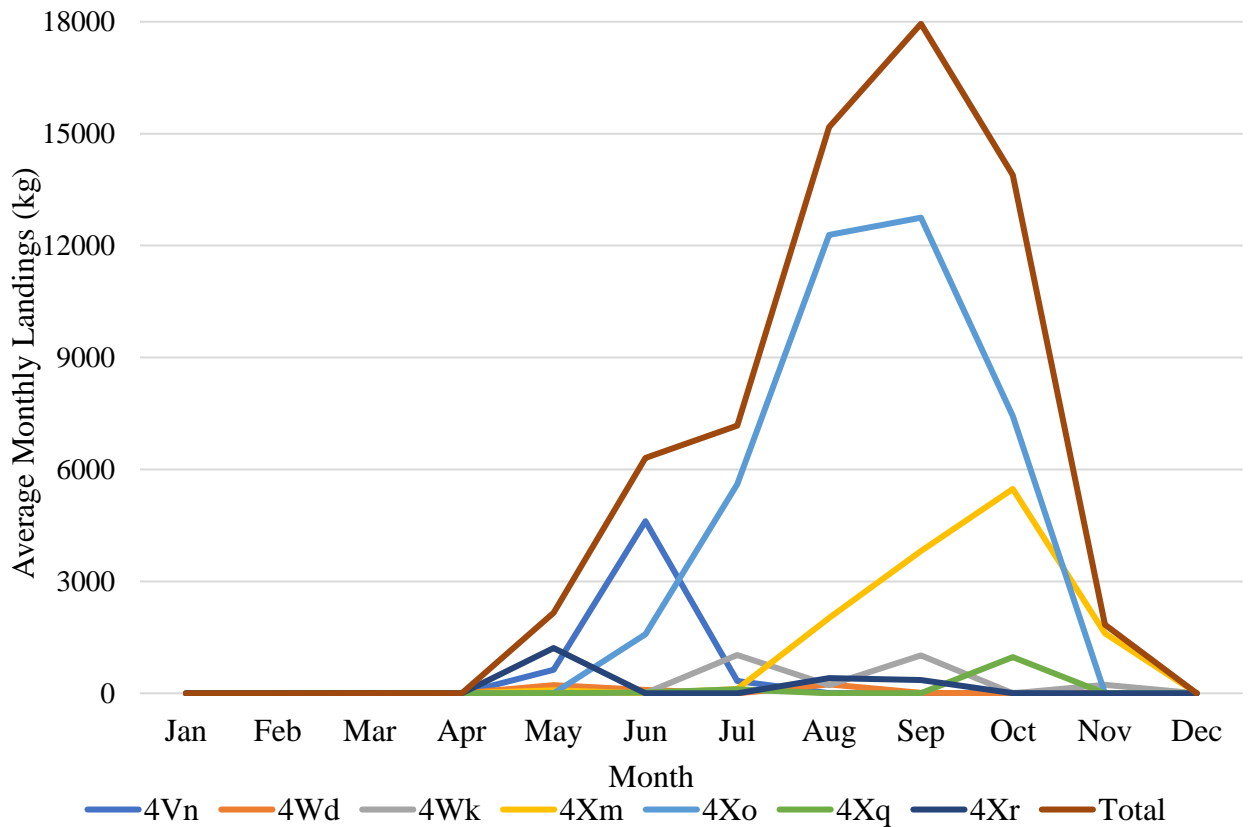


Figure 12. Average monthly landed weight (kg) of herring captured on H/M bait licences in the Maritimes Region from 2018-2021.

Herring bait landings from 2018-2021 predominantly came from NAFO sub-area 4Xo, where the species is most heavily fished in August and September (Figure 12). In sub-area 4Xm, landings peak in October, and for 4Vn, the highest landed weights are observed in June (Figure 12). The landings data for 4Wk showed two peaks in catch, one in July and a second peak later in the fishing season in October (Figure 12).

### 3.5 Estimation of the Commercial Licences Actively Supported by Bait Licences

#### *Commercial Licences Fished By Active Bait Fishers in 2021*

Bait licences in the Maritimes Region are mainly issued to support the lobster and groundfish fisheries (Table 6). In 2021, lobster licences accounted for 46.8% of the commercial licences held by active bait fishers. The second most common licence held by active bait fishers was a groundfish licence, which accounted for 36.3% of the total

licences. The third most common commercial licence was snow crab, held by 10.8% of active bait fishers. No active bait fishers held hagfish, swordfish (longline), tuna or whelk licence in 2021. A total of 427 commercial licences were held by the 194 active bait fishers, highlighting that some harvesters have multiple commercial licences (Table 6).

*Table 6. Commercial licences held by the 194 active bait fishers in the Maritimes Region in 2021. Note: Harvesters can hold multiple commercial licences.*

Commercial Licences Eligible for Bait Licence	# of Commercial Licences Held By Active Bait Licence Holders	% of Active Licence Holders
Crab, Green	14	3.3
Crab, Snow	46	10.8
Crab, Other	4	0.9
Eel (Pot)	8	1.9
Groundfish (Handline & Longline)	155	36.3
Hagfish	0	0.0
Lobster	200	46.8
Swordfish (Longline)	0	0.0
Tuna	0	0.0
Whelk	0	0.0
<b>Total</b>	<b>427</b>	<b>100</b>

#### *Value and Weight of Catch Potentially Supported by Bait Licences in 2021*

The commercial licences of the 194 active bait fishers were researched to investigate the value and weight of commercial catch potentially being supported by bait licences (Table 7). This was achieved through cross-referencing active bait fishers with their commercial licences and summing up the total weight and value of catch of the commercial licences. While the bait licences may not fully support all of this catch, they are at least being used to support a portion of the harvesters' overall fishing operation. In 2021, the 194 active bait licences were potentially used to support the catch of over 6,151t worth of commercial species valued at nearly \$100,000,000 (Table 7). This works out to 28t of commercial catch valued at \$447,973 per active bait licence in the Maritimes Region (Table 7).

*Table 7. Commercial landings by weight and value from the 194 active bait licence holders in the Maritimes Region in 2021.*

	Weight (t)	Catch Value (\$)
Total	6,151	98,554,057
Average Per Licence	28	447,973

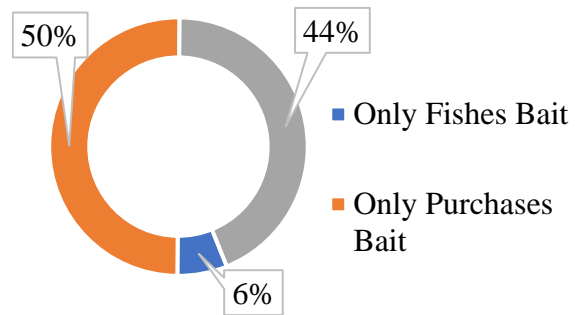


## Chapter Four – Industry Interview Results

### 4.1 Bait and Bait Licence Usage in the Maritimes Region

#### *Understanding Participants' Bait Licence Usage*

In total, the 16 interview participants held or represented 26 commercial licences that require bait. Of the 16 participants, 15 held or represented lobster licences, and one was a fishing association representative who strictly represented groundfish harvesters. Lobster licences were the most commonly held licence, making up 58% of the total commercial licences held by participants. The next most common licence was groundfish (27%), followed by snow crab (7%), eel pot (4%) and green crab (4%). Half of the interview participants (8 out of 16) held a bait licence but do not currently fish their licence (Table 8). The results show that harvesters who fish their bait licence tend to target more than one bait species. Interviewees indicated that their target species changes



*Figure 13. Responses of 16 participants when asked how they acquire their bait.*

throughout the year depending on the demand for their fishing operation, and the water temperature and time of year, which affects the distribution of bait fish. Only one interviewee acquires all their bait through strictly fishing their bait licence and eight interviewees only purchase their bait (Figure 13). Multiple harvesters noted they particularly rely on their bait licence in the weeks leading up to their commercial fishing seasons. Harvesters also mentioned that obtaining access to their preferred bait type and species is crucial for the opening of commercial fishing seasons. Bait licence holders were asked if the change for the 2022 season to only allow herring fishing had any effect on their interest in getting a bait licence and all 16 participants (100%) specified it had no effect.

Table 8. Species targeted under bait licences by the 16 interviewees. Harvesters were allowed to select multiple species if they target more than one species on their bait licence.

Response	Count
Atlantic Mackerel	7
Atlantic Herring	6
Gaspereau	2
Doesn't Currently Fish Bait Licence	8
Total Responses	23

#### *Perspectives and Rationale Behind Bait Licence Usage*

Participants were asked why they chose to fish their bait licence instead of purchasing bait to get a better understanding of individual usage and what benefits harvesters see in using bait licences. The most cited reason was *economic savings* (Table 9), with 6 out of 8 harvesters who fish their licence citing not having to purchase bait as a reason why they choose to fish their licence. Next, 5 out of 8 interviewees reported that fishing their bait licence gives them more reliable or *easier access to their preferred bait type*, meaning fresh, frozen or salted product. Additionally, 3 out of 8 interviewees felt fishing their licence gives them *access to a higher quality of bait* compared to purchasing. Interviewees mentioned that some of the bait purchased from commercial herring seiners is not always the highest quality product due to physical damage from fishing and transportation. Finally, two interviewees cited a *personal enjoyment* of fishing bait species as a factor in why they fish their licence, both referring to themselves as generational mackerel fishermen (Table 9).

Table 9. Responses from the eight participants who fish their bait licence when asked why they fish their licence. A total of 16 responses were captured and sorted into four broad categories.

Response	Count
Economic Savings	6
Easier Access to Preferred Type	5
Access to Better Quality Bait	3
Personal Enjoyment	2
# of Participants Who Answered	8

When licence holders were asked why they choose not to fish their bait licence, they generally cited reasons that were opposite to the answers provided by those who did fish their licence. The most cited reason for not currently fishing their bait licence was that bait fishing has *high expenses* related to fuel prices and crew shares (Table 10). Additionally, it was noted that not every bait fishing trip is a success, meaning harvesters risk losing money if their economic savings from not having to purchase bait fail to exceed the upfront cost of their bait fishing operation. The next most cited reason was *convenience and time constraints*, with 5 out of 8 individuals noting that fishing bait takes up too much of their time and cited that in today's age, it is very convenient to make a phone call or send off an email to acquire bait. Next, 3 out of 8 individuals cited a *lack of abundance* of bait species as a reason for why they do not fish their bait, believing the effort would be too high to fulfill their bait needs or there is simply no bait fish to be caught in their area. Additionally, 2 out of 8 participants discussed that they find it easier to work with purchased bait. Harvesters relayed that purchased bait comes in “nicely packaged 40lbs boxes” that do not take up much space on deck and are easily stored on the boat for longer fishing trips. Finally, one interviewee cited conservation concerns as the reason they stopped fishing their bait licence and instead started using imported bait which they feel is less impactful on the local pelagic stocks (Table 10).

