Making Prevention a Priority:
Towards the Development of a Safety Culture in the Commercial Fishing Industry

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Research Report

This report was jointly prepared by the Comité permanent sur la sécurité des bateaux de pêche du Québec and Transport Canada, with the financial support of the Réseau Québec Maritime.

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Executive Summary

The research project Making Prevention a Priority, whose report was published in August 2020, is an initiative of the Comité permanent sur la sécurité des bateaux de pêche du Québec (CPSBPQ). The study follows up on the findings of the systemic review conducted by the Transportation Safety Board of Canada (TSB) in 2012, and the Globe and Mail 2017 investigation revealing that the fishing sector is the deadliest in Canada.

Due to the complexity of the commercial fishing industry, it is acknowledged that no group or government alone can solve the numerous intertwined safety issues endangering professional fishermen. All players involved in the fishing management and safety must work together with stakeholders to take targeted and concerted actions to solve these issues and, most of all, to foster the development of a healthy safety culture in this industry. This report therefore aims, by a risk analysis based on intelligent data and an assessment of the maturity level of the safety culture in this industry, to lay the foundation of an integrated and concerted approach to reduce the loss of life, material and financial losses and occupational injuries in this industry.

The study was divided in three sections. First, an empirical analysis was carried out of the accidental events (accidents and incidents) involving fishing vessels in Quebec between 2005 and 2015. Secondly, a cost analysis of the occupational injuries and the most common types of injuries for the Quebec fishing industry was done. Lastly, the safety culture has been measured and analyzed for each of the Quebec fishing fleets.

As a result of the research project, eleven recommendations were formulated. These are key elements for decision makers to direct their monitoring and control approaches regarding fishing vessels. The analysis of these data revealed that the crew of fishing vessels of a gross tonnage of 15 and less have the weakest safety culture. These vessels, which are not inspected, are more likely to sustain damage while at sea and are involved in more accidental events than any other classes of vessels. It was also shown that occupational injuries in the harvesting sector are more serious than in other industries, driving an average cost per injury three times higher in other occupations. The costs associated with accidental events involving fishing vessels, which represent human and wage costs as well as the loss of productivity, result in major financial losses for these businesses and have a significant influence on the economic well-being of many coastal communities depending on this industry.

Table of Contents

List of Appendices

List of Charts

List of Graphics

List of Figures

List of Figures

List of Tables

List of Tables

List of Tables

Chapter 1
Introduction

This research project is an initiative of the Comité permanent sur la sécurité des bateaux de pêche du Québec (CPSBPQ), a non-profit organization committed to the promotion and development of a strong health and safety culture in the commercial fishing industry. This research was made possible through the valuable collaboration and support of Transport Canada Marine Safety and Security, Québec Region, a key partner in the project.

The Réseau Québec Maritime (RQM), deeply interested in the innovative and intersectoral approach of the CPSBPQ to the development of a safety culture in fisheries, has approved this research as a lever project for its "Maritime surveillance, safety and security" thematic.

The various provincial and federal government partners active within the CPSBPQ, also hoping to see an improvement in fisheries safety, welcomed the initiative. The Canadian Coast Guard (CCG), Fisheries and Oceans Canada (DFO) and the Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST) participated in this major research project.

The CPSBPQ, assisted by the staff of the Office of Primary Interest—Fisheries, Transport Canada Marine Safety and Security in Rimouski, also partnered with two researchers from the Université de Sherbrooke as well as a researcher from the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST), to bring this project to fruition.[1]

1.1 Structure of the Document

This report consists of seven chapters. Chapter 1 introduces the subject of health and safety in the commercial fishing industry in Québec. The objectives of this study as well as the research question are also outlined in this chapter.

Chapter 2 describes the general framework of the study, i.e., the commercial fishing industry of maritime Québec and the fleets it comprises.

Since this study is made up of three research components, the theoretical framework, the methodology and the results specific to each of these components are presented in the three following chapters.

Chapter 3, under the guidance of Dr. Jean Cadieux, Ph. D. Mathematics and Statistics, researcher, and tenured professor in the Faculty of Administration of the Université de Sherbrooke, provides a statistical analysis of accidental events involving a fishing vessel (incidents and accidents) that occurred in Québec between 2005 and 2015.

Chapter 4, under the guidance of Mr. Martin Lebeau, M.Sc. Finance, scientific professional at the IRSST, analyzes the costs and characteristics of occupational injuries sustained by Québec fishermen between 2005 and 2015.

Chapter 5, under the guidance of Dr. Michel Pérusse, Ph. D. Occupational Health and Safety, researcher, and professor at the Faculty of Administration of the Université de Sherbrooke, portrays the safety culture in the commercial fishing industry in Québec and analyzes the maturity level of this safety culture for the various fleets in Québec.

[1] For more information on the intersectoral partnership, see Appendix A.

Chapter 6 presents the recommendations and identifies some possible solutions based on the interpretations of the results of this research.

Chapter 7 presents the conclusion of the study.

1.2 Research Questions

1.2.1 The Fishing Vessel: A Complex Socio-Technical and Economic System

A fishing vessel must be viewed as a complex socio-technical system. It is a construction, i.e., a combination of mechanical components and technological equipment, stemming from human knowledge and techniques. For this system to operate and perform the task for which it was designed, it must be manned and operated by a group of individuals. This group is known as the crew and generally consists of two to five people on Québec fishing vessels. Since the two components are mutually essential, their combination enables the navigation, fishing, and daily life activities of this group of individuals. Therefore, we refer to the fishing vessel as a sociotechnical system.

The vessel is thus a living environment, a means of transport as well as a work tool. The fishing vessel also serves as both the tool and the place of work. A workplace that moves and evolves in a changing and shifting environment that can sometimes be very challenging. Weather and sea conditions make the work environment unstable. This creates difficult conditions for workers who, while performing their tasks, must sometimes struggle to keep their balance.

Since it is primarily a means of transportation, the fishing vessel is also a piloted system, which adds to its complexity and, therefore, increases the knowledge requirements for its operation. As with any piloted system, there are numerous rules and standards to be observed to ensure the safety of the people on board and the protection of the environment, which make the navigation of the piloted object rather difficult; this is why piloted systems are much more prone to accidents caused by human error.

The economic aspect must also be included in this socio-technical reality. Since the purpose of the fishing vessel is naturally to capture the living resources of the sea and to trade in them, each fishing vessel must therefore also be considered as a micro-business. Fishing boat owners and licence holders in Québec are mostly the masters of their own vessels. Therefore, they operate the vessel and manage the crew on board. They handle both navigation and fishing operations. They also bear the huge responsibility for the administrative management of their business. The fishing industry is highly controlled and monitored to ensure the protection of resources. The bureaucratic and administrative obligations related to the management of a fishing enterprise are therefore numerous and complex, putting further strain on the masters.

1.2.2 Fisherman: A High Risk Occupation

Considering the complexity of the socio-technical and economic system that is a fishing vessel, one can easily understand that this system can be subject to failures: failure of a mechanical-technical component, failure caused by human action or inaction, failure caused by external factors, such as natural elements. The fact that fishing vessels are subject to accidents is therefore not surprising. However, when one learns that a fisherman is fourteen times more likely to die on the job than a police officer (Grant, 2017), this raises questions.

"Despite safety gains in many other industries, fishing continues to have the highest fatality rate of any employment sector in Canada." (Grant, 2017.) Why does the situation in commercial fisheries not appear to be changing? This stagnation is so worrisome that in 2009, the Transportation Safety Board of Canada (TSB), the agency whose mandate is to advance transportation safety through investigations, undertook for the first time in its history a systemic investigation into safety issues involving commercial fishing vessels. After releasing more than 370 investigation reports on fishing vessels and making 42 recommendations since 1992, the TSB decided to conduct a wide-ranging investigation in order to identify all of the deficiencies in the industry and to set some safety goals. The report of this investigation was published in 2012.

In 2018, one year after the publication of a powerful article in the *Globe and Mail* newspaper revealing the extent of the problem of fishing accidents, Canada experienced its deadliest year in 15 years in the commercial fishing industry, with 17 deceased fishermen (TSB, 2018). Clearly, despite some efforts by the authorities and the industry, things are not changing in Canada. But what about the situation in Québec? Is it similar to that of the other coastal provinces?

1.2.3 Statistics: A Major Safety Issue

Attempting to answer this question leads fairly quickly to a major problem: data. Where are they? How can they be accessed? Are they reliable? At the outset of this research, it soon became apparent that all authorities and organizations related to commercial marine fishing are collecting and compiling data on the activity itself and on incidents and accidents occurring in the practice of the activity. However, each of the interested entities collects this data for its own purposes within its mandate and uses its own criteria to record it.

As a result, none of the databases on accidental events involving fishing vessels is complete. Besides, cross-referencing between the different databases is, ultimately, impossible due to a lack of harmonization in the choice of vessel identification variables and in the collection methods. Data from each of the regulatory authorities can, therefore, only be pooled manually. This issue is a long-standing one, as all research on fishing accidents has always encountered this difficulty related to the non-compatibility of data from various sources (Binkley *et al*., 2008).

Since it is essential for organizations to fully understand and assess the risks to the industry that are likely to develop into an adverse event leading to an accident, they must be able to rely on trustworthy and intelligent statistical data. This data is also vital to measure the industry's health and safety performance and to assess the performance of initiatives put in place by certain organizations to improve the safety of fishing vessels and their crews. In its 2012 report, the TSB identifies the issue of fishing industry statistics as one of the top ten safety issues related to fishing accidents: "The lack of quality, coordinated data on fishing vessel accidents makes it difficult for organizations to identify and communicate safety risks and trends." (TSB, 2012: 3)

Our **first research question** is therefore the following: **can we, using existing data from the various provincial and federal authorities and organizations, paint a picture of accidental events in the commercial fishing industry in Québec, with the aim of understanding the trends and identifying the main health and safety issues on which we must act in a coordinated manner to reduce the loss of life, material and financial losses, and occupational injuries?**

1.2.4 Safety Culture: A Solution for Improving Safety

In 2018, after a rather dismal year in the world of fisheries safety, the TSB has reiterated the key recommendation of its 2012 systemic investigation report by publishing in its Watchlist that coordinated and effective approaches among all stakeholders are required to promote and support the development of a strong safety culture in the commercial fishing industry (TSB, 2018). In this document, the TSB states that the issue of safety in the commercial fishing industry "will remain on the Watchlist until there is sufficient evidence that a healthy safety culture has been established throughout the industry and in fishing communities across the country" (TSB, 2018: 5).

The TSB has made several recommendations over the years aimed at developing a safety culture in the industry. In fact, it was during the investigation conducted following a major water ingress aboard the scalloper "Alex B.1" off Havre-Saint-Pierre in September 2001 that the TSB first introduced this concept to the fishing community. In fact, it is on this recommendation that the TSB (2003: 25) concludes this investigation report: "That Transport Canada, in coordination with Fisheries and Oceans Canada, fishermen associations and training institutions, develop a national strategy for establishing, maintaining and promoting a safety culture within the fishing industry."

Yet, what exactly is this safety culture? How can it be fostered and developed if we ignore its nature and mechanisms? Little has been said by the TSB and authorities about this concept, which appears to be the basis of the solution to advancing health and safety in commercial fisheries. Still, it is surprising that something is being recommended without really being able to explain it or to agree with something without really understanding it. Another problem with this concept: how to determine if a healthy safety culture has been established if there is no scale?

Although there is a great deal of literature on the concept of safety culture, it is clear that the theories outlined in this literature are primarily applicable to organizations with complex and often hierarchical functional and organizational structures. In short, the literature review conducted did not identify any definition adapted to the very singular reality of commercial fishing.

This brings us to our **second research question: can we define the concept of safety culture in the commercial fishing industry and can we measure it in order to identify its shortcomings and determine the best ways to act on this culture to help it evolve and thus advance health and safety in this industry?**

We are convinced that by answering these two questions, we will be better equipped to engage in a profound reflection in order to foster our understanding of this immunity to change that seems to prevail among professional fishermen. It is important that we deepen our knowledge of the fishing communities and the contextual reality of their profession to be able to accompany and help them progress down the safety culture continuum. This research project will be very useful to the authorities in guiding changes in their approaches to monitoring and control of fishing vessels.

We also hope that our analysis of safety culture will help them to better choose their educational and awareness-raising interventions. Finally, we strongly hope that the same type of study will be carried out in the different coastal provinces of Canada, which would make it possible to draw up a report for the entire country and to compare health and safety performance among professional fishermen across Canada.

We strongly believe that it is through research and knowledge building that we will be able to identify and undertake the actions that will have the greatest impact in advancing health and safety in this profession. To date, this research project has generated a great deal of interest from a number of researchers, particularly those in the health field. There is no doubt that many of them will undertake research on the issues raised in this study over the next few years.