*Table 10. Responses from the eight participants who do not fish their bait licence when asked why they choose not to fish it. A total of 17 responses were captured and sorted into five broad categories.*

Response	Count
Risk of Losing Money/High Expenses	6
Convenience / Time Constraints	5
Lack of Abundance	3
Purchased Bait Higher Quality/Easier to Work With	2
Conservation Concerns	1
# of Participants	8

#### *Avenues for Purchasing Bait*

Interviewees were asked where/from whom harvesters purchase their bait, the 15 interviewees who purchase bait provided 20 responses that were grouped into four

categories. The most cited market for purchasing bait was industry processors, meaning the fish processing plants, which was specified by 12 interviewees. Four interviewees specified they get their bait from bait dealers/importers, who are individuals who specifically sell fish, sometimes imported, for use as bait. Three participants indicated they purchase bait from herring/mackerel/gaspereau commercial licence holders, and one individual specified they buy gaspereau from an Indigenous community for use as bait.

### *Bait Preferences and Practices*

When asked how baiting practices vary throughout a fishing season, interviewees provided in-depth answers discussing variations in soak time and the species or types of bait used in their fishing operation. Multiple harvesters indicated that their preferred bait species sometimes depends upon what they believe other harvesters to be fishing with to try to gain any potential advantage over other fishers. Two interviewees described that they regularly modify their baiting methods throughout the fishing season depending upon the size of lobsters they wish to target. Groundfishers showed less variation in their baiting practices than lobster or snow crab harvesters. In the context of the lobster fishery, harvesters discussed shorter soak times in the spring/summer months and generally longer soak times during the winter.

Survey participants were asked to rank herring, mackerel and gaspereau in terms of their overall preference as bait. Interviewees named herring and mackerel as the preferred bait species in the Region (Figure 14). Results showed that 50% of the interviewees named mackerel as their preferred bait species, and 50% noted herring as their preferred species. No harvesters indicated their first preference is gaspereau, but many highlighted their heavy use of the species in the spring when fresh gaspereau becomes readily available (Figure 14). There was less variation in harvesters' preference for herring compared to mackerel.

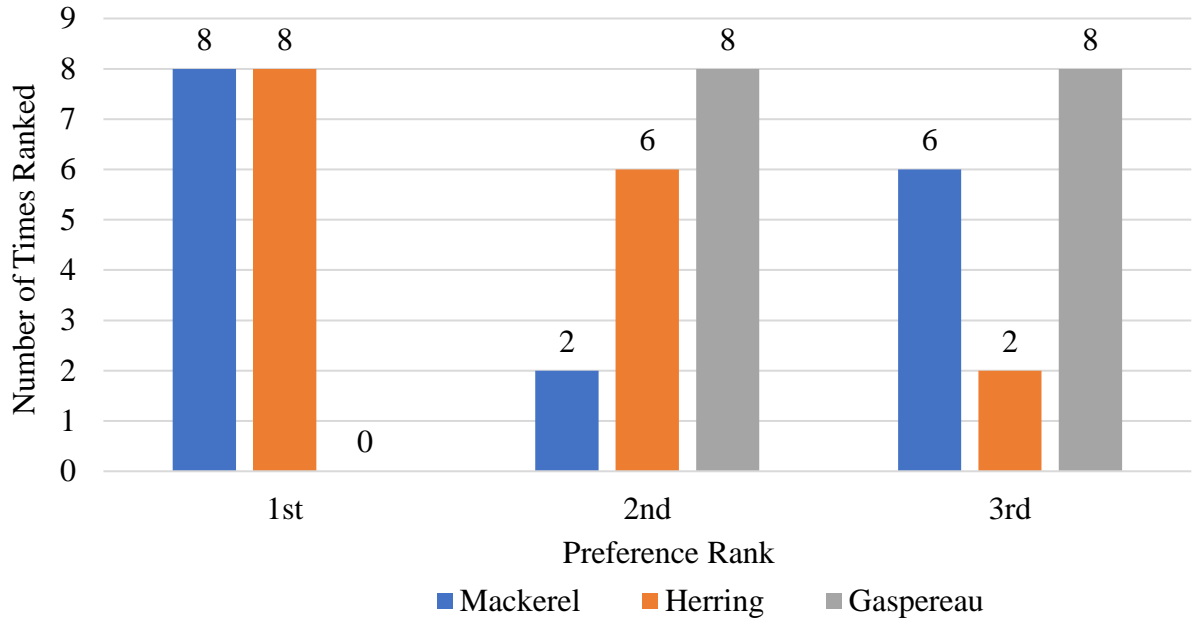


Figure 14. Ranked preferences of the 16 interviewees' overall preference for using mackerel, herring, or gaspereau to support their commercial fishing operation. 1st = preferred species, 3rd = least preferred species.

Harvesters were surveyed on their preference to use fresh or frozen bait (bait type) in their fishing operations. The majority of respondents (56%) preferred to use fresh bait as opposed to frozen bait (31%). Additionally, 2 out of 16 respondents (13%) specified they had no preference in the type of bait they use to support their commercial fishing operation.

#### 4.2 Availability and Concerns of Bait in the Maritimes Region

##### *Affects of the Mackerel Closure and Reduced Herring Quotas*

Harvesters were asked if the mackerel closure and recent SWNS/BoF herring quota cutbacks affected the price of bait in their area. Participants overwhelmingly indicated that the price has increased, with 87.5% of participants indicating the price of bait in their area has increased, and 12.5% of participants relayed that the price of bait has remained the same. No participant cited decreased bait prices. Both participants who cited that the price of bait has stayed the same were from Cape Breton. Harvesters' noted that "bait is now a big deal, it's a big expense that we never had to pay attention to before" and that "the price of bait has sky-rocketed." Others described the situation as "alarming," and observed price increases in all bait species, including those outside of herring, mackerel and gaspereau.

One harvester highlighted that they had observed the price of mackerel double over the past six months, and they expect the price to keep rising. Others discussed that herring has also doubled in price and is expected to rise above \$2 per pound next season. More conservative estimates placed the price increase at 20-30% across all bait species compared to the previous year.

*Supply and Availability of Bait*

Participants were asked two questions to gauge their level of concern about the supply or availability of bait for the current fishing season (2022) and subsequent fishing season (2023+). Interviewees could rank their level of concern as: no concern, mild concern, moderate concern or major concern. Interviewees had heightened concerns regarding the supply and availability of bait for future fishing seasons compared to the current fishing season (Figure 15). Four interviewees (25%) indicated they had major concerns regarding the current supply and availability of bait and four interviewees ranked themselves in the no concern category. However, when asked about future fishing seasons, ten interviewees (63%) indicated they had major concerns and no interviewee noted they had no concerns regarding future fishing seasons (Figure 15). Two concerned harvesters mentioned that this season was the hardest to get access to their preferred species or type. One interviewee said, “sellers are taking advantage of us” and another said, “there were times this year I was just trying to find something to put in the trap.”

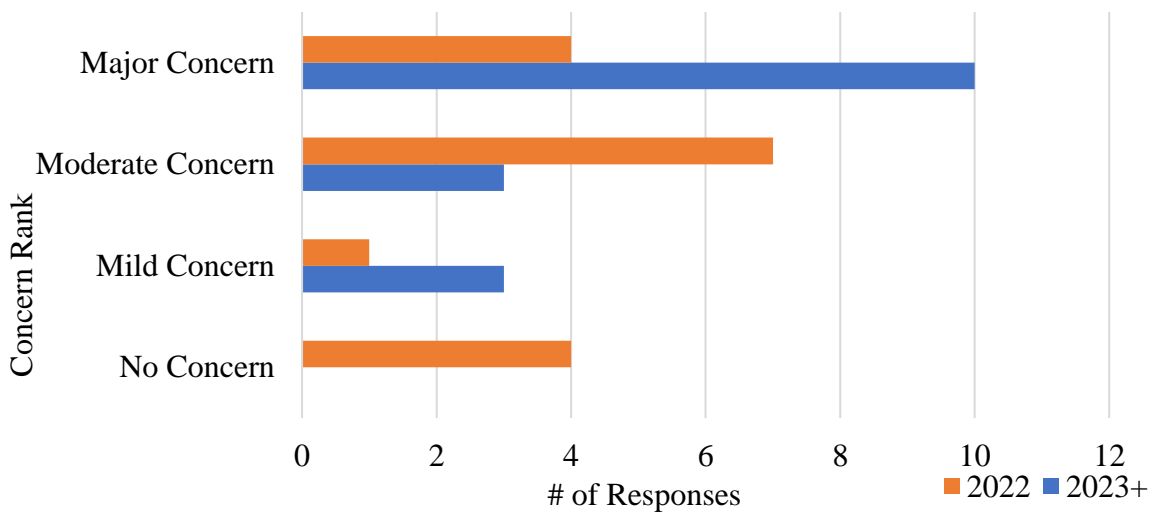


Figure 15. Interviewees’ concerns regarding the supply and availability of bait in the Maritimes Region for the current and subsequent fishing seasons. Orange = current fishing season, blue = future fishing seasons.

### *Mitigation Measures*

The closure of the Atlantic mackerel fishery and reduced access to the SWNS/BoF herring stock has resulted in some harvesters using different species of bait outside of the species they typically fish with. Nearly half of the interview participants, or 7 out of 16 (43.8%), cited using different species of bait outside of those they typically fish with due to decreased availability of herring or mackerel. To mitigate concerns, multiple harvesters noted they turned to European markets for access to Atlantic mackerel.

Harvesters were asked what species they recently started using due to the mackerel closure and herring quota cuts; the 16 participants provided 38 responses covering 20 species or types of bait (See Appendix 3). While the question was intended to investigate how decreased access to herring or mackerel affects the use of other species, it was instead interpreted by most interviewees more broadly as “what species of bait have you recently tried”. While this was not the intent of the question, it still resulted in interesting conversations. The most mentioned species was redfish (*Sebastes Marinus*), with 6 out of 16 respondents highlighting they had recently started using the species. Harvesters who tried redfish felt it was a successful bait and multiple harvesters indicated they would continue using it in the future. The next most mentioned bait type or species was gator bait, a non-fish bait product consisting of pig or cow hide soaked in fish oil. Interestingly, 5 out of 16 participants recently tried out the product and they overwhelmingly indicated that it was a poor bait. A few harvesters noted, that around 2020, gator bait was highly advertised throughout the fishing community using media such as Facebook to promote the product. Additionally, 3 out of 16 participants mentioned they fished with groundfish cuttings/racks, sculpin (Family Cottidae) and green crab (*Carcinus maenas*). Green crab was a particularly successful bait, and harvesters generally noted groundfish cuttings/racks and sculpins to be fairly successful bait species. Other interesting baits mentioned by harvesters include deer, glow sticks/flashing lights and synthetic products. These non-traditional baits were all relatively unsuccessful, and one harvester called the flashing lights a "waste of money and time." A full list of the species brought forward by harvesters can be found in Appendix 3.

The interviewees were also asked if they had any ideas for alternative bait species harvesters could turn to if there were a decreased availability of herring, mackerel or gaspereau in the future. This question was presented in a way to get harvesters thinking about species that may be underutilized in the fishing industry, but may have potential for increased usage. The most commonly cited species was Atlantic Menhaden (*Brevoortia tyrannus*), a bait fish with a similar appearance to Atlantic herring. Atlantic menhaden is currently abundant in New England and Maine and its distribution is thought to be moving northward. The next most cited species were Asian carp (Family Cyprinidae). Other interesting answers included pollock (*Pollachius virens*), fly-based products, cuttings or racks from local finfish aquaculture operations, and lobster callers. Lobster callers were described as an acoustic device that is placed in traps to mimic the natural sound of prey species, and the interviewee indicated they have been shown to be successful in the Pacific crab and lobster fisheries.

#### **4.3 Perceptions and Availability of Alternative Baits**

##### *Attitudes Towards Alternative Species or Types of Bait*

To gauge interviewees' attitudes and interest in using alternative species or types of bait outside of the baits they typically fish with, they were asked to rank their likeliness on a scale of 1-5, with a one indicating they are very likely to try an alternative bait and a five identifying they are very unlikely to try an alternative bait (Figure 16). Harvesters were split on the issue, with eight participants ranking themselves in the unlikely categories (rank of 4 or 5) and six ranking themselves in the likely categories (rank of 1 or 2). Three participants ranked their attitudes as neutral. The most commonly cited rank was "very unlikely," which received 37.5% of the votes (Figure 16).



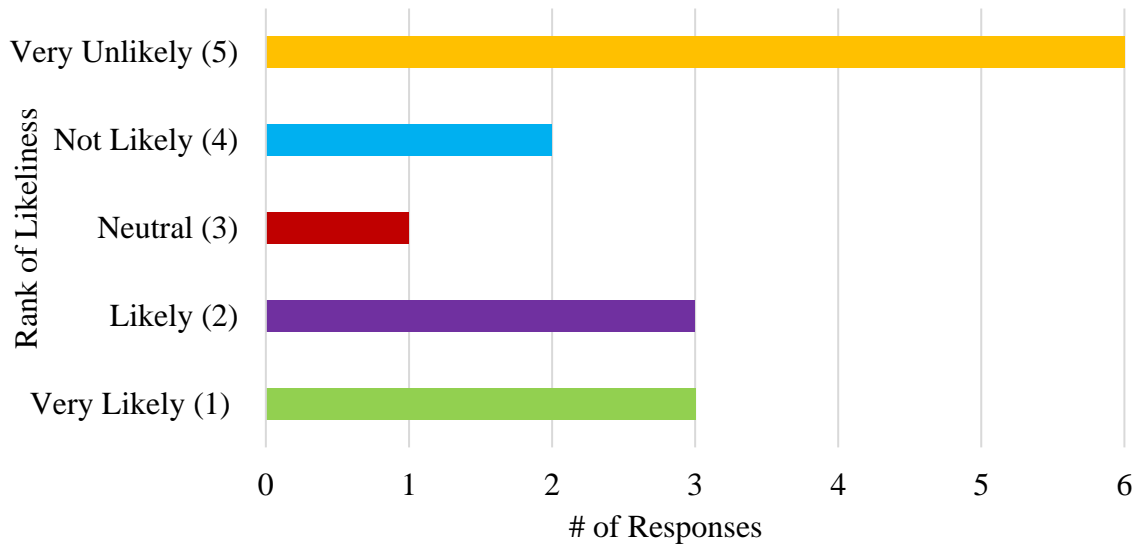


Figure 16. Participants' likeliness to try an alternative bait product in their fishing operations. Interviewees were asked to rank their likeliness on a scale of 1 to 5, with one specifying they are very likely to try an alternative bait up to a five identifying they are very unlikely to try an alternative bait. 15 interviewees answered this question, and one chose to pass.

The six individuals (40% of the responses) who ranked themselves in the likely categories relayed that they feel that as long as it is a successful bait, harvesters will have no issues using it. One interviewee commented, "I'll try anything once," and others noted that they regularly experiment with different bait species. A fishing association representative noted that they had observed a major shift among lobster harvesters over the past 10 years in their willingness to use different species of baits outside of herring, mackerel and gaspereau. Two of the neutral discussed how they were willing to experiment with different baits as long as it took place outside the peak competitive months of their fishery or when there was a high market demand for their commercial product to minimize the economic risk if the bait was unsuccessful. The eight respondents (53.3% of responses) who ranked themselves in the unlikely category were asked a follow-up question to learn why they were unlikely to try baits outside of those they typically use. Almost all of the respondents (7 out of 8) discussed that they believed any alternative bait outside the ones they currently fish with are less successful and will reduce their economic profits from fishing. Additionally, 4 out of 8 described themselves as "old school" or reluctant to try new things. Finally, one interviewee relayed that they have no desire to use different species due to the learning curve associated with switching baits. Overall, harvesters who listed themselves in the unlikely categories discussed that they have no desire to use different baits due to

their past success using their typical baiting methods. However, multiple harvesters noted they might be forced to adapt in the immediate future due to decreased availability of their typical bait species.

#### *Access to Alternative Species or Types of Bait*

Interviewees highlighted that they do not always have access to a diverse range of bait products. Harvesters are limited to what is available locally if they do not have time or the financial freedom to place an order for imported baits or travel outside their immediate area to obtain bait. Seven harvesters specified they do not have access to baits outside of herring, mackerel or gaspereau. Four respondents discussed that access to alternative baits is not constant or highly dependent upon the time of year. It was also noted that access to baits such as crab species and groundfish depends on what commercial fisheries are currently operating while access to redfish, sculpins, or cunner relies on what harvesters retain and sell as incidental catch. One interviewee explained that the supply of imported bait is very limited, and it sells out quickly since shipments consist of small quantities that are highly coveted in the fishing industry. There were five participants who felt they had access to alternative species. They commented that it is "fairly easy to obtain if you ask around" or "it is available, but you just gotta be willing to pay for it." One halibut fisher noted that they have many options, but the real question is "whether the bait will stay on the hook or not and fish well."

### **4.4 Perceptions and Availability of Synthetic Baits**

#### *Perception and Attitudes Towards Synthetic Bait*

Interview participants were surveyed on their likeliness to try synthetic bait and they were asked to provide a rank ranging from a one (very likely) to a five (very unlikely) on their likeliness to try a synthetic product. Interviewees were divided on the issue, with 9 out of 16 participants ranking themselves as "very likely" and 5 out of 16 participants ranking themselves as "very unlikely" (Figure 17). The remaining two respondents classified themselves as "likely" (Figure 17).

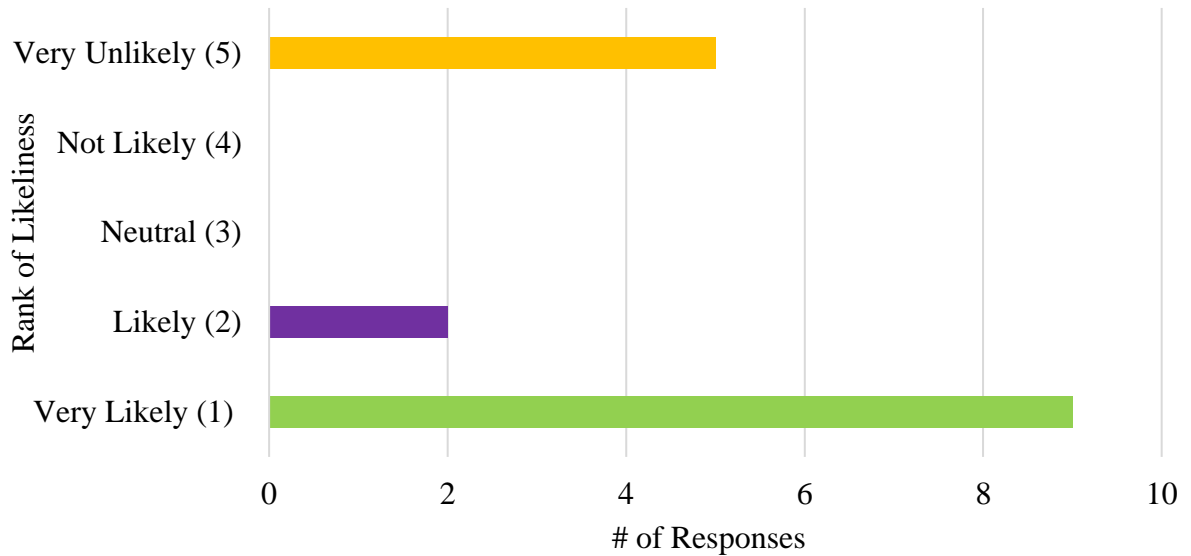


Figure 17. Industry’s likeliness to try a synthetic bait product in their fishing operations. Interviewees were asked to rank their likeliness on a scale of 1 to 5, with one signifying they are very likely to try a synthetic product and a five signifying they are very unlikely to try a synthetic product.

When asked about their past experiences with synthetic bait products, five participants explained they had tried synthetic bait. However, all five did not have positive things to say about their experience. One interviewee called the product “garbage”, and one participant specified that using synthetic products was an insult to their crew. A common theme was that synthetic products lack the “fishy” smell required to attract lobsters, while others discussed that lobsters are extremely “picky” in what they consume. Interviewees were asked if they felt synthetic products had a place or future in the fishing industry, and the group was heavily divided on the subject matter. Results showed that 6 out of 16 felt there was a place or future for it in the fishing industry. Examples of comments include "I believe it will be a significant player in the next 20 years", or "they are the future along with imports." Multiple respondents also discussed the potential economic and ecological benefits of decreased dependence on forage fish as bait. Six others indicated they believe it could have a future if the product is improved upon. A groundfish harvester relayed the products were not yet feasible with the longline gear type. However, they expressed interest in synthetic bait if the fishery adopted compatible gear types in the future, such as groundfish traps. Finally, 4 out of 16 respondents had doubts, calling it a "far-fetched dream," or they discussed statements indicating nothing will ever outperform real fish as bait.