Québec Fleet

- Increase in incidents
- Decrease in serious and minor accidents
- Stable disaster recurrence

Crabbers

- Low rate of accidental events for this fleet, except for crabbers in Area 16 (North Shore), which ranks third in terms of the accident/fleet ratio

Shrimpers

- Highest accidental event rate in the entire Québec fleet

Lobster Boats

- Abnormally high rate of incidents caused by breakdowns and mechanical failures for the Magdalen Islands fleet

Multifisheries

- Rate of accidental events proportional to the relative weight of this fleet

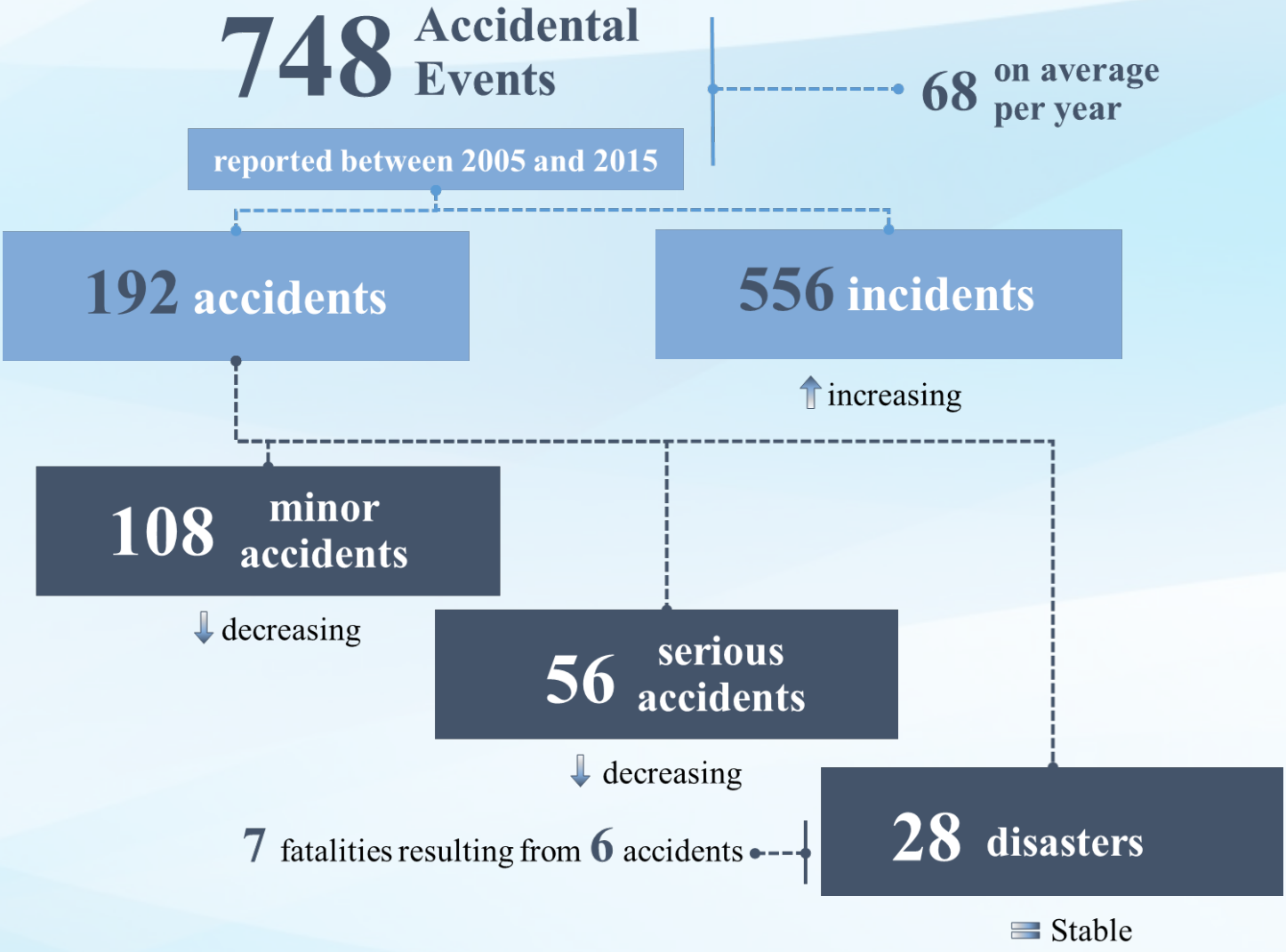
Scallops and Other Molluscs

- Very high accidental event rate for this fleet, ranking second in terms of the accident/fleet ratio

Groundfish

- Rate of accidental events proportional to the relative weight of this fleet

OVERVIEW OF ACCIDENTAL EVENTS, 2005 TO 2015



Accidental Events: Highlights

60%

occur when winds are **under 10 knots** or when **the sea is calm**

55 %

occur on vessels **21 years old and older**

58%

occur on **uninspected vessels** (gross tonnage of 15 and under)

Québec Fleet

- 335 occupational injuries (around 30 per year)
- Total costs estimated at $63.5M

Crabbers

- Among all crabbers, those in Area 12 have the most occupational injuries and are in 4th place in terms of total costs

Shrimpers

- 1st in costs and number: although shrimpers represent only 4% of the total fleet, they are associated with 20% of occupational injuries and 26% of total accident costs

Lobster Boats

- Although the number of occupational injuries and associated costs are proportional to the relative weight of this fleet, the high number of occupational injuries (69) is a concern

Multifisheries

- Ranked 2nd in terms of the total costs of occupational injuries in this fleet

Scallops and Other Molluscs

- Only 7 occupational injuries reported during the study period

Groundfish

- Only 9 occupational injuries reported during the study period

OVERVIEW OF OCCUPATIONAL INJURIES, 2005 TO 2015

Total average costs

per year
=
$5.8M

1 death costs

on average
$3.2M
to Québec society

Average cost of an injury

$189,400
for fisheries

$52,000
all industries combined

44% of occupational injuries affect the **25 to 44 age group**

Most costly accidents
1st: Stuck or crushed
2nd: Transportation occurrence
3rd: Excessive effort when lifting

67% of **all accident costs** are **human costs**

Most expensive parts
1st: Hand
2nd: Body system
(e.g., drowning, nervous shock)
3rd: Shoulder
(repetitive movements)

Québec Fleet

- The safety culture of the Québec fleet as a whole is average
- The majority have not reached the proactive stage of maturity

Crabbers

- Area 17 and Area 12 crabbers are among the fleets that show a strong safety culture
- Unlike their counterparts on the South Shore, crabbers on the North Shore have a rather average safety culture

Shrimpers

- Are the best in safety culture

Lobster Boats

- Demonstrate numerous safety culture weaknesses, especially inadequate compliance

Multifisheries

- Display an average safety culture, but there is an improving trend

Scallops and Other Molluscs

- Only fleet that demonstrates a weak, even pathological safety culture

Groundfish

- Display an average safety culture

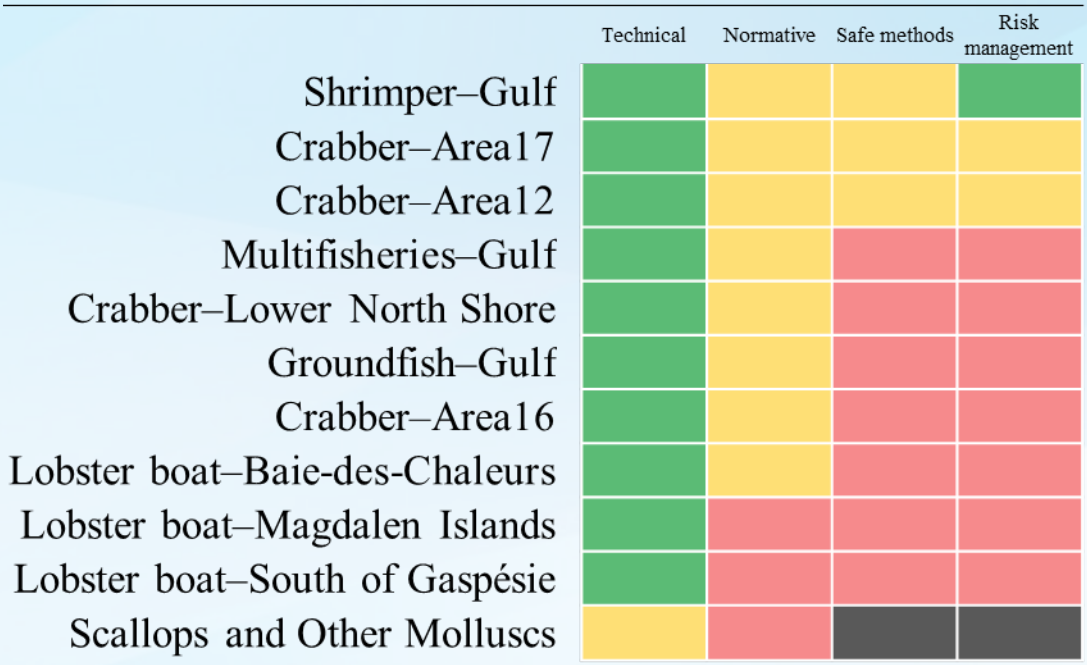
Overview of the Safety Culture, 2019

4 Stages of Safety Culture Maturity

Pathological → Reactive → Buyer → Proactive

weakest — strongest

Maturity Level by Fleet



70% of the Québec fleet is at the **Reactive** stage

Survey Sample

101 masters

52 crew members

72 vessel observations

Culture Assessment

Artefact Triangulation

Calculation Method

the more the vessel dimensions are important ↓ stronger is the culture

the culture for uninspected vessels is weaker than the culture for inspected vessels

the larger the workforce ↓ stronger is the culture

SUMMARY OF RECOMMENDATIONS

Recommendations	Objectives
1 Surveillance and Inspection	
Transport Canada shall review its current approach to surveillance and inspection based on the gross tonnage of the vessel.	Tailor approaches to the specific realities of fleets. For fleets with weak culture, supervision should be reinforced, and more inspections should be carried out on vessels with a gross tonnage of 15 and less. For vessels over 15 gross tonnage that have a strong safety culture, a self-regulatory approach can be adopted.
2 North Shore and Lower North Shore	
Increase on-site activities on the North Shore region and mainly on the Lower North Shore.	Increase the number and/or frequency of visits made by officials to all vessels on the Lower North Shore and supervise professional fishermen in their efforts to upgrade their compliance.
3 Scallops and Other Molluscs Vessels	
For scallops and other molluscs vessels, repeat the analysis with a sample of at least ten triads[2].	Check whether, in terms of safety culture, the scallops and other molluscs vessels are really at the pathological level and, if so, identify the causes for this low level of maturity.
4 Training	
Develop OHS leadership training for masters.	Provide the tools necessary for masters to develop their leadership skills, improve their knowledge of health and safety management and enable them to positively influence their crew members.
5 Magdalen Islands Lobster Boats	
Establish a preventive maintenance program in collaboration with CCG.	Reduce the rate of incidents caused by mechanical failures for lobster boats in the Magdalen Islands by providing them with marine engineering mechanics supervised by officials.
6 Shrimpers	
Further the analysis of the causes of occupational injuries.	Further research related to the priority targets, i.e., analysis of workstation ergonomics, study of the relationship between the health status of fishermen and their propensity to suffer injuries and the impact of fatigue.

[2] The triad consists of an interview with the master, an interview with at least one crew member and observation of the vessel and its equipment.

Recommendations	Objectives
7 Multifisheries	
Perform deeper analysis to identify trends among the accidental occurrences studied.	Better understand the issues by distinguishing groups according to the type of fishery, the region of origin of the master, the type of occupational injury and the time of the accident or incident.
8 Personal Protective Equipment	
Develop, in partnership with CNESST, awareness and training activities to encourage and promote the use of PPE and its maintenance.	Increase the use of PPE and provide professional fishermen with the tools to properly maintain them.
9 Familiarization and Emergency Measures	
Increase awareness and training activities related to emergency preparedness familiarization and exercises.	Increase awareness and training activities that focus primarily on liability and the consequences that a violation may represent for masters.
10 Research Initiatives	
Support, encourage and promote scientific research in the commercial marine fisheries community and create opportunities for collaboration as an advisor to the scientific community from all sectors and disciplines.	Improve understanding of disaster issues to reduce their occurrence through case analyses. Collaborate with indigenous communities to validate the results obtained for them. Promote and support research initiatives aimed at designing a technical solution to the problem of cable and net entanglement in propellers and/or appendages.
11 Statistics in Fisheries	
Improve and harmonize the collection and exchange of information on fishing vessels between the different ministries and thus enable decision-making based on reliable data available in real time.	Establish an interdepartmental project to ensure that data collection from the different agencies allows for information transfer and knowledge sharing, using a common identifier.

Chapter 2
Research Framework

2.1 The Commercial Fishing Industry in Québec

Cod has been the main resource exploited in the Gulf of St. Lawrence for more than two centuries. Gaspesian, Acadian and Mi'kmaq fishermen captured by line this groundfish that was highly prized by Europeans and dried on the beaches of the Gaspé Peninsula before being exported. From the beginning of the colony until the Second World War, there was practically no innovation in the harvesting techniques. Fishermen used small wooden boats propelled by sail and oar that were called "Gaspé barges". In 1820, there were 680 of these barges on the Gaspé Coast.