### *Availability of Synthetic Bait*

The majority of interview participants expressed they had access to synthetic bait products; some have even been given samples to try for free. Results showed that 9 out of 16, or 56.3% of interviewees, felt they had access to synthetic bait products. In contrast, 7 out of 16, or 43.7% of interviewees, felt they do not have access. Those who felt they had access talked about the ease of ordering the product online, and two interviewees noted that a few years ago, an individual was attaching synthetic bait fliers on fisher's boats to promote the product. One participant also discussed that these products are highly available at fish shows or conventions. However, one interviewee felt that harvesters in Southwestern NS did not have access to these products and that access is very localized to harvesters in PEI and the Gulf Region. Another commented that it was readily available in past years, but access has decreased over the past five years, and they "don't hear about it much anymore."

### **4.5 Industry Perspectives on Potential Management Amendments**

Harvesters were consulted about the idea of better aligning the management of the Maritimes Region's bait fishery with forage fish rebuilding efforts and the approaches used in other Atlantic Canadian regions. Interviewees were specifically asked for their opinions and insight into potential gear amendments such as reduced length of authorized gillnets, the implementation of a minimum mesh size, and daily closures or a delayed spring opening. They were also asked if they thought the recent maximum daily catch limit for herring was a reasonable limit.

### *Gillnet Length*

The majority of interviewees (9 out of 16) did not feel that reducing the authorized length of gillnets from 90 to 50 fathoms would be a reasonable way to manage removals in the bait fishery. These interviewees commonly cited that they did not feel this change would result in any significant benefits on stock rebuilding efforts since they feel the bait removals are negligible compared to the large-scale removals from commercial fishing operations, such as the purse seiners. Others discussed that going any smaller than 90 fathoms would drastically reduce the effectiveness of the gear type. One individual commented that a reduced gillnet length would require them to purchase a new set of gillnets since they

currently use the same nets for bait and commercial fishing. Instead, they recommended reducing the length to 54 fathoms. They explained that this is because gillnets are commonly sold in lengths of 18 fathoms, and if a harvester wanted to fish the maximum of three nets, they would be over the authorized length by 4 fathoms unless they cut up a net. They further explained that this amendment would gain increased industry support if the authorized length were reduced to 54 fathoms so that harvesters did not have to cut up any of their existing commercial gillnets. Interviewees who were in favour liked that this potential change would align the regulations in the Maritimes Region with those currently in place in the Quebec, Gulf and Newfoundland Region; others felt there were some conservation benefits in using this approach.

#### *Minimum Mesh Size*

Interviewees were highly supportive of implementing a minimum mesh size for gillnets in the bait fishery, with 87.5% of participants supporting its implementation. Interviewees provided comments such as “larger fish are good for everybody, “it is just a good business practice in the fishery,” and “I 100% support this move”. Harvesters felt this is an advantageous change due to the potential reproductive benefits of letting smaller, younger fish reach sexual maturity. Some highlighted that the implementation would create more fairness within the fishery through standardized regulations for all participants. Others liked that this change would align management in the Maritimes Region more closely with the regulations used in other Atlantic regions. Five individuals noted that they believed there already was a minimum mesh size for the bait fisheries in the Maritimes Region. A fishing association did note that they wish that any potential gear amendments be implemented gradually to give industry time to adapt and effectively make the required changes. One of the opposing interviewees felt this change would inconvenience harvesters with no conservation benefits. The other highlighted that the change would limit their ability to catch smaller herring with a high-fat content which they prefer to use as bait. Interviewees were asked to suggest a minimum mesh size that they felt would be practical to implement in the bait fishery. Almost all of the suggestions recommended following the minimum mesh size currently used in their area’s commercial herring or mackerel fishery, and the most common suggested size was  $2^{1/2}$  or  $2^{3/8}$  inches.

*Feedback on 2022 Amendment – Herring Trip Limit*

Harvesters’ opinions were split when asked if they felt the 3,000lbs daily trip limit was reasonable for the 2022 herring bait fishery. When surveyed, seven harvesters felt 2000lbs is a reasonable limit, seven felt it was unreasonable and two interviewees abstained from the question (Table 11). A follow-up question was asked to the seven who felt the limit was unreasonable with 4 out of the 7 interviewees specifying the limit was set too low, and 3 of the 7 felt it was too high. Those who felt the limit was too high indicated that setting the limit any higher may incentive the illegal sale of catch and effectively allow for commercial-scale removals. Those who felt it was too low discussed the high fuel prices and that harvesters need to catch a certain amount of fish to cover the cost of fishing. Two individuals discussed moving towards a weekly catch allocation instead of a daily one to give harvesters more flexibility if they wanted to do all their bait fishing in a single day instead of over multiple smaller trips.

*Table 11. Responses of the 16 interviewees when asked if they felt the 3,000lbs daily trip limit for herring was reasonable in the bait fishery. Two interviewees chose to pass on the question.*

Response	Count
Yes	7
No (too high)	3
No (too low)	4
Pass	2

*Amendments to Close Times*

Interviewees were generally not in favour of implementing daily or weekend closures similar to what is used in the Gulf Region’s bait fishery. Harvesters felt that this change would provide minimal conservation benefits as fishers would increase their fishing on days they are authorized to fish. A fishing association commented that “effort control fisheries always fail.” In addition, five participants cited safety concerns. Interviewees who cited safety concerns explained that restricting fishing to certain days would incentivize harvesters to fish for bait in rough or dangerous maritime conditions, putting themselves, their crew and their vessel at risk. One interviewee questioned the practicality of the change

by saying, “fishing doesn’t operate on a five-day-a-week schedule; DFO does.” Interviewees in favour felt this change would decrease fishing pressure on bait stocks and would not heavily affect harvesters’ fishing operations. One interviewee highlighted that this management approach has been successful in the gaspereau commercial fishery.

Interviewees were in almost unanimous support of implementing a delayed opening for the bait fishery. Only one participant opposed this potential management amendment. Interviewees explained that while the current regulations authorize year-round fishing, this is not practical due to the highly migratory behaviours exhibited by herring and mackerel, which results in them only being available to harvesters at certain times of the year depending upon their location in the Region. For most harvesters in the Region, herring and mackerel are only fished from mid-April until the end of November. Harvesters indicated they would be willing to support a shorter season that reflects bait fish distribution patterns. Multiple harvesters noted that bait fishing is not feasible during the winter months due to the high cost of fishing and low bait fish abundance, meaning a delayed opening would not affect any of their typical bait fishing practices. Two interviewees explicitly conveyed that a delayed opening later in the spring would protect a greater proportion of spawning individuals. Multiple interviewees noted that some spring bait landings, especially mackerel, are often full of spawn. One interviewee commented that harvesters do not prefer to use mackerel full of spawn as bait when targeting lobsters, as its presence makes it a less successful bait. Additionally, one interviewee remarked that a more defined bait fishing season might reduce accounts of illegal fishing or misuse of bait licences.

## **Chapter Five – Discussion**

Bait licence usage is highly variable in the Maritimes Region, with harvesters tailoring their bait fishing activity to the localized abundance of forage fish, economic factors and the requirements of their commercial fishing operation. The use of alternative and synthetic bait products may increase in the Region in the coming years due to shortages of local herring and mackerel; however, not all harvesters are keen on using these types of bait.

Increased stakeholder engagement is required in the bait fishery to ensure the fishery is managed with respect to harvesters' bait requirements while balancing forage fish rebuilding efforts.

### **5.1 Characteristics of the Bait Fishery in the Maritimes Region**

#### ***Bait Landings in the Maritimes Region***

The landings from H/M bait licences steadily increased throughout the four-year study period, which is likely due to three main factors. First, the number of bait licences and active bait fishers in the Maritimes Region is increasing, which means there are more harvesters actively targeting bait fish. A interview with a fishing association revealed they have recently been getting more inquiries from their harvesters about bait licences and noticed increased bait licence usage in their area. Second, the rising price of bait and decreased commercial quotas may cause harvesters to value their bait licences more heavily, resulting in increased usage. In addition, harvesters indicated that fishing their own bait can result in economic savings if forage fish are abundant in their surrounding area. Finally, the recent implementation of stricter management approaches, such as daily catch limits and increased dockside monitoring, disincentivizes illegal fishing and is believed to be a large factor in the observation of increased bait landings.

Bait harvesters land significantly more mackerel on their bait licences compared to herring despite interview data showing that harvesters almost equally prefer each species as bait. Interviews and landings data revealed that bait fishing is restricted by migratory patterns and localized abundances. For example, in the Guysborough and Richmond County area (4Wd) landed the third largest weight of mackerel out of the seven NAFO-subareas. However, this area also landed the least amount of herring in the Region, highlighting that different areas land different bait species. Interestingly, while mackerel dominated the landings over the four-year study period, the two most recent fishing seasons have seen increased proportions of landed herring. This trend is likely attributed to a decreased mackerel abundance in the Region, which makes the species more difficult to catch, thus increasing the relative proportion of herring landings.



### *Bait Licence Usage in the Maritimes Region*

MARFIS data shows that bait licence usage in the Maritimes Region is dominated by lobster and groundfish harvesters, however conversations with industry indicated they more commonly use bait licences to support their lobster as opposed to their groundfish licences. Conversations with a groundfish management board outlined that some of their harvesters do not use their bait licence as they prefer to purchase frozen bait as it is easier to work with and store on deck for multi-day fishing trips. The estimation of commercial licences actively supported by bait licences result may be misleading because it only shows the number of commercial licences that are held by active bait fishers. If active bait fishers hold multiple commercial licences, the table doesn't describe which licences are actually supported by bait fishing. For example, an active bait fisher could hold a lobster, groundfish and eel (pot) licence but only use the landings from their bait licence to support their lobster fishing activity. While the table is useful for identifying which licences are held by active bait fishers, it should not be used to accurately quantify which licences are supported by bait fishing activity.