The emergence of technologies developed during the two great wars changed the fishing landscape in Québec. Engines appeared as a means of propulsion. Hydraulics has replaced human power. Equipment such as radars and radios allowed fishermen to move further away from the coast. The market also changed dramatically at that time, as refrigerators and freezers now made it possible to preserve fresh fish. The popularity of our dried cod, called Gaspé cured, began to decline and fishermen had to adapt.

It was by developing bottom trawl cod fishing that fishermen discovered new species. While attempting to fish cod, they also accidentally harvested other species such as shrimp, redfish, and snow crab. From 1960 to 1980, fishing became much more diversified as many fishermen switched from fishing cod to catching these new species. However, it was the 1992 cod moratorium and the 1994 redfish moratorium that really transformed fishing into the model we know today.

According to 2015 data from Fisheries and Oceans Canada (2018), annual landings of fish, crustaceans and molluscs now represent a total of $238.5M in Québec. The main fishery is the snow crab fishery with $86 million, followed by the lobster fishery with $74 million and the shrimp fishery with $50 million. Groundfish landings now represent only $17.3 million (Fisheries and Oceans Canada, 2018).

In Québec, about 3,800 people work on board fishing vessels to catch the sea's resources. On average, there are just over three crew members per vessel (85% of vessels have fewer than five people on board).

2.2 The Québec Fleet

According to Fisheries and Oceans Canada's 2015 figures (2018), Québec's fishing fleet includes 1,222 vessels spread over three territories: Gaspésie and Bas-Saint-Laurent, the North Shore and the Magdalen Islands. Most of these boats are small vessels of about twelve to fifteen metres in length, built in fibreglass, engaged in inshore fishing, often on a daily basis, and with a gross tonnage of 15 or less. There are 946 of these small vessels in the fleet that are not required to be inspected and certified by Transport Canada, as only vessels over 15 gross tonnage are subject to the inspection scheme. There are therefore 276 certified fishing vessels in Québec. These vessels, generally built of steel and ranging in length from 18 to 24 metres, are engaged in mid-shore fishing and undertake trips varying from three to seven days.

They are divided into fleets according to the species fished and the home territory of the vessel. The largest fleet in Québec is the Magdalen Islands lobster fleet, which has 324 vessels, while the southern Gaspé fleet has 157 vessels. There are a few lobster boats on Anticosti Island and on the Middle North Shore, 19 and 6, respectively. However, their number should increase over the next few years due to the phenomenal increase in the lobster catch rate in the Jacques-Cartier Strait.

The second largest fleet is the crabber fleet, with 183 vessels. However, since this fleet is spread over three territories and its vessels fish in different areas, it has been divided into four groups to help us refine our analyses:

- the Bas-Saint-Laurent fleet, with 22 vessels fishing in the St. Lawrence Estuary upstream from Sainte-Anne-des-Monts (Area 17)[3];
- the North Shore fleet, with 39 vessels fishing on the North Shore of the St. Lawrence River between Pointe-des-Monts and Natashquan (Area 16);
- the Lower North Shore fleet, with 57 vessels fishing on the North Shore between Natashquan and Blanc-Sablon (Areas 16A, 15, 14 and 13);
- the Gaspé fleet, with a few units in the Magdalen Islands, which has about 65 vessels fishing in the Gulf of St. Lawrence (Area 12).

Despite the fact that shrimp represents the largest landings in terms of quantity with 18,216 metric tons, the Québec shrimp fleet has only 47 vessels. This fleet is mainly located on the Gaspé Coast in Rivière-au-Renard. These vessels are among the largest and most complex of the Québec fleet. They fish from the beginning of April sometimes until December. This fishery is also mid-shore and is practised in the Gulf and Estuary of the St. Lawrence. A shrimp fishing trip lasts about seven days. It is also aboard shrimpers that we find the largest crews, an average of five people.

The fleet that is the most difficult to define is without doubt the multifisheries fleet, because the vessels are of quite varied types and they are spread out over all the territories. As their name indicates, they fish several species. Most of them have a small quota of snow crab, but since this quota is insufficient to provide them with a decent income, they must also fish other species—such as Greenland halibut—to make their fishing enterprise profitable. Although they have long been the poor children of the industry, most are now enjoying good economic prosperity. Finally, the two smallest fleets are the scallops and other molluscs and groundfish fleets. There are 29 vessels in the scallops and other molluscs fleet and 88 in the groundfish fleet. These two fleets are spread throughout the territories.

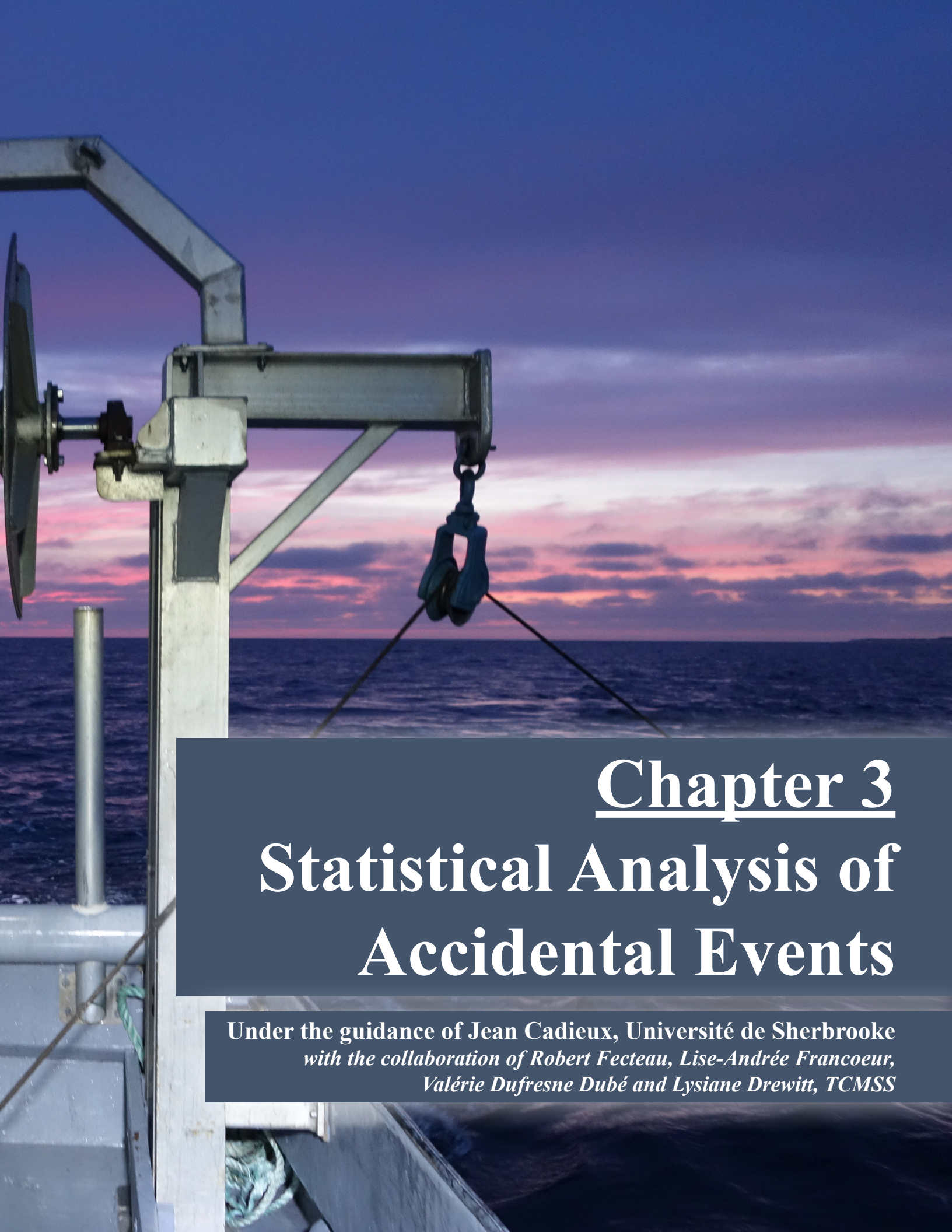
2.3 Limitations and Advantages of Analysis by Fleet

This study will therefore be limited to Québec fishing vessels carrying out commercial fishing activities in Québec waters. By analyzing accidental events and occupational injuries by fleet, we will be able to detect trends by type of fishery, by type of vessel and, in most cases, by region or even by community.

Furthermore, since safety culture is partly derived from the general culture of individuals—that is, from the beliefs and values instilled by their loved ones and community—we believe it is best to analyze safety culture by fleets. One of our tenets is that the safety culture from one vessel to another should be quite similar within a fleet, with fishermen learning a lot by observing their peers and trying to emulate them. The purpose of this exercise is not to point out singular units; rather, we wish to obtain a picture of the stage of maturity in occupational health and safety for a group, in this case, for a fleet.

[3] See charts 19 and 20 in Appendix D for a representation of the crab and lobster fishing areas.

The subdivision of the Québec fleet into fleets was a fairly complex exercise that we carried out using data from Fisheries and Oceans Canada. For some fleets such as lobster boats and shrimpers, this was obvious. However, for Area 12 crabbers and multifisheries, it turned out to be a bit more difficult. However, we believe that the data used in this study accurately represent the reality of the Québec fleets.



Chapter 3
Statistical Analysis of Accidental Events

Under the guidance of Jean Cadieux, Université de Sherbrooke
with the collaboration of Robert Fecteau, Lise-Andrée Francoeur, Valérie Dufresne Dubé and Lysiane Drewitt, TCMSS

3.1 Theoretical Framework

As part of this research, the statistical analysis of accidental events in the commercial fishing industry is based on data collected by the CCG and the TSB, more specifically on a compilation of accident reports from the CCG Search and Rescue Service. The information in the TSB database has allowed us to refine our understanding of a recorded accidental event or to complete the master sample in the rare cases where the occurrence had not been compiled by the CCG Search and Rescue service.

In order to fully understand the nature of the results, it is important to clarify the definitions used in our project. Since there is no universal guide for the coding of accidental events adapted to the Québec commercial fisheries sector, it was necessary to refer to the terms used by the Canadian Coast Guard in order to develop our conceptual framework.

3.1.1 Severity of Accidental Occurrences

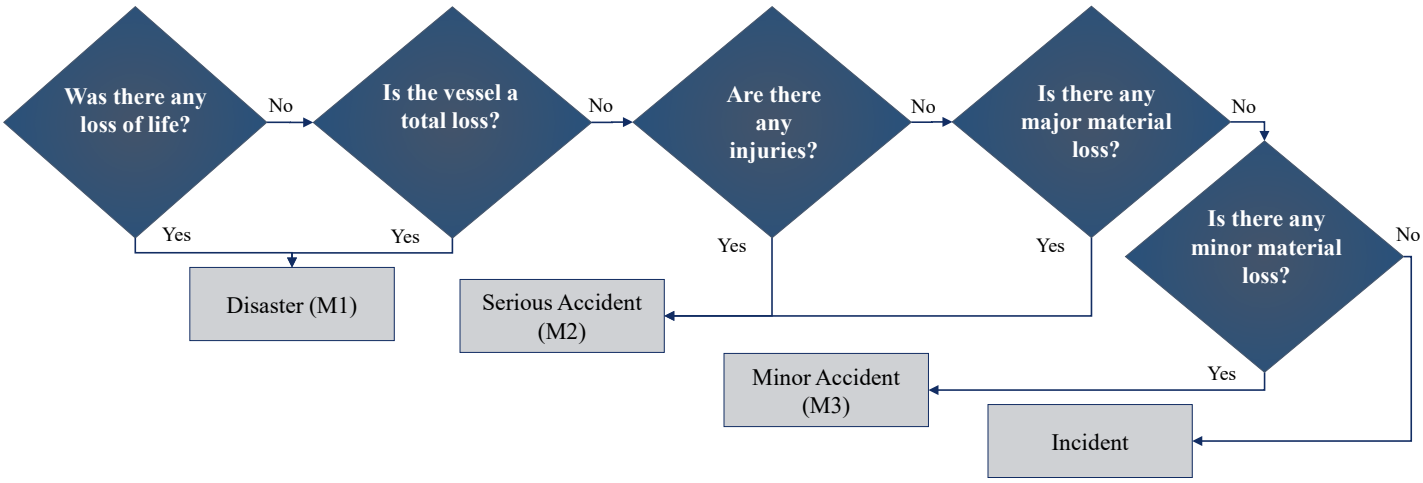
The CCG refers to accidental events by distinguishing marine incidents (M) based on severity. The four CCG categories are false alarms and hoaxes (M4), minor accidents (M3), serious accidents (M2) and disasters (M1). Table 1 below summarizes the descriptions used by the CCG.