Harvesters utilize bait licences for their personal preference, which best suits the individual needs of their fishing operation. Therefore, there is no definitive one-size-fits-all narrative to describe the patterns of bait fishing in the Maritimes Region. No clear Region-wide pattern emerged when comparing the timing of lobster fishing seasons with bait fishing activity, but localized trends could be inferred. Analysis showed that the timing of bait fishing could occur prior to the opening of a lobster season, concurrently with the season or after the closure of a fishery. For example, it appears lobster harvesters in Northern Cape Breton (4Vn) concurrently fish their bait and commercial licence. In Northern Cape Breton, the majority of bait fishing occurs in May-July, coinciding with the lobster season in LFA 27, which operates from May 15<sup>th</sup> to July 15<sup>th</sup> (DFO, 2020c) (See Appendix 3 for LFA Map). Mackerel is more abundant than herring in Cape Breton; the species typically arrives in late May to early June (DFO, 2007), requiring harvesters to immediately fish bait if they wish to obtain fresh mackerel for use in their lobster season. Harvesters in SWNS tend not to concurrently fish lobster and bait; instead, they heavily fish in months leading up to the LFA 33 and 34 seasons which operate from the last Monday in November until May 31<sup>st</sup>

each year. Bait landings in SWNS (4Xo, 4Xm and 4Xq) are relatively small throughout the spring and early summer but peak in September, before the onset of the lobster season. In the Eastern Shore (4Wk), harvesters almost exclusively target mackerel and the bulk of their bait fishing occurs from July to October, which takes place after the closure of the lobster season, which runs from April 19<sup>th</sup> to June 20<sup>th</sup> (DFO, 2020c). The timing of bait fishing varies within the Maritimes Region as harvesters are restricted to certain species by forage fishes' migratory nature and distribution patterns (Rafferty, 2014; DFO, 2021g). During the interviews, harvesters explained that the localized abundances of bait species are highly variable throughout the year, creating only specific periods where they can be targeted.

While the landings highlighted localized patterns related to the timing of bait fishing, interview data showed harvesters particularly rely on their bait licences in the weeks leading up to the opening of commercial fishing seasons in order to obtain access to fresh bait and overall low bait licence usage in SWNS. Harvesters can catch bait and store it on ice for up to three weeks to “chill” the bait and keep it fresh instead of freezing it. Most interviewees preferred fresh over frozen bait, citing that it is more successful at attracting prey because it gives off more of a natural “fishy” scent. Lobster harvesters discussed that they care more about what they use as bait in the initial weeks after their season opens and tend to bait more heavily during this period. This is because lobster fisheries are at their competitive peaks early in the season as fewer lobsters are on the market, increasing the demand and price, resulting in harvesters setting and hauling their entire trap limit every day. Additionally, lobsters are more heavily distributed inshore during the late spring, summer and fall months which coincides with the opening dates of lobster seasons in the Region, which further increases levels of competition (DFO, 2020c). As a result, harvesters have a heightened bait preference and heavily bait their traps early in lobster seasons as they seek to gain any potential advantage over their fellow harvesters to maximize their economic outputs. One harvester described the onset of a lobster season as a “buffet” for lobster, meaning the seafloor is littered with traps giving lobsters more choice in what bait they wish to target. Similar observations were drawn by Harnish & Willison, 2007, who

observed harvesters using increased amounts of bait per trap at the beginning of lobster fishing seasons due to increased levels of competition.

Another pattern that emerged was a decreased use of bait licences for fishers located in LFA 34, which encompasses large ports in coastal communities such as Yarmouth, Pubnico, Clark's Harbour and Port La Tour. Despite LFA 34 having the most lobster licences in the Region (DFO, 2020c), only six active bait fishers operate in 4Xq. Interviews indicated that harvesters in SWNS, such as LFA 34, may be less likely to utilize their bait licences due to economic factors and LFA regulations. As previously mentioned, the LFA 34 fishery lands the largest annual weight of lobster for inshore LFAs each year, and has the longest season and largest trap limits in the Region (DFO, 2020c). Due to these factors, harvesters operating in LFA 34 (and 33) have the largest annual bait requirements in the Region. This creates a situation where LFA 34 fishers may be less incentivized to fish their bait licences and instead tend to rely on purchasing bait. The higher bait requirements make it more difficult for harvesters to obtain a significant portion of their overall bait requirement through fishing themselves, and the high economic outputs can allow harvesters to justify the higher expenses associated with purchasing bait. Additionally, the longer seasons give harvesters a shorter off-season to conduct bait fishing outside of the commercial season, which may factor into their desire not to fish their bait licence. This trend is not observed in LFA 33 to the same extent, as there are larger abundances of forage fish in this area compared to LFA 34. This, along with well-developed inshore gillnet fisheries such as the Little Hope Box, allows for lower expenses and more effective bait fishing, which incentivizes the use of the bait licence.

A surprising result was that all interviewees cited that the decision to only authorize herring on the 2022 bait licence had no effect on their desire to request a licence, despite mackerel accounting for 84.0% of the total landings over the study period. Further conversations concluded that harvesters apply for their bait licences every year, whether or not they have any plans on fishing their licence. This is out of fear that the H/M bait fishery will become closed-entry and terminal, as happened with the Gaspereau bait fishery whereas harvesters who did not renew their licence became unable to obtain a bait licence in the future (DFO,

2022f). This may partly explain the large gap between the number of total licences and active bait fishers. This trend is expected to continue due to the closure of the mackerel fishery, which likely heightens their concern about losing the licence, and the increasing price of bait which places greater value on the ability to fish your own bait. It is unknown at this time what effect the herring-only bait licence will have on the total landings and bait licence usage for the 2022 fishing season. In 2018 there were 2,979 lobster licenses issued in the Maritimes Region (DFO, 2020c), far exceeding the total number of issued and active bait licences. This highlights that not only do some harvesters choose not to fish their bait licence, but a large amount also choose not to apply for a bait licence; however, those that do apply for a bait licence appear to value its issuance.

#### *Summary of the Characteristics of the Bait Fishery*

Bait fishing activity in the Maritimes Region is dominated by lobster fishers and to a lesser extent groundfishers. Overall, bait licence usage depends upon a harvester's economic status, their geographical location corresponding to the localized abundance of forage fish, and the timing of their commercial fishing seasons. Therefore, any potential amendments to the opening of the bait fishing season must consider commercial fishing seasons and migratory patterns of forage fish to ensure harvesters are able to catch bait prior to the opening of their commercial fishery. Ensuring harvesters are consulted on changes in bait fishing regulations is crucial due to the complex and highly variable patterns of usage throughout the Region.

### **5.2 Alternative Baits in the Maritimes Region**

#### *Attitudes Towards Alternative Bait Species in the Maritimes Region*

Interviews revealed that harvesters are willing to try and use alternative baits on the basis they are successful; however, usage is limited to the time of year when their fishery is relatively uncompetitive, and the expected catch is low. Harvesters were unwilling to risk varying their typical baiting practices when the expected catch and market prices are high out of concerns for potential economic losses. The Maine lobster fishery experienced a bait shortage in 2019, where herring quotas were cut by 85% due to population declines (Lemieux, 2019). The shortage required harvesters to transition away from herring, and it

was noted that the increased use of alternative baits resulted in many fishers realizing “you don’t need a herring to catch a lobster” (Stoll et al., 2019; Kestrel, 2020). The current interest in only experimenting with alternative baits when the expected catch is low raises concerns about biases in the testing methodologies and knowledge gaps surrounding the viability of alternative bait species in the Maritimes Region.

#### *Ideas for Alternative Bait Species and Parallels with the Maine Bait Crisis*

The 2019 Maine “bait crisis” was a result of decreased access to the herring, the predominate bait species among Maine lobster harvesters (Kestrel, 2020). The reduced quotas were due to climate change, overfishing, and other anthropogenic factors resulting in decreased herring abundances (Stoll et al., 2019). The decreased availability of herring in Maine resulted in harvesters using a wide range of adaption strategies and bait supply becoming more diverse and globalized (Stoll et al., 2019). A similar scenario of more diverse and globalized bait usage could occur in the Maritimes Region, with significantly more harvesters turning to countries such as Iceland and Norway for imported herring and mackerel for use as bait. Increased usage of imported baits raises concerns and questions about the sustainability of the products and the cost to harvesters’ fishing operations. For example, freshwater fish such as Asian carp (*Cyprinus carpio*), catfish (order Siluriformes) and Northern pike (*Esox lucius*) have the potential to carry foreign diseases and parasites and the risk of spread to the marine environment is not fully understood (Lemieux, 2019). Interview participants in this study mentioned Asian carp as a potentially successful alternative bait; however, the Canadian Food Inspection Agency currently lists the species as susceptible to carrying foreign diseases such as viral hemorrhagic septicemia (Government of Canada, 2022). Additionally, increased usage of imported or non-traditional bait species could lead to issues related to consumers’ perceptions of the sustainability of the fishery, affecting market prices and the livelihoods of commercial harvesters (Stoll et al., 2019). Further research is needed to investigate the impacts of increased reliance on imported bait species and the implications to fisheries in the Maritimes Region and foreign fish stocks.

Bait shortages resulted in Maine harvesters turned to a diverse range of alternative baits. Some of the baits they transitioned to mirrored suggestions put forth by interviewees of this research. For example, the Stoll et al., 2019 study observed a recent increased use of cow and pig hide as bait. Similar comments were captured in this study, with harvesters in the Maritimes Region reporting increased usage of what they referred to as “gator bait” during the same time period. A particularly crucial adoption strategy that Maine fishers utilized was increasing the use of Atlantic menhaden, a pelagic forage fish species also known as “pogies.” Coincidentally, menhaden was the most mentioned species by harvesters in this research when asked for their insight on potentially viable alternative bait species. Atlantic menhaden are currently listed as healthy and not overfished by the most recent NOAA stock assessment (Chagaris et al., 2020; NOAA, 2022b). Pogies are genetically similar to herring as they are both members of the family Clupeidae. Atlantic menhaden’s geographical range stretches from Florida to Nova Scotia (NOAA, 2022b), but the species is not yet considered to be highly abundant in the Maritimes Region. There are currently limitations to its use in the Region since there is no directed fishery, and harvesters are not authorized to retain Atlantic menhaden as incidental catch. However, the distribution patterns of marine fish are likely to change if sea temperatures continue to warm in Canada (Government of Canada, 2021). If the trend continues, Atlantic menhaden may soon be more common in the Region (Lucca & Warren, 2018), which would likely result in a call from harvesters to create a directed Atlantic menhaden fishery and possibly even for the authorization to catch the species on a bait licence.