Table 1: CCG Categories of Marine Occurrences (2000)

CCG Category	Description of the CCG
False alarm or hoax (M4)	Situations that result in a SAR response and are found to be unjustified or fictitious, such as when flares are mistakenly reported
Minor accident (M3)	No cases of distress or perceived significant risk are evident. (General calls for assistance.)
Serious accident (M2)	Distress could occur if action is not taken quickly; in other words, immediate intervention is required to stabilize the situation and prevent a case of distress.
Disaster (M1)	A vessel or person is threatened by serious and imminent danger and requires immediate assistance. (The presence or imminence of a life-threatening situation has been detected at some stage of the incident).

As part of this study, we separated accidental events into two categories: incidents and accidents. Incidents are fortuitous events, but without material and/or human damage, whereas accidents have so-called minor or major consequences or are considered disasters (tragedies). The distinction between the types of accidental occurrences has been made according to the elements illustrated in Figure 1 on the following page.

Figure 1: How to Determine the Severity of Accidental Events



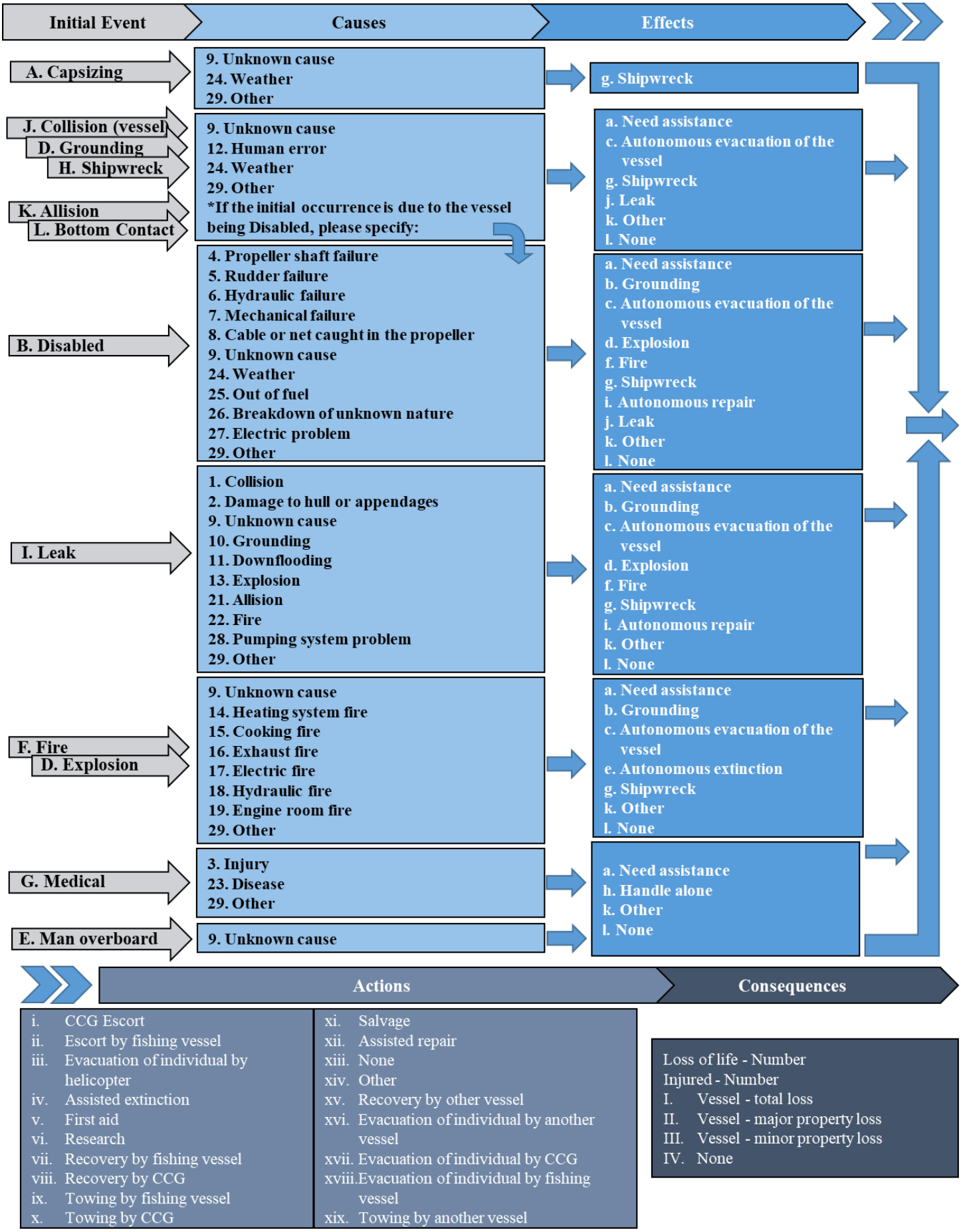
3.1.2 Sequence of Accidental Events

The classification used by the Canadian Coast Guard has been enriched to allow us to categorize accidental events as accurately as possible based on the data collected.

The categorization used in this research allows not only to refine the analysis of the causes of the events, but also to specifically identify the risk factors behind the incidents and accidents.

The logical sequence of an accidental event is then broken down into a sequence beginning with the occurrence of an initial event, which is explained by causes that generate effects for which actions are taken and which lead to consequences. Figure 2 on the next page summarizes all the classification possibilities according to the type of initial event. For more information, please refer to the Glossary of Accidents and Incidents in Appendix E.

Figure 2: Sequence of Accidental Events in Commercial Marine Fisheries by Type of Initial Accidental Event



3.2 Research Approach

3.2.1 Development of the Master Sample

Initially, the master sample was to consist of data from five agencies: CCG, DFO, TSB, CNESST and insurance company MP2B. However, the lack of a common reconciliation key for all partner databases made it impossible to automate statistical processing.

The master sample used in this study was ultimately developed by three partners: CCG, TSB and DFO. The team of professionals from Transport Canada based in Rimouski and led by Robert Fecteau set to work in order to put the databases together. The team spent several weeks verifying and cross-checking each of the data in the three databases in order to produce the master sample used in this research. Appendix B presents the variables included in the project.

The variables in the CCG database made it possible to identify several findings, particularly with regard to the nature and degree of seriousness of the accidental occurrence, its location, the potential impact of weather conditions on the risk of an accident, etc. For the DFO fishing operations database, one of the variables used was to identify the activity in progress at the time of the accidental event—fishing, in transit, etc.—and the stage of progress of the season and the number of landings made, which are indicators of the level of fatigue.

3.2.2 Limitations of the Study

To illustrate the complexity of the undertaking of analyzing accidental events in the fishing industry, it should first be noted that not all accidents are reported to the CCG or the TSB. For instance, an accident that occurs at a dockside does not usually require the intervention of the CCG, but rather paramedics and police services. Also, when a claim is filed, it is done from the name of the insured and not from the name of the vessel or the name of the renter of the latter, and this, in both the insurer's and CNESST's databases. Finally, since claims are not always made in real time, it was practically impossible to match the dates in the insurer's database with the dates of an event identified by the CCG or the TSB.

It is also important to note that the partners' databases are designed to meet the needs of each partner and for specific departmental uses. As a result, there was a lot of missing or erroneous data for various reasons, without being useless to their respective users. For the CCG, the database is primarily derived from event reports, which are used to provide a history of the steps taken during rescues in order to improve the emergency and archiving process. Names used for vessel identification were not standard and spelling was often incorrect, making the identification process quite cumbersome. For DFO, the use of databases is for stock assessment and management purposes. Here again, the data related to the issuance of fishing licences had their share of inconsistencies. These inconsistencies were sufficient to make it electronically impossible to join the two databases using a unique identifier.

The analyses are based on data covering a period from 2005 to 2015. Thus, the overall results do not represent the current picture in 2020, but rather the picture of a decade. In fact, the availability of data varies by department. Since the information is not accessible in real time, the statistical portrait of accidental events remains a relevant decision-making tool

when it comes to evaluating the measures put in place and targeting priorities, without allowing for immediate adjustments to strategies.

Finally, since it was impossible to match CNESST data with that of the CCG due to the absence of a matching key (the vessel identifier being absent from the CNESST database), the number of accidental events in this report is underestimated. Back to the example of an accident that occurs at the wharf, it is highly likely that a claim to CNESST will be made without the CCG having any record of the same event, which partly explains the disparities observed between CNESST, CCG and TSB accidental occurrences.

Furthermore, minor injuries are often unreported, indicating that the number of incidents identified in this study is less than the actual number.

Despite this, we believe that the analyses allow us to identify trends and adequately guide decision-makers in their assessments.

3.2.3 Data Processing and Analysis

The analysis of accidental events in the commercial fishing industry is based on models and techniques recognized in the literature and frequently used in statistics. Regression and CHAID analyses are the methods used in our research.

> Usually, regression models are constructed to explain (or predict, depending on the perspective of the analysis) the variance of a phenomenon (dependent variable) using a combination of explanatory factors (independent variables). In multiple linear regression, the dependent variable is always a continuous variable while the independent variables can be continuous or categorical. Linear regression is called multiple when the model consists of at least two independent variables (Yergeau and Poirier, 2013).

As noted by Yergeau and Poirier, "[a]s it is exceedingly rare, if not impossible, to predict a phenomenon using a single variable," multiple linear regressions were used in this study.

Categorical variables were analyzed using the exploratory technique published by Gordon V. Kass in 1980, the Chi-square Automatic Interaction Detector (CHAID) technique. This technique consists of analyzing the data according to a decision tree. The main advantage of this approach is the visual result obtained from the algorithmic analysis, which is more easily interpreted.

It is possible to determine the interactions that exist between several variables and to establish the dependency relationships between the variables. This technique is frequently used when research is exploratory and multiple regression analyses are not necessarily feasible. This technique has been applied to analyze the relationships between cause, effect, type of event, severity of events, and conditions intrinsic to fishing fleets.

3.3 Results

3.3.1 Statistical Analyses

From 2005 to 2015, 748 accidental events were reported to the CCG or the TSB. Of these occurrences, Table 2 shows that 74% were incidents with little consequence. At the same time, it can be seen that in 26% of cases, or 1 out of 4, accidents with more significant consequences were reported.

Table 2: Number of Accidental Events by Severity

Severity of the event	No.	Percentage (%)
Disaster (M1)	28	3.7
Serious (M2)	56	7.5
Minor (M3)	108	14.4
Incident	556	74.3
Total	**748**	**100.0**

Charts 1 and 2 show the geographical distribution of these events according to their severity and the type of material losses incurred. Accidents occur almost everywhere depending on the intensity of fishing. Nevertheless, a concentration of accidental events can be seen in the Honguedo and Jacques-Cartier Straits, in the Magdalen Islands and at the northern tip of the Gaspé Peninsula.

Chart 1: All Accidental Events by Severity

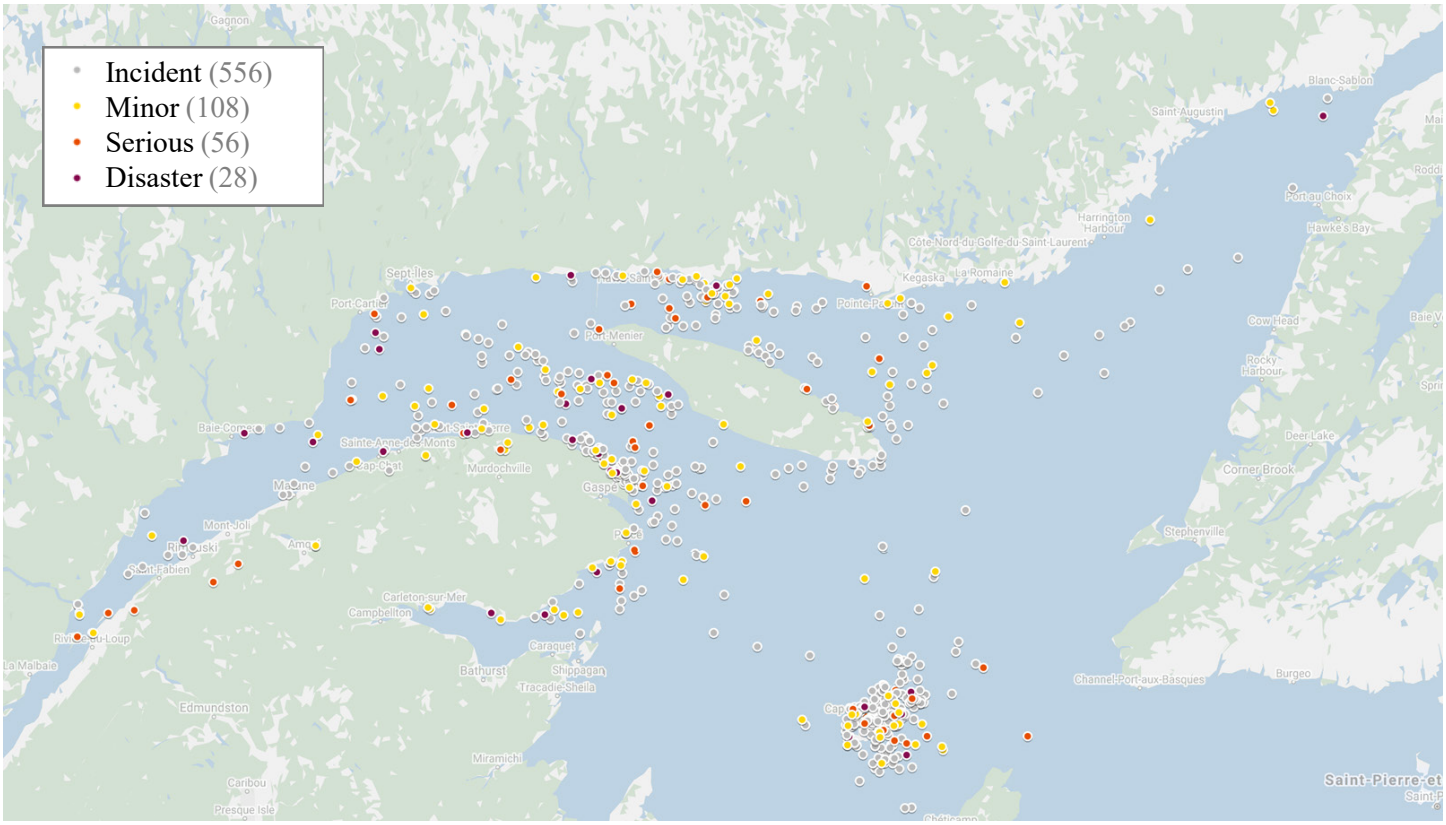
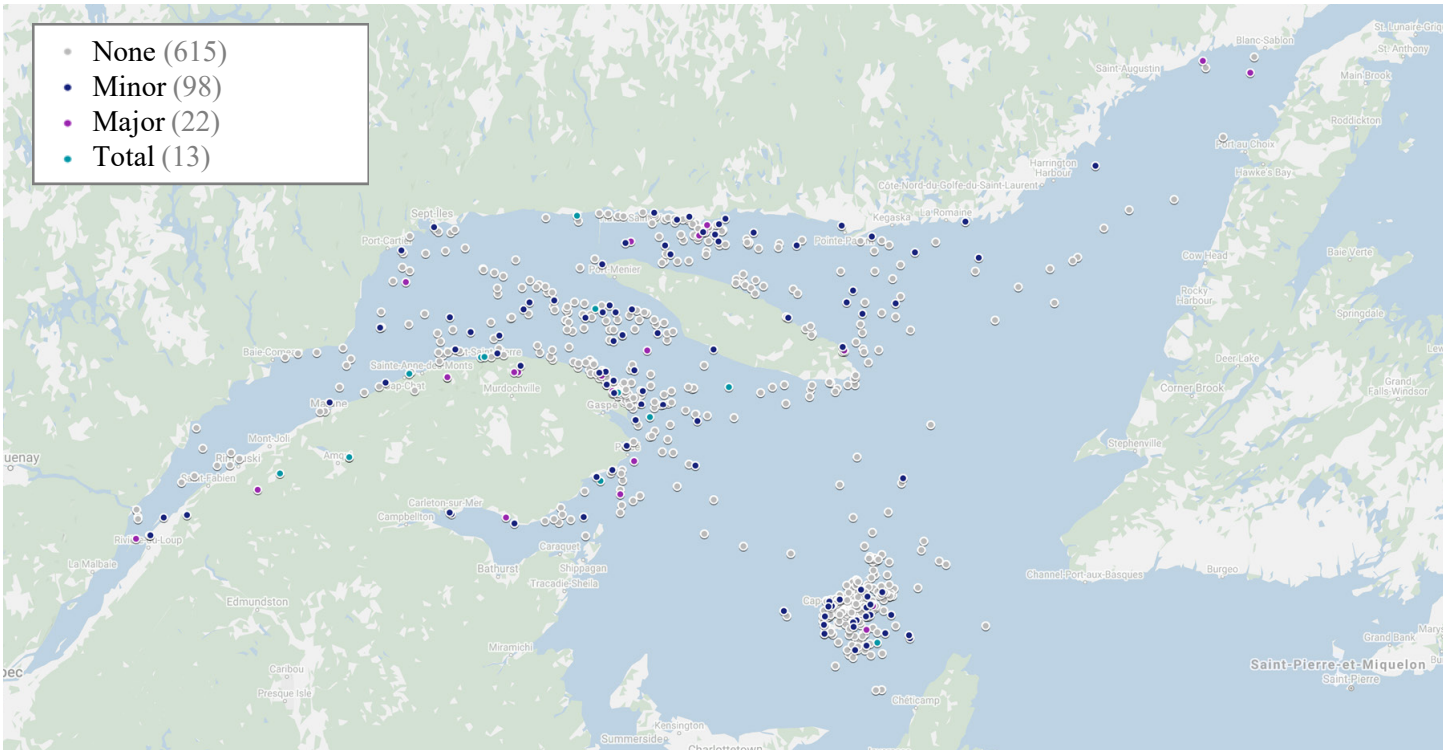
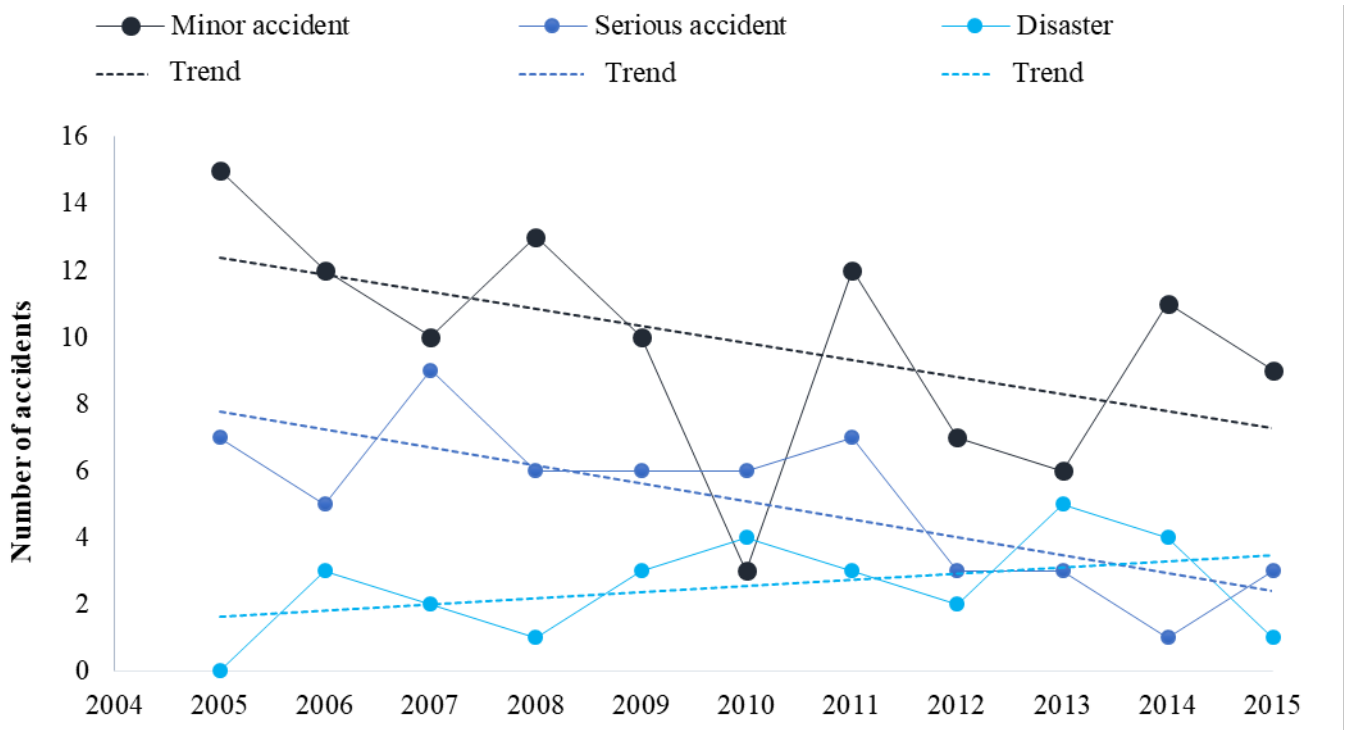


Chart 2: All Accidental Events According to the Type of Material Loss

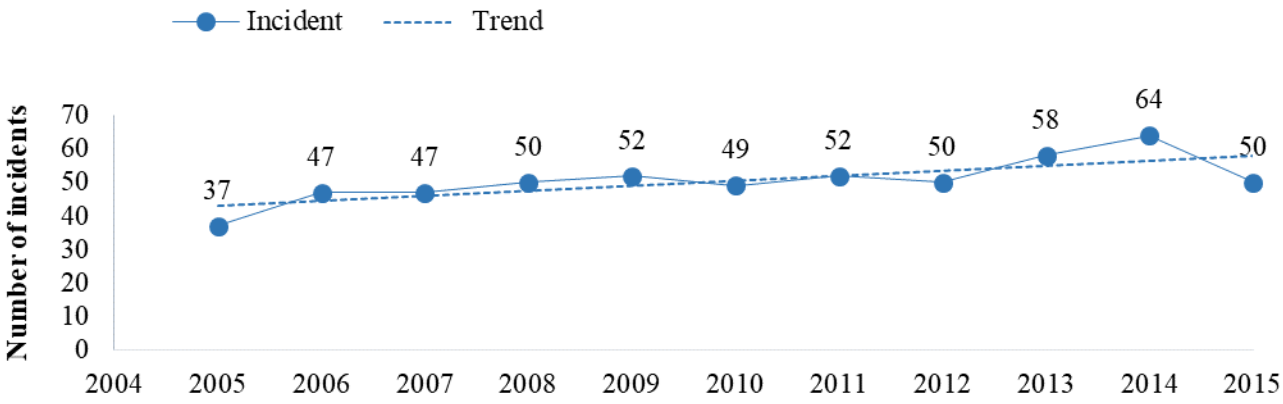


The analysis of the evolution of the severity of accidental events as a function of time allows us to identify the main trends. The number of accidental events is essentially the same from year to year, approximately 68 per year (748 cases in 11 years). While the number is constant in terms of quantity, it is the nature of accidental events that has changed since 2005.

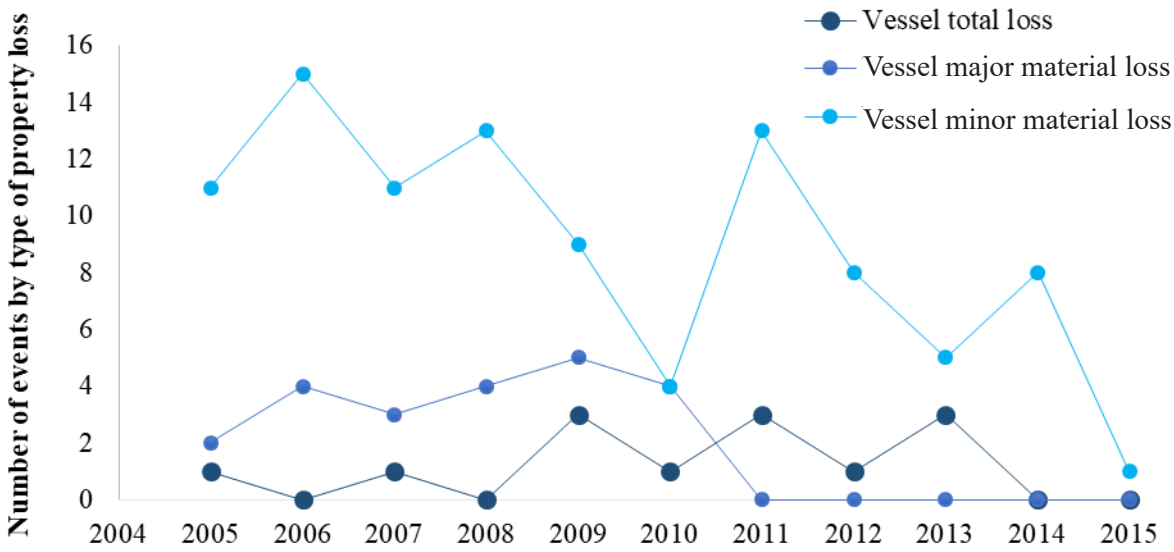
Graphic 1: Number of Accidents by Severity per Year (2005–2015)



Graphic 2: Number of Incidents per Year (2005–2015)



Graphic 3: Number of Accidental Events by Type of Material Loss (2005–2015)



More specifically, in addition to disasters whose recurrence is stable over time, serious and minor accidents have decreased over time, to the benefit of incidents, which have proportionally increased since 2012. In the period analyzed, we identified six accidents resulting in loss of life:

- 2009: Two deaths—Capsizing—Multifisheries, North of Gaspésie
- 2010: One death—Fall overboard—Lobster boat, Baie-des-Chaleurs
- 2011: One death—Fall overboard—Lobster boat, Magdalen Islands
- 2013: One death—Injury—Shrimper, Gulf of St. Lawrence
- 2013: One death—Capsizing—Multifisheries, North Shore
- 2014: One death—Fall overboard—Shrimper, St. Lawrence Estuary

Compared to 2005, serious accidents have been decreasing since 2012, as have accidents with major injuries and losses. The number of incidents has been increasing since 2012. For this type of event, there are few human and financial consequences. Overall, regardless of the type of accidental event, major losses have decreased significantly over time. In short, while serious and minor accidents have been declining since 2005, incidents are on the rise.