A significant issue that harvesters brought up about alternative baits was that their availability is not constant throughout the Maritimes Region. The availability of alternative baits depends on what commercial fisheries are currently operating in the Region and what harvesters are landing as bycatch. Harvesters noted that alternative baits are mainly available when the mobile groundfish fleet, specifically the trawlers, are active. Additionally, the availability of imported baits fluctuates throughout the year, and the product is often tough to get as it is in high demand when shipments arrive.

### *Summary of Alternative Bait Species in the Maritimes Region*

It is important that fishery managers and harvesters alike have a thorough understanding of the viability of alternative bait species in the Maritimes Region. Commercial fishing relies on successful baits to lure prey towards fishing gear. Therefore, a decrease in viable bait species is concerning for maintaining the livelihoods of fish harvesters and coastal communities in the Region. Further research should be conducted surrounding the formal testing of alternative baits. This research should be conducted in partnership with DFO, harvesters and fishing associations to promote relationship building and enable knowledge co-production (Cook et al. 2021). Additionally, further research should be centred on reviewing the adaptation and mitigation measures used by Maine lobster fishers to learn from their approaches so they can be adapted for use in the Region if a similar crisis arises.

### **5.3 Synthetic Baits in the Maritimes Region**

#### *Understanding Synthetic Baits*

Synthetic baits are an attractive option for limiting the amount of forage fish used in the fishing industry and reducing fishing pressure on rebuilding stocks in the Maritimes Region (Dellinger et al., 2016). An Atlantic Canadian example of a synthetic bait producer is Bait Masters Inc., a PEI-based company that has created a synthetic bait which uses 75% less forage fish. The product consists of small amounts of dehydrated forage fish, fish oil and filler product that is held together using an organic coating that gives it the appearance of a sausage (Delphino et al., 2020; Bait Masters Inc., 2022). Synthetic baits, such as this product, can address major ecological risks, such as the unknown impact of reduced forage fish stocks on trophic dynamics, while providing economic and operational benefits to the fishing industry (Dellinger et al., 2016). Synthetic baits are marketed as a cheaper alternative to traditional baits. In addition, the products do not have to be frozen, which provides economic savings to harvesters as they would not need to rent or buy freezer space to store their bait (Delphino, 2020; Dellinger et al., 2016).

#### *Attitudes Towards Synthetic Baits in the Maritimes Region*

While interview results showed harvesters were split on their likeliness to use a synthetic product, most of the harvesters who were interested in trying the bait also noted they had

not previously used a synthetic product. No harvester who had previously tried a synthetic bait conveyed that they would use the product again, highlighting that it is probable that those who listed themselves as “likely” would move to the “unlikely” category once they tried a synthetic product. Harvesters’ perspectives on synthetic baits ranged from it being “total garbage”, with one harvester noting they would be better off fishing with no bait in their traps to one harvester relaying they did catch some lobsters using the product; however, the harvester reported that it was not nearly as effective as their typical bait species. Interestingly, one lobster boat captain described the use of synthetic bait as an insult to their crew. They explained that lobster fishing is physically demanding, and therefore, it would be insulting to fish with a bait that they know is less successful than herring and mackerel. They believe using a synthetic product would result in their crew performing the same amount of physical labour but the entire crew reaping less economic benefits due to decreased catch and crew shares.

Harvesters’ opinions and insight on synthetic bait do not align with recent studies comparing its effectiveness to traditional bait species. A recent PEI study concluded that synthetic and traditional lobster baits performed equally in PEI lobster fisheries (Delphino et al., 2020). Harvesters indicated one of the issues they have with claims such as these is that these tests are often conducted by non-fishers which they believe incorporates biases into the testing methodologies. Harvesters additionally noted that most of the testing on synthetic baits takes place outside of the commercial lobster seasons, which raises concerns about the accuracy of these trials and claims that synthetic bait performs just as well as traditional baits. Similarly to alternative baits, harvesters will only consider using a synthetic product when the expected catch is low in their fishery, or when they have no other options for bait. This raises questions regarding the testing methodologies and if synthetic bait is adequately studied in the fishing industry. Harvesters in this study noted that they would be willing to use synthetic bait if the product is improved upon and is cost-effective. Additional research is required on testing synthetic baits in-season by actual fishers so a greater understanding of their feasibility in the Maritimes Region can be reached.



### *Summary of Synthetic Bait in the Maritimes Region*

Overall, synthetic bait is a very polarizing topic in the fishing industry. However, harvesters do see potential ecological benefits in its increased usage. Most indicated they would use the product in the future if it was approved and could catch fish at similar rates to traditional baits. More research should be conducted on synthetic baits effectiveness in the Region, and trials should be conducted in-season by actual lobster fishers so testing conditions mirror those of a directed commercial fishery. While some noted synthetic bait as a “far-fetched dream,” its use and improvement should be investigated if bait fish stocks continue to decline into the critical zone or rebuilding efforts prove to be unsuccessful.

## **5.4 Stakeholder Engagement in the Bait Fishery**

### *Stakeholder Engagement and Effective Management*

Resource and fisheries management is a dynamic environment where many competing and diverse interests intersect simultaneously. Throughout the interviews, harvesters discussed that they didn't feel that DFO prioritizes discussions about bait and the bait fishery and some discussed that this was their first time discussing the topics with DFO. Engaging with stakeholders is a crucial way of mitigating risk, yielding effective management through more informed decision making and gaining community support for management initiatives (Talley et al., 2016; Caves et al., 2013). Collaborative decision-making enables adaptive management, which is advantageous in reconciling competing societal demands and responding to complex ecosystems such as the marine environment (Caves et al., 2013). In fisheries management, it is widely accepted that consultation and engagement with stakeholders can enable conditions for social learning and knowledge co-production as well as reduce potential conflict between government and industry (Butler et al., 2020; Talley et al., 2016). Effective communication with stakeholders will additionally build trust and significantly affect stakeholders' attitudes and willingness to participate in the management process (Food and Agriculture Organization, 2016; Cook et al., 2021).

### *Bait Fishery Advisory Committee*

A key tool that DFO utilizes to consult with fishers and provide a space for open discussion between the Department and the commercial industry is advisory committee meetings.

However, there is currently no existing advisory committee for the bait fishery. This is a concern due to the diversity in bait licence usage, making it challenging to determine the impacts of potential management amendments on individual harvesters and their fishing operations. The relatively high scientific uncertainty surrounding forage fish stocks in the Region increases the urgency for transparent and open conversations with industry so areas of uncertainty can be highlighted and clearly explained to harvesters. Uncertainty and the associated risk are difficult to communicate to stakeholders. However, it is vital to do so when working with data-poor or model-limited stocks such as herring or mackerel. Increased transparency and open conversations with industry can result in a greater understanding from fishers regarding the challenges at hand and can lead to knowledge co-production and the formulation of new approaches to potentially limit uncertainty (FAO, 2016; Talley et al., 2016). The lack of an advisory committee for the bait fishery is concerning and is a missed opportunity by DFO to allow for industry input on the management of the fishery and as a forum for harvesters to relay concerns to DFO related to bait fish and stock recovery efforts.

## **Chapter Six – Recommendations and Conclusions**

### **6.1 Recommendations**

#### *1. Improve enforcement in the bait fishery*

Illegal fishing is a significant concern in the bait fishery. As previously discussed, the licensing regulations are difficult for C&P officers to enforce and dockside monitoring is generally only required for 10% of all bait fishing trips. While the recent implementation of daily catch limits in the H/M fishery was a crucial amendment to disincentive illegal fishing, the change itself is ineffective unless it can be properly enforced. It is recommended that this research be used to improve enforcement efforts by providing support to C&P officers regarding the nature of bait fishing in the Region. For example, this research should be used to inform C&P how harvesters use their bait licences, including where and when fishing takes place and what areas have the most active or renewed licence holders. The research should also be used to consolidate enforcement efforts in areas with the highest annual value, or weight landed on bait licences.

Additionally, you could look for areas with an increased number of renewed licences but a surprisingly small amount of active fishing activity as places where there is potentially misreported or illegal fishing that could benefit from an increased C&P presence.

### *2. Promote avenues of funding for alternative bait research*

As forage fish stocks in the Region remain in the critical zone, commercial harvesters must have access to alternative baits to support their fishing operations. To provide DFO and industry with a greater understanding of the effectiveness and viability of baits outside of herring, mackerel or gaspereau, it is recommended that DFO promote industry-led research on alternative baits. While testing alternative baits is not a novel idea, interviewees were concerned that actual fishers did not conduct past research on alternative baits. Additionally, some harvesters indicated they routinely experiment with alternative baits, but only when the expected catch is low in their fishery out of concerns of economic losses if the bait is unsuccessful. Therefore, it is recommended that DFO promote and support harvesters to apply for Section 52 licences or to the Atlantic Fisheries Fund (AFF) for support to test alternative baits. Section 52, or ‘scientific’ licences, could provide harvesters with a few extra traps to test alternative baits throughout the entire fishing season to reduce biases of non-fishers conducting the research and experimenting only taking place when the expected catch is low. Additionally, the AFF could provide grants to create a formal study or to compensate fishers for their participation. DFO could promote these avenues at advisory committee meetings and offer support to individuals or groups who have questions about the application process. A specific type of research that could be investigated is the combination of a lobster caller paired with synthetic bait. This combination could overcome issues with synthetic products, such as the lack of a “fishy” scent, while utilizing a bait that uses a decreased amount of natural-origin fish.

### *3. Create a bait fishery-specific advisory committee*

Stakeholder engagement and communication efforts in the bait fishery should be improved by creating a bait-specific advisory committee to provide licence holders in the Maritimes Region with a platform to share their insights and participate in bait fishery management. Throughout the interviews, harvesters relayed they had current and future concerns related

to bait and the bait fishery. Interviewees indicated they felt left out of past conversations relating to the fishery and multiple individuals noted this was their first conversation with DFO about bait. The creation of an bait-specific advisory committee would be beneficial over using the existing herring or mackerel committee meetings because only some of the people who attend these meetings are a stakeholder in the bait fishery, and their presence may complicate discussions. At a minimum, it is recommended that Senior DFO Fishery Advisors who manage fisheries that require bait ensure the topic of bait is discussed at advisory committees for fisheries that use bait to ensure harvesters are given an avenue to discuss their bait needs or concerns with the Department.