Table 3: Type of Actions Taken and Severity of Accidental Events (2005–2015)

Actions taken	Severity of the accidental event				Total
	Disaster	Serious	Minor	Incident	
Research	6	0	0	1	**7**
CCG Escort	7	41	87	389	**524**
Escort by fishing vessel	0	6	3	4	**13**
Towing by CCG	4	7	6	18	**35**
Towing by fishing vessel	3	7	23	173	**206**
Towing by another vessel	1	0	0	0	**1**
Recovery by CCG	5	2	0	2	**9**
Recovery by fishing vessel	9	1	0	1	**11**
Evacuation of individual by CCG	1	0	0	0	**1**
Evacuation of individual by helicopter	2	2	1	1	**6**
Assisted extinction	3	0	1	0	**4**
Assisted repair	0	0	0	2	**2**
First aid	4	2	2	1	**9**
Salvage	0	1	2	0	**3**
Other	1	0	0	1	**2**
None	1	0	0	3	**4**
Total actions	**47**	**69**	**125**	**596**	**837**
Total accidental events	**28**	**56**	**108**	**556**	**748**
Action rate per accidental event	**1.68**	**1.23**	**1.16**	**1.07**	**1.12**

In order to improve the rescue process, the CCG classifies and compiles all the actions taken. Table 3 shows the different types of actions taken during a response according to the severity of the accidental events.

Note that the CCG can call on commercial or other vessels to provide assistance more quickly. The analysis of statistics makes it possible to highlight facts. From 2005 to 2015, the 748 events required 837 different actions. Thus, there is an average of 1.12 actions per call. In other words, 12% of accidental occurrences require more than one action.

The more serious the accident, the more actions are required:

- An incident requires 1.07 actions
- A minor accident requires 1.16 actions
- A major accident requires 1.23 actions
- A disaster requires 1.68 actions.

In 93% of the cases, the actions taken are limited to escorting or towing. In 32% of cases, for logistical reasons—mainly because other vessels are closer—the CCG calls in and supervises other vessels (ferries, fishing vessels, merchant marine vessels, etc.) as part of a response.

Table 4: Number of Accidental Events by Vessel Intrinsic Conditions (2005-2015[4])

Characteristics		Incident		Minor		Serious		Disaster		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%
Boat age category	0 to 10 age group	74	62.7	19	16.1	20	16.9	5	4.2	118	28.8
	11 to 20 age group	154	76.6	34	16.9	9	4.5	4	2.0	201	26.9
	21 years and over	314	76.6	53	12.9	26	6.3	17	4.1	410	54.8
	Unknown	14	73.7	2	10.5	1	5.3	2	10.5	19	2.5
	Total	**556**	**74.3**	**108**	**14.4**	**56**	**7.5**	**28**	**3.7**	**748**	**100.0**
Overall lenght	12m and less	299	78.3	41	10.7	28	7.3	14	3.7	382	51.1
	More than 12m	257	70.2	67	18.3	28	7.7	14	3.8	366	48.9
	Total	**556**	**74.2**	**108**	**14.4**	**56**	**7.5**	**28**	**3.7**	**748**	**100.0**
Gross tonnage	15 and less	336	77.1	49	11.2	34	7.8	17	3.9	436	58.4
	More than 15	218	70.3	59	19.0	22	7.1	11	3.5	310	41.5
	Total	**554**	**74.3**	**108**	**14.5**	**56**	**7.5**	**28**	**3.8**	**746**	**100.0**

The analysis of Table 4 allows us to highlight elements relating to the frequency of accidental events, according to their severity, as a function of the intrinsic conditions of the vessels. The first observation is that 54.8% of accidental events involve vessels 21 years old and older, compared to 26.9% for vessels 11 to 20 years old and 26.9% for vessels 10 years old and younger. Vessels 10 years and under figure significantly less in incidents, but more in minor and serious accidents.

In terms of length and gross tonnage, the results are essentially the same. Vessels 15 and under in gross tonnage are more involved in accidental events (58.4%) than those over 15 in gross tonnage (41.5%). Accidental events are highest in the incident category for vessels 15 and under in gross tonnage (77.1%).

Table 5 on the following page highlights elements relating to the frequency of accidental events, according to their severity, as a function of the conditions extrinsic to the vessel for the period 2005 to 2015.

Contrary to the basic hypothesis and popular belief, 58% to 60% of accidental events take place when the wind speed is less than 10 knots or when the sea is calm. Nearly half of the disasters occur under these same conditions, even though they are mild.

With respect to waves, it should be noted that no accidental occurrences have taken place when waves exceeded 4 m since 2005. Nevertheless, minor accidents are more likely to occur in calm seas, while disasters are more likely to occur in the presence of strong winds and/or when the sea is rough.

[4] All three relationships are statistically significant (max p-value = 0.031). In a column, the colour green indicates a more advantageous positioning while blue indicates the opposite.

In light of these results, it would appear that when weather conditions are optimal, the absence of a visible threat causes crews to lower their guard. It is important to mention, however, that when navigation conditions are favourable, there is a higher concentration of vessels in certain fishing areas, which increases the probability of incidents or accidents.

Table 5: Number of Accidental Events by Vessel Extrinsic Conditions (2005-2015[5])

	Incident		Minor		Serious		Disaster		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Wind speed according to the Beaufort scale										
Breeze (less than 10 knots)	319	**76.6**	59	**14.2**	24	5.8	14	3.4	416	58.0
Moderate winds (10 to 20 knots)	181	**81.9**	21	**9.5**	12	5.4	7	3.2	221	31.0
Strong winds (Over 20 knots)	50	**65.8**	10	**13.2**	11	**14.5**	5	**6.6**	76	10.7
Total	**550**	**77.1**	**90**	**12.6**	**47**	**6.6**	**26**	**3.6**	**713**	**100.0**
Wave height according to the Douglas scale										
Calm sea (less than 1.25 m)	262	75.3	52	**14.9**	23	6.6	11	**3.2**	348	60.2
Moderate sea (1.25 to 4 m)	181	78.7	21	**9.1**	15	6.5	13	**5.7**	230	39.8
Rough sea (more than 4 m)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**443**	**76.6**	**73**	**12.6**	**38**	**6.6**	**24**	**4.2**	**578**	**100.0**

3.3.2 CHAID Analysis

The variables studied in this research are the actions taken in response to the accidental event, the causes, the seriousness of the events, the requirement for inspection, the type of material losses and belonging to a fishing fleet. The results obtained are detailed in this section and the decision trees are presented in Appendix F to facilitate reading.

a) Causes and Actions (Interventions)

First, we seek to understand what actions are taken by the various stakeholders according to the causes of accidental events. The analysis shows that 95.6% of the actions[6] undertaken are either escort (70.1%) or tows (25.5%) (see Figure 10 in Appendix F).

Interventions requiring escorts occur during incidents caused by mechanical failures (engine, transmission, etc.), hydraulic failures, breakdowns, or because of illness or disease of one of the crew members. In the case of minor accidents, escort is required when the cause is due to a cable/net caught in the propeller and when collisions occur. In serious accidents, escort is required due to injuries, hull or appendage damage, human error, weather, fires of any kind and downflooding.

[5] Both relationships are statistically significant (max p-value = 0.024 for winds and 0.032 for waves). In one column, the green indicates a more advantageous positioning while blue indicates the opposite.

[6] Although an accidental event may result in more than one action, the CHAID algorithm can only consider the first action taken. In order to mirror the algorithm, it acts as a magnet. When two elements attract each other, they move away from the centre together while repelling those that do not attract them. In Figure 3 on page 36, we note that 0–10-year-old boats are the opposite of 11 and older ones; they repel each other. Boats 10 years and under have more hull damage, they attract away from the centre and so on.

Towing interventions also occurs during incidents caused mainly by mechanical failures [engine, transmission, etc.], hydraulic failures, breakdowns, human error, or fires of any kind. In the case of minor accidents, towing interventions are necessary when the cause is due to a cable/net caught in the propeller or to damage to the hull or appendages.

The other types of interventions are insufficient in number to break them down into smaller units of analysis and were therefore not included in this study.

Conclusions can be drawn from the above. First, in order to reduce the frequency of incidents, mostly caused by mechanical [engine, transmission, etc.] or hydraulic failures and breakdowns of unknown nature, preventive maintenance could be carried out at the beginning of the season.

Then, considering that minor accidents occur when cables or nets are caught in the propeller or during collisions, a review of work methods and the design of a best practises guide for fishermen would be interesting avenues to explore to resolve these problems. The contribution of research should also be considered in order to propose technical solutions to this type of accidental event such as the installation of a guard around the propeller and rudder.

Finally, serious accidents and disasters occurring mainly in cases of damage to the hull or other appendages, fires of all kinds, human error or downflooding, the presentation of testimonials from fishermen who have experienced this type of event and similar case studies as well as training could be promoted in order to reduce this type of accident.

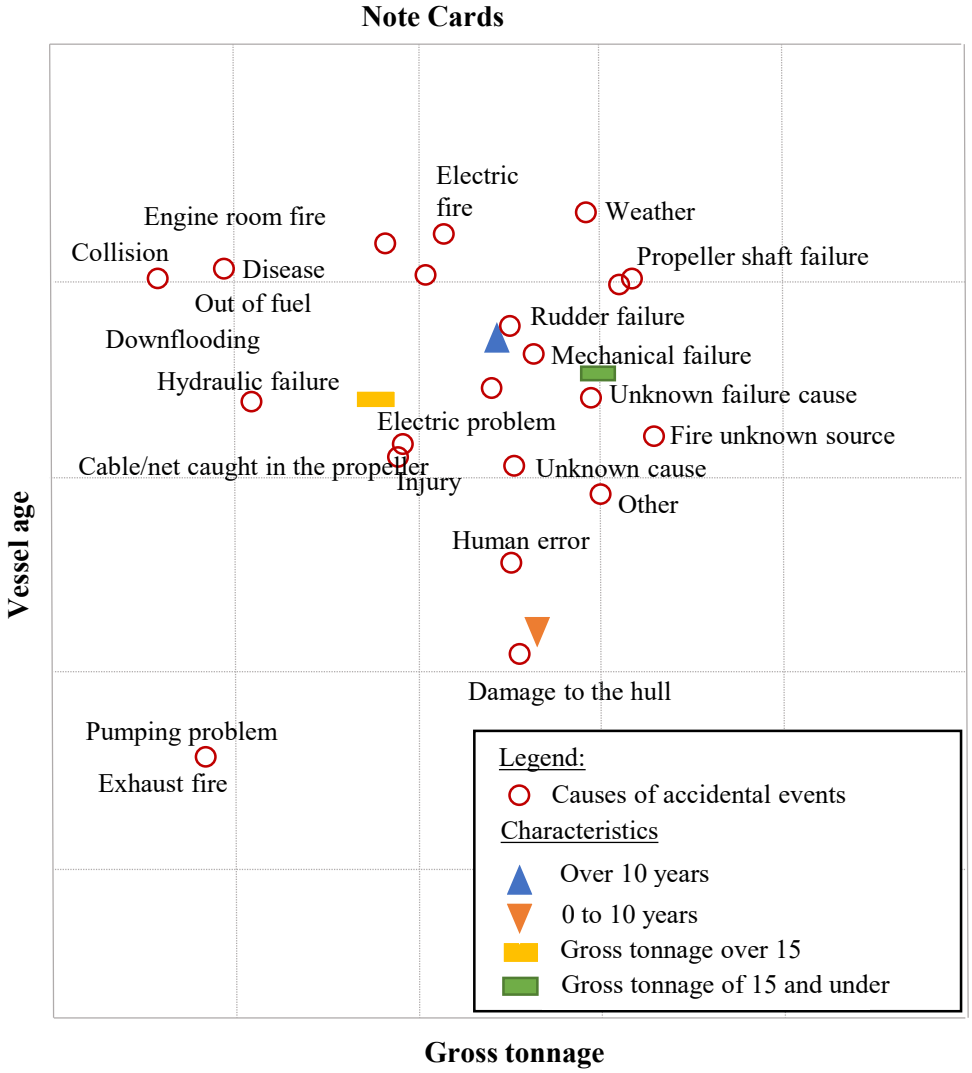
Figure 3 on the following page presents an analysis of the correspondence between the types of causes underlying accidental events and the intrinsic characteristics of fishing vessels, i.e., age [10 years and under or over 10 years] and tonnage [gross tonnage 15 and under or over 15].

The analysis of Figure 3 leads to certain conclusions. Vessels older than 10 years are more prone to fire or electrical problems of all kinds, as well as failures related to rudder or propeller components.

Vessels 10 years and under are less prone to wear and tear problems; however, human error and damage to the hull or appendages are more present. Vessels over 15 gross tonnage are more affected by hydraulic problems and nets caught in the propeller. In the fleet over 10 years old, if it were not for diseases, it would all boil down to failures or incidents, regardless of the gross tonnage of the vessel.

Finally, vessels over 10 years old, regardless of their size, are more prone to accidents due to failures of all kinds. A preventive maintenance program and more frequent inspections of these vessels are interesting avenues to explore.

Figure 3: Causes Based on the Age and Size of the Vessel



b) Causes, Severity and Inspection

The purpose here is to understand the causes of accidental events in terms of their severity and whether there were inspections (gross tonnage over 15) or not (gross tonnage 15 and under). The analysis shows that these vessels subject to mandatory inspections have significantly fewer failures or breakdowns. In addition, for these vessels, weather, downflooding and collisions are causes of accidental events that are very rare, i.e., less than 1% (see Figure 11 in Appendix F). Moreover, since vessels over 15 gross tonnage are often equipped with more complex fishing equipment, they suffer more damage due to component wear and hydraulic problems. Vessels of 15 gross tonnage and less are more affected by failures and breakdowns.

Accidental events affecting vessels with a gross tonnage of 15 and under are the least well documented. It is both necessary and useful to document all occurrences in a standardized manner. It is recommended that the causes be better documented, as quickly as possible, for all types of vessels. An update of the information collection procedure and training related to completion are possible solutions to standardize the collection process among all the stakeholders involved in the safety of commercial fishing.

c) Losses, Accidents and Causes

The variables studied reflect the magnitude of financial losses according to the groups of accidents and the causes of those accidents (see Figure 12 in Appendix F). Downflooding, fires, collisions and shipwrecks cause the greatest financial losses. Cables and nets caught in the propeller cause major financial losses. Failures, breakdowns, and diseases rarely result in financial losses to fishing businesses, but are of significant recurrence, resulting in substantial financial costs to society—including costs related to the deployment of resources for search and rescue responses—and a potential loss of efficiency for all stakeholders.

d) Fleet Analysis

The accidental events between 2005 and 2015 are presented in Table 6 according to their distribution within each of the fleets. The rightmost column illustrates, *ceteris paribus*, the **proportionality** of these events for each of the fleets. The charts in Appendix D show the geospatial location of accidents for each of the fleets.

Table 6: Number of Vessels and Accidental Events per Fleet

Fleet	No. of vessels	% of the fleet	No. of accidental events	% of accidental events	Accident/fleet proportionality
Shrimper	47	4	126	17	++++
Scallop vessel and other molluscs	29	2	38	5	++
Crabber - Area 16	39	3	46	6	++
Crabber - Area 12	65	5	41	5	=
Crabber - Area 17	22	2	13	2	=
Lobster boat - Anticosti	14	1	16	2	=
Lobster boat - Gaspésie	4	0	2	0	=
Lobster boat - Magdalen Islands	324	27	220	29	=
Lobster boat - Mid North Shore	6	0	0	0	=
Multifisheries	322	26	189	25	=
Groundfish	88	7	48	6	=
Crabber - Lower North Shore	57	5	3	0	- - -
Crabber - Area 12	48	4	0	0	- - -
Lobster boat - Baie-des-Chaleurs	76	6	4	1	- - - -
Crabber - Area 17	81	7	2	0	- - - -
Total	**1222**	**100**	**748**	**100**	

Likely due to the proximity effect or the type of fishery that is practised (inshore or mid-shore), communities make differentiated use of CCG and other stakeholders' search and rescue resources. Thus, more intervention required by a fleet does not necessarily mean that it is engaging in unsafe behaviours. Indeed, the interpretation of the results must be made in light of certain considerations, namely the number of fishermen per boat as well as the number of hours worked, which can vary considerably not only from one fleet to another, but also from one boat to another. Nevertheless, the analysis of Table 6 makes it possible to highlight certain phenomena. The shrimper fleet represents 4% of the fleet but required the assistance of external stakeholders in more than 17% of cases.

Several factors may explain this high demand, including fishing areas often located at significant distances from home ports and the fact that trawling is a very demanding fishing activity for the equipment and the vessel, which may increase the exposure of shrimpers to not only more risks, but also to greater risks.

The Magdalen Islands lobster fleet stands out for the number of accidental events (29%) despite its relative importance in the Québec fleet (27%). In this case, the physical proximity of the CCG's Cap-aux-Meules Search and Rescue Centre may explain the strong representation of this fleet in the number of accidental events.

Areas 12 and 16 crabbers are subject to a greater number of accidental events (5% and 6%) than their counterparts from the Lower North Shore and Area 17 (0% and 2%).

The fact that the crabbers in the first group fish in the waters of the Gulf (mid-shore fishery) while the other fish close to the coast (inshore fishery) is an explanatory factor for this result. Thus, it would appear that fishing far from the coast and long trips expose the fishermen to greater risks.

For the scallops and other molluscs fleet, although it constitutes only 2% of the fleet, it accounts for 5% of the recorded cases. This result could be explained by the geographic location of the fishing areas and by the impacts of dredging activities on the equipment and the vessel. On the one hand, we know that this fishery uses a type of equipment that is heavy and cumbersome to handle, which is a risk factor from the outset. For instance, on many occasions during a fishing day, the dredge is hoisted on board and then released into the sea. During each hoisting or dropping operation, contact with the hull can occur and ultimately potentially affect the integrity of the vessel. On the other hand, a more detailed analysis of the fishing conditions and the context of the event involving these scallops and other molluscs vessels must be carried out considering that the majority of commercial scallops and other molluscs fishing activities take place on the North Shore, a region where there is a high number of accidental events.

The cases attributable to the crab and lobster fleets of the Lower North Shore, as well as those attributable to the lobster fleets of the Baie-des-Chaleurs and the South Gaspé Peninsula, are the least numerous. For the other fleets, the number of accidental events is proportional to the size of the fleet.

In general, statistics show that the longer the trips are, far from the coast and in the vicinity of CCG stations, the more assistance from external stakeholders will be required in the event of a problem.

e) Fleet: Causes and Material Losses

Here we try to break down material losses according to fleets and causes of accidents. The results are detailed in the following paragraphs according to the three main groupings identified by the analysis, which represent 59.5%, 30.2% and 10.3% of the cases listed (see Appendix F). The groupings represent the fleets and cases with the most statistically significant congruence relationships. In other words, the CHAID analysis identified three groupings that are detailed in this section.

The first grouping identified includes the multifisheries fleets, scallops and other molluscs fleets, shrimpers, Area 12 crabbers, Area 16 crabbers, Lower North Shore crabbers and South Gaspé lobster boats, which account for 59.5% of the recorded cases; of these, 78% were incidents with no losses (see Figure 14, page 176). Breakdowns of all kinds and failures, disease and downflooding represent 42% (314/445) of the occurrences. Injuries, damage to the hull or other appendages, and weather accounted for 11% of occurrences. Human error, fires and collisions were the causes of major losses. Cables or nets caught in propellers account for 12.4% of accidental events and are costly in more than half of the cases.

The second grouping identified includes the Magdalen Islands lobster fleet, the Baie-des-Chaleurs lobster fleet and the North of Gaspésie lobster fleet, which account for 30.2% of the total accidental events, and of these, 93% were incidents with no losses (see Figure 13, page 175). Failures of any kind and cables or nets caught in the propeller represent the most common accidental events (23%). Damage to the hull or other appendages and fires are rare accidental events (2%).

The third grouping identified includes the groundfish, Anticosti lobster and crab fleets in Area 17, which are the ones that suffered the least number of accidental events. Only 10.3% of accidental events involved them, of which 74% were incidents with no loss (see Figure 15, page 177).

However, when they report an event, its severity is significant. This low rate can be explained in part by the fact that CCG activities are more complex in these areas (around Anticosti Island and in Area 17), in particular due to the remoteness—or even absence—of CCG search and rescue centres in these areas. Failures of all kinds, breakdowns, injuries, and illnesses account for 68% (52/77) of accidental events. Damage to the hull or other appendages, human error, cables, and nets caught in the propeller, weather and fires are less frequent but very costly events.

The causes of accidental events can be broken down by fleet[7] and the main findings are described below (see Appendix F).

Essentially, for **crabbers** (all Areas combined), the majority (43% to 57%) of the causes can be summarized as incidents such as mechanical failures or rudder failures as well as cables or nets caught in propellers, which generate significant costs.

In the case of **lobster boats of Magdalen Islands**, the causes can be summed up as mechanical failures (56%), rudder-related problems (12.3%) or failures of an unknown nature (12%). The prevalence of these problems is higher in this fleet than in others.

As for the **other lobster boat groups**, the causes can be summarized as mechanical failures (42%) and damage to the hull or appendages (13%), resulting in major costs.

For shrimpers, the causes were mechanical failures (40%), cables or nets caught in propellers (18%), breakdowns (6%) and diseases (6%).

[7] Analyses have been relaxed in their criteria in order to produce segments more easily.

For the other fleets—**scallops and other molluscs, multifisheries and groundfish**—the causes are limited to mechanical failures (42%), breakdowns (13%) or cables or nets in propellers (9%). Electrical problems and human errors are more prevalent in these fleets than in any other.

Since the shrimper fleet required the greatest number of external interventions, this group was analyzed in isolation according to the causes of accidental events (see Appendix F). This more in-depth analysis highlights certain elements. Firstly, there are more failure problems (hydraulic and electrical breakdowns) in this fleet, which is probably due to the use of more complex fishing rigs. When the causes are human error, hull damage, propeller shaft failure, injuries, electrical fires or downflooding, losses are considerable. Fatigue can be the cause of accidents due to human error. Crew member training can help them identify indicators of possible damage, broken trees, fire or downflooding hazards. Familiarization and awareness activities are possible solutions to reduce the prevalence of accidental events.

Analyses whose results tend to show that the shrimper fleet requires the most external resources, particularly those of the CCG, call for further explanation. In fact, it should be specified that shrimpers have to deal with more difficult navigation conditions since they practice mid-shore fishing. This fishery, which involves several crew members, is characterized by a season spanning several months and trips at sea over a longer period. More specifically, most shrimpers fish from early April to early December and make trips of about seven days at sea. In short, shrimpers travel great distances to reach the fishing grounds and remain there for an extended period of time. The risks they incur are therefore higher due to their longer period of exposure.

In summary, for all fleets, the picture is essentially the same. Incidents, which are at the origin of most interventions, consist of failures and breakdowns of all kinds, with no great consequences. A preventive maintenance program could be put in place along with intensified inspections, which could help mitigate this problem. Minor and major accidents are often caused by nets or cables caught in propellers.

This problem undoubtedly deserves further consideration, but a review of work practices and the implementation of a research project on the design of a guard around the propeller and rudder remain relevant angles of approach.

3.3.3 Analysis of Alternatives

Table 7 presents the severity of accidental events according to other variables available in the database.

Table 7: Number of Accidental Events by Severity (Season, Licence, Ethnic Origin)

Possibilities		Incident		Minor		Serious		Disaster		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%
Period in the season	Start	111	79	11	8	14	10	4	3	140	18
	Middle	70	81	9	11	3	4	4	2	86	12
	End	53	83	6	9	4	6	1	2	64	9
	After	3	100	0	0	0	0	0	0	3	0
	Transit	65	68	18	19	9	10	3	3	95	13
	Unknown	254	71	64	18	26	7	16	4	360	48
	Total	**556**	**74**	**108**	**14**	**56**	**8**	**28**	**4**	**748**	**100**
Licence type	Unknown	77	68	23	20	10	9	4	4	114	15
	Renter	67	68	16	16	9	9	6	6	98	13
	Owner	412	77	69	13	37	7	18	3	536	72
	Total	**556**	**74**	**108**	**14**	**56**	**8**	**28**	**4**	**748**	**100**
Is the user Indigenous?	Unknown	72	69	19	18	9	9	4	4	104	14
	No	443	77	74	13	39	7	20	4	576	77
	Yes	41	60	15	22	8	12	4	6	68	9
	Total	**556**	**74**	**108**	**14**	**56**	**8**	**28**	**4**	**748**	**100**

Analysis of the data included in Table 7 sheds light on various findings.

Typically, accidental events occur more at the beginning of the fishing season and are incidents (in 74% of cases). In these cases, the master is the owner of the vessel and is non-native. To overcome this situation, a better preparation before leaving could be useful.

Whether the master is the owner or not does not seem to be a determining factor in accidental events.

Indigenous users are associated with only 5.3% of accidental occurrences, but their vessels tend to be more prone to accidents. A more detailed analysis of this trend provides a better understanding (see Appendix F). Proportionately, the analysis confirms that indigenous users are more associated with accidental events caused by human error, damage to the hull or other appendages, or cables/nets caught in propellers. To be proportional to other groups for the same type of events, the total is expected to be approximately **7** accidental occurrences, compared to **28** for this group.