*4. Amend the fishery to open on May 1<sup>st</sup> and close on November 30<sup>th</sup>*

It is recommended that the bait fishing season in the Maritimes Region is amended to begin on June 1<sup>st</sup> and extend until November 30<sup>th</sup> each year. Harvesters were in almost total support of this amendment, with 14 out of 15 interviewees stating they would support a delayed opening in the bait fishery. This amendment would provide two primary benefits to the bait fish stocks in the Region. One, it would protect a greater proportion of spring spawners by delaying the onset of fishing by extra weeks to ensure bait fish can reproduce before being captured. Harvesters noted that mackerel caught early in the year are often full of spawn and that fish with roe is a less successful lobster bait. Secondly, a fishing season would aid in C&P enforcement efforts as they would make bait fishing more predictable to allow fishery officers to specifically target enforcement efforts. While a later opening date may protect a greater proportion of forage fish, it would also greatly impact harvesters ability to catch bait prior to the opening of some commercial seasons. A May 1<sup>st</sup> opening would be a fair compromise as it would allow for at least 15 days of bait fishing before the first opening of the first LFA in the Region.

*5. Implement a minimum mesh size of 62mm and gillnet height of 150 meshes*

Finally, it is recommended for DFO to implement a minimum mesh size of 62 mm and a maximum gillnet height of 150 mesh for the H/M bait fishery in the Maritimes Region. These changes would better align bait fishery management in the Maritimes Region with the approaches used in other Atlantic Regions while supporting forage fish rebuilding

efforts. A minimum mesh size and a maximum gillnet height would allow a greater proportion of small or younger fish to survive and reach sexual maturity to allow them to spawn, thus increasing the overall reproductive potential of the bait stocks. When industry was asked if they would support this amendment, 14 out of 16 interviews supported the change. The proposed minimum mesh size of 62mm follows the authorizations given to harvesters who fish in the Little Hope box. When harvesters were asked what size they felt was appropriate, most of those in favour indicated following the limits used in the commercial fishery would be a fair compromise with industry. Also, to ensure harvesters are removing fish fairly and equitably, a maximum gillnet height of 150 meshes should be implemented, which matches the approaches used in the Gulf and Quebec Region.

## **6.2 Conclusion**

The bait fishery is often overlooked and is critically understudied, yet it remains of great importance to harvesters and is crucial to many fishing operations in the Maritimes Region. Although, research showed that not all eligible harvesters in the Maritimes Region choose to apply for and fish their licence, those who do tend to greatly value their licence. Active bait fishers cite fishing their licence can result in economic savings in some cases, reducing financial strains on their fishing operation. The licences are particularly beneficial in allowing harvesters to obtain access to high-quality, fresh bait for use at the onset of their commercial fisheries when competition is high. Harvesters had concerns about the supply and availability of bait for the current fishing season (2022), but their concerns were heightened when asked about future fishing seasons. As forage fish stocks remain in the critical zone and bait licence usage appears to be on the rise in the Maritimes Region, DFO must find a balance between rebuilding efforts and supplying harvesters with some level of intermediate access to bait species like herring and mackerel. If a level of intermediate access is not feasible, DFO must ensure harvesters have access to some form of viable alternative bait for use in their commercial fishing operations. Additional steps should be taken to improve management and stakeholder engagement in the Maritimes Region's bait fishery to enhance rebuilding efforts and ensure the long-term survival of forage fish in the Region.

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## **Appendices**

### **Appendix 1**

#### **What are industry's views on bait licences and alternative sources of bait?**

- What species do you target under your bait licence?
- Is there a preference between herring/mackerel/gaspereau for bait?
- What commercial licences do you fish your bait licence for?
- What do you do with bait once you catch it? Do you freeze it? Use it as fresh bait?
- Are you concerned with the supply or availability of bait for your current fishing season (2022)?
- Are you concerned with the supply or availability of bait for the fishing season next year (2023)?
- Has the mackerel closure had an impact on your fishing operations or supply of bait for the current fishing season?
- Do you have any ideas for alternative species of bait besides herring, mackerel or gaspereau?
- Are you likely to try alternative species of bait outside of the species that you typically fish with?
- Would you or have you tried any synthetic baits products? By this I mean products such as the bait pucks or bait sausages that use filler product to reduce the amount of natural origin fish used in the bait.
- Do you think there is a place for synthetic bait in the fishing industry? Would it work? Why or why not?

#### **What are industry's perspectives on management plans and stakeholder engagement?**

- How do you personally feel about the current state of the herring and mackerel bait fisheries and the related management approaches?
- Do you feel you have a way to make your opinions known to DFO about how the bait fisheries is being managed? If so ... What are these ways?

- Do you think the existing commercial herring and mackerel advisory committees would be good places for DFO to consult with industry on the management of the bait fishery? (e.g., are herring and mackerel AC's the appropriate forum?) Why or why not?
- Do you think your fishing association would be a good group for DFO to contact if we wanted feedback on the management of the herring and mackerel bait fishery?
- Are you happy with your current level of involvement in bait fisheries management and the rebuilding of the herring/mackerel stock?
- With mackerel and the SWNS/BoF herring stocks in the critical zone, DFO is introducing new conservation measures in both the commercial and the bait fisheries. This year, for example, the commercial and bait fisheries for mackerel are both closed, and the bait licences only allow fishing for herring. Did this have any effect on your interest in getting a bait licence?
- Another change this year is that bait fishers are only allowed to keep about 3000 lbs of herring per trip (1,360 kg). Do you think that's a reasonable limit? What impact would it have on you if it were lower in the future?
- DFO is hoping that closing the mackerel fisheries will help the mackerel stock to rebuild. When it's ok for the fisheries to reopen again, there may be a need for tighter restrictions for a little while than what you had before. One of the restrictions being considered is reducing the length of the gillnets in the bait fishery. Last year, bait fishers were allowed to use up to 90 fathoms of gillnet. In the future, do you think reducing the length to something like 50 fathoms would be a reasonable way to manage removals in the bait fishery? What effect do you think this would have on discarding?
- In recent years, other DFO regions have implemented minimum mesh sizes for gillnets to allow a greater proportion of smaller fish to grow larger and spawn and increase the overall reproductive potential of the stocks. Do you think that implementing a minimum mesh size for gillnets in the bait should be considered for our region now too? If a minimum mesh size were implemented in our region, it may increase the size of fish caught. Do you currently choose a gillnet mesh size according to the expected size of the herring or mackerel you are targeting?
- Another option being considered to help protect mackerel and herring in the future is closing the bait fishery a couple of days a week, likely on the weekends. How well do you think this would work?
- If you had to pick between gillnet modifications and daily closures, which would you pick, and why? Do you have any other suggestions for helping to protect mackerel and herring in the bait fishery?
- In the past, bait licences and licence conditions have been available early to mid-winter. This time frame isn't realistic anymore. The science updates for both herring and

mackerel aren't ready until late winter or early spring, and after that there need to be advisory committee meetings to talk about the upcoming season with stakeholders. If the bait fishery didn't open until late spring each year, would you have any concern about this? Do you have any suggestions for a potential opening date?

- Mackerel, as well as some of the herring management areas, have a total allowable catch (TAC). This year, once the total allowable catch for a herring management area has been reached, that area is going to be closed to bait fishers. What impact do you think this will have on bait fishers?
- Do you think there's a better approach DFO should take for keeping removals, including removals from the bait fishery, within total allowable catches for herring and mackerel?

## Appendix 2

### CONSENT FORM

Project Title: Forage Fish in Decline: Understanding the Usage and Management of Bait Fisheries in the Maritimes Region

Lead Researcher: Ian McLean, Master of Marine Management Candidate, Dalhousie University, Ian.McLean@Dal.ca

DFO Contact: Jeffrey Reader, Senior Advisor for Small Pelagic Fisheries, Maritimes Region, Jeffrey.Reader@dfp-mpo.gc.ca

[Versioning: After receiving ethics approval, add the date of approval and the consent form version number. The first approved version is v1.0. If subsequent amendments to the consent form are requested and approved, the date of approval and version number (e.g. v2.0) must be updated.]

#### Introduction to the Project

You are invited to take part in a research study being conducted by Ian McLean, a graduate student in the Master of Marine Management program at Dalhousie University, as part of an internship with Fisheries and Oceans Canada. The purpose of this research is to further the knowledge related to how bait fisheries operate and how bait licences are used in the Maritime Region. This study is limited to bait licence holders and directors of fishing organizations in the Maritime Region who are at least 18 years old and consent to participate in the study.

If you choose to participate in this research you will be asked to answer two main questions and a series of sub questions in an telephone or Microsoft Teams interview concerning bait usage, views on alternative sources of bait and future potential management amendments. The two main research questions are “what are industry’s views on bait licences and alternative sources of bait and “what are industry’s perspectives on management plans and stakeholder engagement?” The interview should take approximately 30-45 minutes.

Your participation in this research is entirely your choice. You are not required to participate in the study, your participation is voluntary. You do not have to answer questions that you do not want to answer by simply letting me know that you wish to skip the question, and you are welcome to stop the interview at any time if you no longer wish to participate. All you need to do to end the survey is tell me that you no longer wish to participate. I will not include any incomplete surveys in my analyses. If you do complete your survey and you change your mind later and wish to not participate, your information will be removed and destroyed. It is important to note that I will only be able to remove your interview data up to the analysis stage in my research because at this stage your name will not be associated with a set of answers so I will not know which responses are yours.

#### How Your Information Will Be Protected

Your responses to the survey will be anonymous. **Anonymity** is the inability to identify any one individual as having participated in a certain research study. **Anonymized information** “is irrevocably stripped of direct identifiers, a code is not kept to allow future re-linkage, and risk of



re-identification of individuals from remaining indirect identifiers is low or very low. There will be no questions in the survey that ask for identifying details such as your name or email address. Once the interviews have been transcribed, any identifying aspects or transitional conversations will be removed. All anonymous, transcribed responses will be saved on a secure Dalhousie server, DFO server or an encrypted USB drive. Only the project supervisors, Jeff Reader and myself will have access to the survey results.

You have the right to the correction of, access to, and protection of, your personal information under the *Privacy Act* and to file a complaint with the Privacy Commissioner of Canada over DFO's handling of your information. Personal information collected is described in the Commercial Fishing Registration Cards, Certificates, Permits and Licence Information Personal Information Bank. The Privacy Commissioner of Canada can be reached at 1-800-282-1376 (Toll-free) or (819) 994-5444.

### **How the Results Will Be Shared**

I will describe and share general findings of this research with staff at DFO for their use in managing the bait fishery. I will also be presenting the findings at the 2022 Sustainable Ocean Conference, the 2022 Making Waves Conference, and in my final graduate report. I will destroy all information within 12 months of completing/reporting the results. After the completion of the interview, participants will be asked if they would like a copy of the results. If they express interest, their name will be noted and they will receive a copy of the results via email once the research has been completed.

### **Possible Benefits, Risks and Discomforts**

The risks associated with this study are no greater than those you encounter in your everyday life. However, you may experience psychological/emotional (e.g., feeling embarrassed, anxious, upset) risks when answering questions regarding fishing practices and attitudes towards potential management measures. All survey questions are optional, so please do not feel like you have to answer these questions if they make you feel uncomfortable in any way.

There will be no direct benefit to you in participating in this research. The research, however, might contribute to new knowledge on how harvesters use their bait licences and their perceptions of alternative sources of bait.

You should discuss any questions you have about this study with me or Senior Advisor for Small Pelagic Fisheries, Jeff Reader. Please ask as many questions as you like before or after participating. My contact information is [Ian.McLean@dfo-mpo.gc.ca](mailto:Ian.McLean@dfo-mpo.gc.ca) and Jeff Reader can be reached at [Jeffrey.Reader@dfo-mpo.gc.ca](mailto:Jeffrey.Reader@dfo-mpo.gc.ca)

If you have any ethical concerns about your participation in this research, you may contact Research Ethics, Dalhousie University at (902) 494-3423, or email [ethics@dal.ca](mailto:ethics@dal.ca) (and reference REB file # 2021-2022)."

If you agree to complete the survey, I will ask for verbal consent prior to starting the interview.

Appendix 3

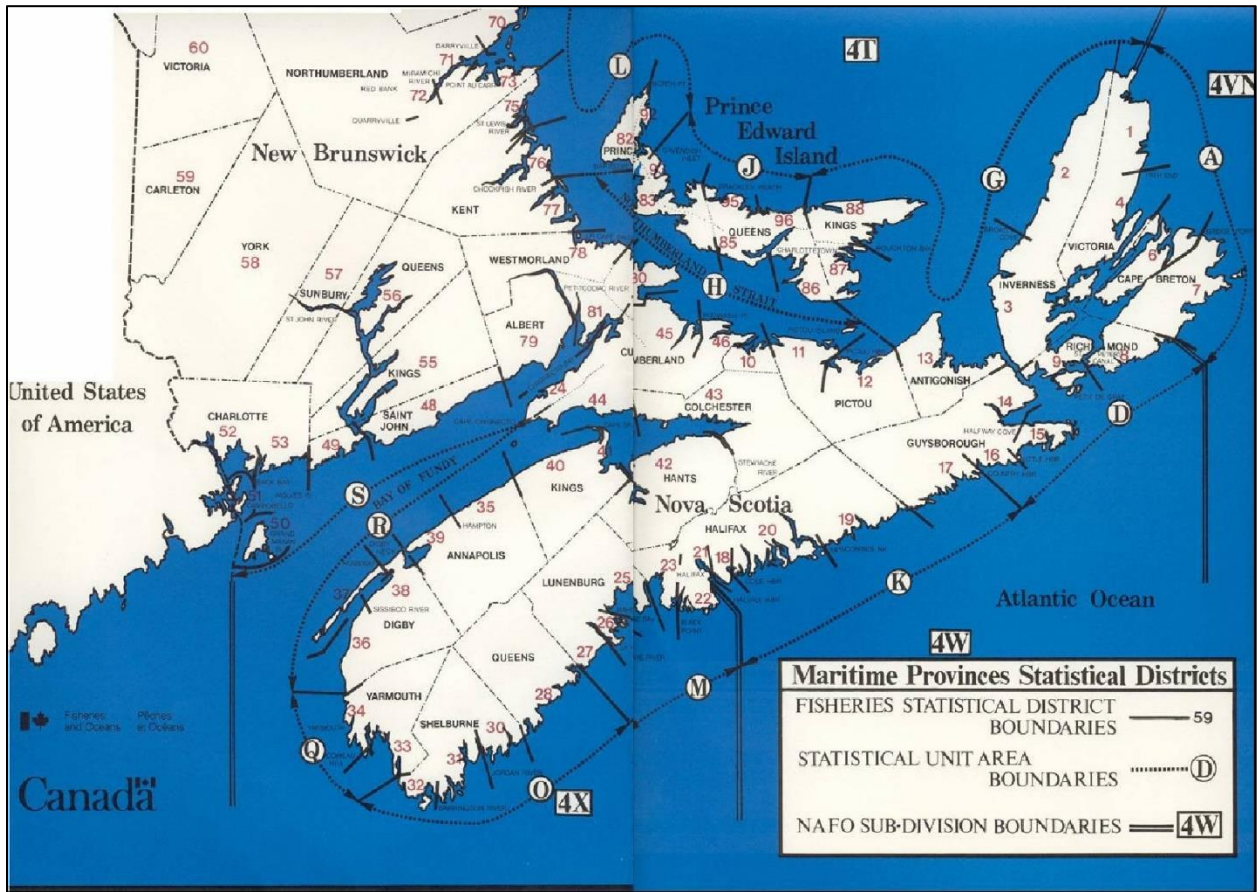


Figure 18. Map of the NAFO Sub-areas located in DFO's Maritimes Region (DFO, 2021h).

Table 12. Interviewees' responses when asked which species they recently started using due to the mackerel closure and herring quota cuts.

Common Name	Species	Count	Comments
Redfish	<i>Sebastes Marinus</i>	6	All harvesters either felt it was a good or very successful bait.
Gator Bait	N/A	5	Pig or cowhide soaked in fish oil. All harvesters indicated it was a poor bait.
Groundfish Clippings/Racks	Various	3	Two harvesters indicated this was a good bait and one that it was a poor bait
Sculpin	Family Cottidae	3	Harvesters indicated it was a good bait.
Greeb Crab	<i>Carcinus maenas</i>	3	All three harvesters indicated it was a very successful bait.
Jonah crab	<i>Cancer borealis</i>	2	Both harvesters indicated it was a very successful bait
Tuna Heads	Various	2	Both harvesters indicated they were poor bait.
Northern Propeller Clams	<i>Cyrtodaria siliqua</i>	2	One harvester felt it was a good bait while the other felt it was a poor bait.
Rockfish	Genus <i>Sebastes</i>	2	Shipped in from British Columbia. Both indicated it was a good bait.
Glow Sticks/Flashing Lights	N/A	2	Both harvesters indicated they were poor baits. One noted all the lights broke overtime and the other called them a 'waste of money and time'.
Synthetic	N/A	2	Both harvesters indicated they were poor bait.
Atlantic Cod	<i>Gadus morhua</i>	1	The harvester indicated it was a good bait.
Black Cod	<i>Anoplopoma fimbria</i>	1	Imported from Alaska. The harvester indicated it was a poor bait.
Gizzard Shad	<i>Dorosoma cepedianum</i>	1	Freshwater fish from Ontario, harvester caught it themselves and shipped it to Nova Scotia. The harvester indicated it was a very poor bait.
Catfish Heads	Various	1	Imported from the US. The harvester indicated it was a poor bait.
Atlantic Surf Clam	<i>Spisula solidissima</i>	1	The harvester indicated it was a good bait.
Deer	<i>Odocoileus virginianus</i>	1	The harvester indicated it was a poor bait.

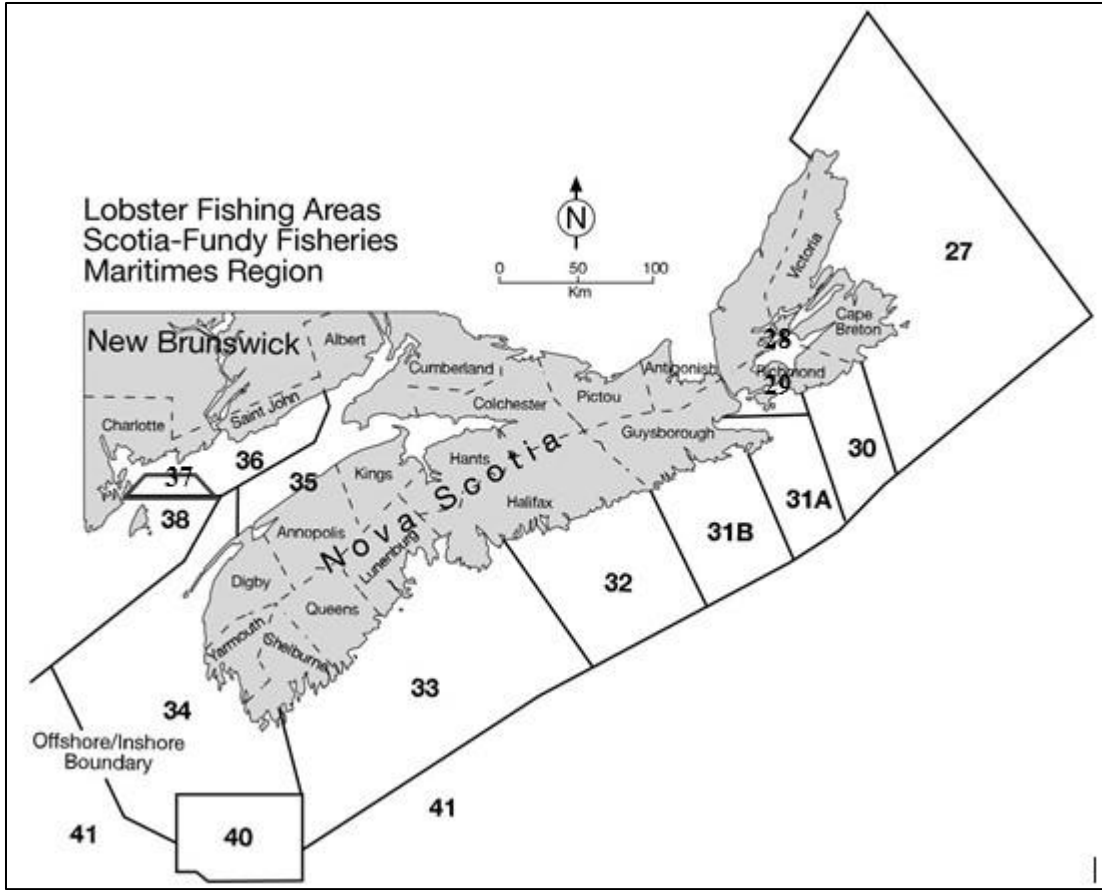


Figure 19. Map of the LFAs in the Maritimes Region (DFO, 2020c).