There are too many accidental events for which contextual data (type of activity underway, number of trips made, stage of the season) have not been collected. It is therefore impossible to produce a detailed analysis of the fatigue level.

Some Answers to Fundamental Questions

Among crab and lobster fishermen, is fatigue a risk factor depending on the stage of the season?

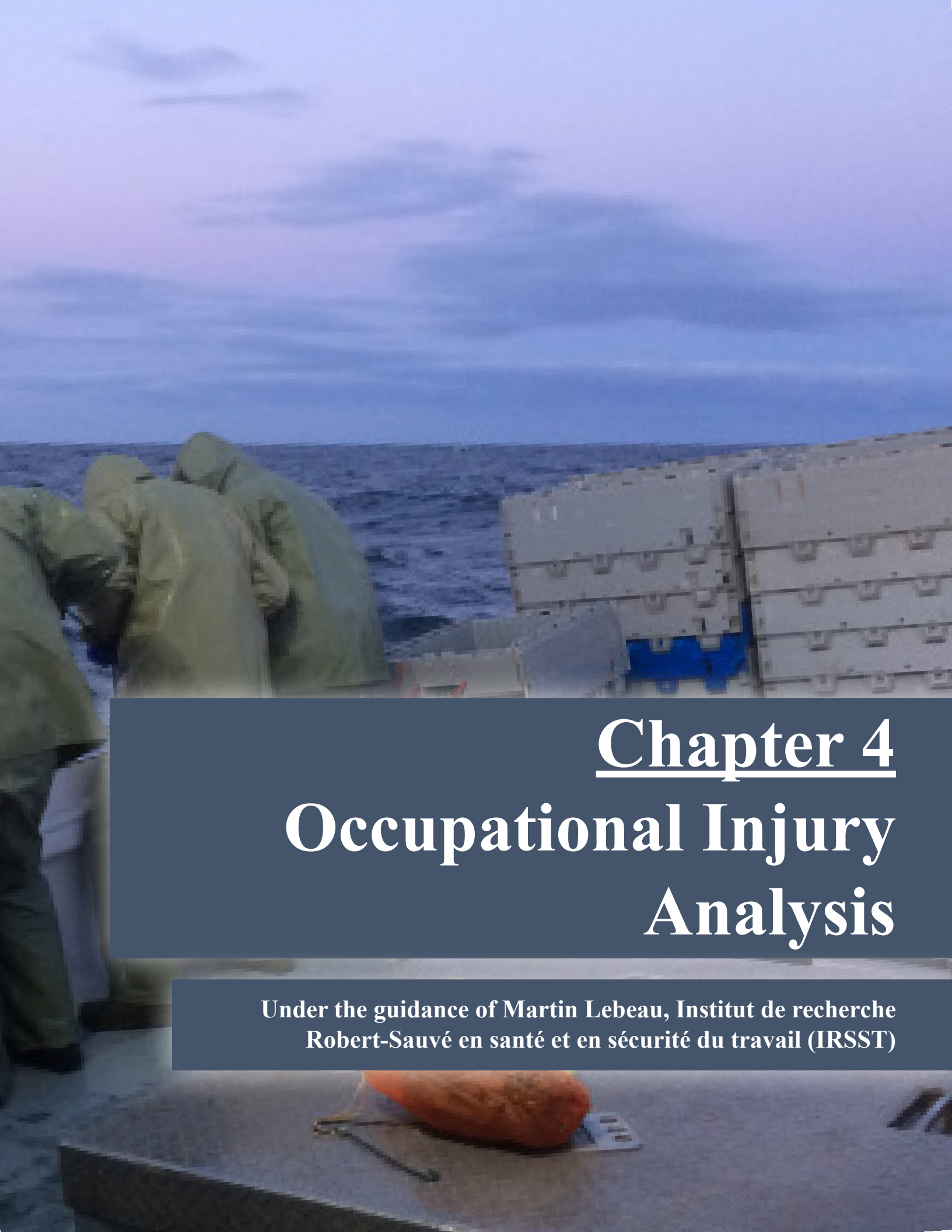
- No. There are just as many accidental events, regardless of the time of the season. More specifically, there is technically no concentration of accidental events at a statistically distinct time of the season.

Do the types of fishing (sentinel and experimental) have an impact on accidents?

- There are not enough occurrences—a total of five accidental events for these two types of fisheries—to be able to make a statistical statement.

Does competitive or quota fishing (global or participation) have an influence on the occurrence of accidents (all together)?

- Global (competitive fishing) causes more accidents (see Appendix F). However, when analyzed together with other criteria, this effect disappears. It is a minor type of criterion, at least for the accidental events under study. This means that although the number of accidental events is high for the competitive fishing group, **it is not possible to conclude that competitive fishing is more at risk than quota fishing.**



Chapter 4
Occupational Injury Analysis

Under the guidance of Martin Lebeau, Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST)

4.1 Theoretical Framework

Calculating the costs of occupational injuries is of great use to all occupational health and safety (OHS) stakeholders. First, these estimates provide a better idea of the magnitude of the problem under study. Simply putting a dollar figure on the consequences of occupational injuries is often effective in convincing decision-makers to take preventive action, since the amounts estimated give insight into the potential benefits of prevention. Estimating the costs of occupational injuries also makes it possible to make comparisons and classifications useful for prioritizing OHS actions. For instance, in the case of the commercial marine fisheries sector, questions such as "What are the costliest types of fishing accidents?" Or "Which fleet has the costliest occupational injuries?". These estimates could also be used to compare the fisheries sector to other economic sectors within the same jurisdiction, or to compare the situation of the fisheries sector between different jurisdictions (countries, provinces, or regions). Finally, a monitoring of the evolution of the costs of occupational injuries can be performed. This makes it possible, among other things, to evaluate the extent to which prevention activities have had the expected effects. The general objective of calculating the costs of occupational injuries is therefore to improve the allocation of resources for research and prevention of occupational injuries.

But how do we calculate the costs of occupational injuries? And what cost elements should be included in this type of analysis? The first studies that were carried out on the subject focused exclusively on the costs borne by employers. The work of Heinrich (1931) is often identified as the origin of this type of study. It is to him that we owe the visualization of costs in the form of an iceberg, the direct costs being the small part immersed and the indirect costs being the largest part hidden under water. From the employer's point of view, direct costs are usually the costs that are insured, such as CNESST contributions, but may also include other costs related to the accident. Indirect costs are all other costs that are more difficult to measure, such as lost productivity and employee turnover costs.

Far more comprehensive studies have been carried out over the past 20 years. These attempts to estimate the costs of occupational injuries to society as a whole, not just to the employer. Among these studies are those carried out by NOHSAC in New Zealand, Safe Work Australia, the Health and Safety Executive in Great Britain and Paul Leigh in the United States. The methodology developed by the IRSST and used in this study draws on the methodologies used in the work conducted internationally.

The theoretical framework revolves around a starting question: what would have been the benefits to society if no injuries had occurred? An attempt is therefore made to evaluate the difference between the current situation (with occupational injuries) and a counterfactual scenario in which no occupational injury would have occurred.

The bottom-up approach is the one usually favoured to achieve this objective. It consists in first establishing the number of occupational injuries and then calculating their various costs[8].

[8] The top-down approach, on the other hand, uses aggregate values for costs, and then estimates the proportion of these costs related to occupational injuries.

In this study, occupational injuries in the commercial marine fisheries sector were provided by CNESST.

The cost calculations are made in terms of incidence, i.e., only new injuries that occurred during the study period (2005 to 2015) are considered and an attempt is then made to estimate their current and future costs.

For instance, in the case of a death, an attempt will be made to estimate the loss to society of each year of life lost. The discounted sum of the financial and human costs calculated for each of the years gives the total cost of death[9].

Employers, workers, and the community are the three economic agents considered. The sum of the costs borne by these three economic agents gives the total cost borne by society as a whole. Table 8 below presents the costs that were estimated in this study, broken down by the economic agent that incurs them.

Table 8: Cost Elements by Economic Agent

Costs	Employers	Workers	Community
Medical expenses	Medical assistance fees Rehabilitation costs	-	-
Wage costs	Wage of the injured worker on the day of the accident	-	-
Productivity loss	Wage loss Income replacement and death benefits	Wage loss (net compensation)	Uncollected income taxes
	Benefits Employer-paid benefits for an absent employee	Lost benefits	Benefits paid by contributors
	Housework Compensated housework	Inability to perform housework (net compensation)	-
Administrative costs	Recruitment and training of new employees	-	-
Human costs	Compensation for bodily injury	Pain, anxiety, stress and loss of enjoyment of life for the injured person, family members and friends (net compensation)	-

[9] In this study, all costs are expressed in 2017 constant dollars. Amounts are discounted using a 3% discount rate and transformed into 2017 dollars using the Québec Consumer Price Index published by the Institut de la statistique du Québec.

4.2 Research Approach

The method developed at the IRSST for calculating the costs of occupational injuries (Lebeau *et al.*, 2014) and described in the previous section was therefore used in this study. The data used were provided by CNESST and were subsequently merged with the Fisheries and Oceans Canada database on gear, catches and landings to obtain a more accurate picture. The limitations of this new database were mentioned previously.

Therefore, as mentioned in the previous section, the costs of occupational injuries calculated for the present study represent the sum of the financial and human costs generated by injuries occurring during the study period, i.e., from 2005 to 2015. They are borne by employers, workers, and the community.

More specifically, it is the sum of these various costs:

- Medical and rehabilitation costs: All expenses incurred to treat and rehabilitate an injured or sick person.

- Wage costs: Hours not worked (or not productive) but paid by the employer in the form of wages and benefits, on the day of the accident. Thus, a half-day of lost work is attributed to each accident.

- Productivity loss: The value of paid and unpaid work that is no longer performed by the injured worker. For cases with compensated days, this lost productivity is measured by the gross daily wage (including benefits) multiplied by the number of compensated days. For deaths, the wages and benefits lost up to the worker's expected retirement age are estimated (human capital method). To this is added the value of unpaid housework, calculated from estimates by Statistics Canada.

- Administrative costs: Staff turnover costs (recruitment, training, etc.). Cases associated with staff turnover are identified in the CNESST database based on several criteria (e.g., one death per accident). Costs are calculated by multiplying the worker's salary by 30%, which is similar to what is done in other similar studies.

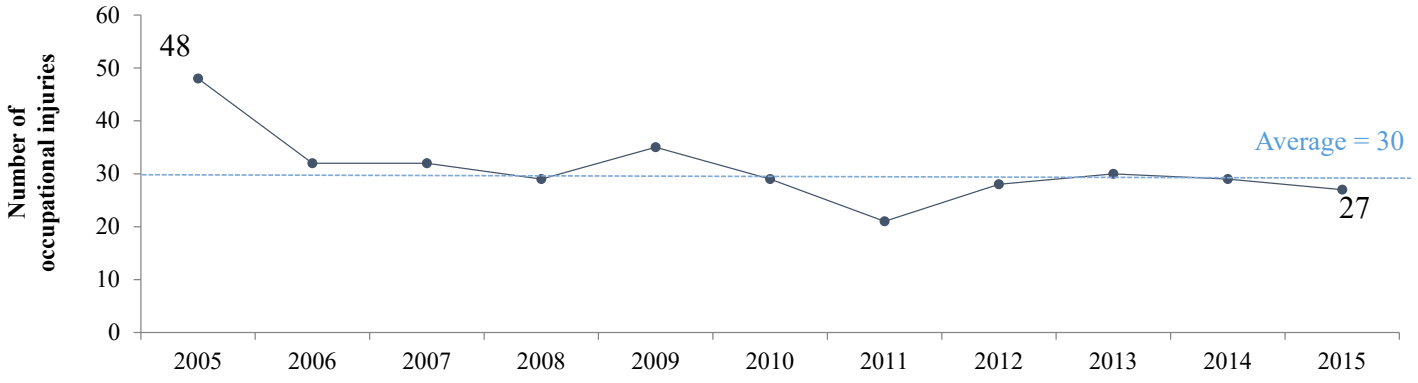
- Human costs: The value of the change in the quality of life of the worker and their entourage (family, friends, and other community members), considering the duration of these changes and the potential years of life lost (death). These costs are calculated using an indicator, Disability-Adjusted Life Year (DALY), and the statistical value of a human life used by the ministère des Transports du Québec (MTQ)[10]. These human costs are assessed for all injuries resulting in permanent compensated injury and/or death.

[10] The statistical value of a human life used by the MTQ is $3,533,667 in 2015 dollars (Sambe et Dogoua, 2017).

4.3 Results

The CNESST database has identified 335 injuries related to a fishing boat accident from 2005 to 2015, which represents an average of about 30 injuries per year. The number of injuries accepted at CNESST has decreased over the period under study, from 48 in 2005 to 27 in 2015 (chart 4). There were six injuries resulting in one death over the same period. Four of these six deaths were caused by drowning following falls overboard.

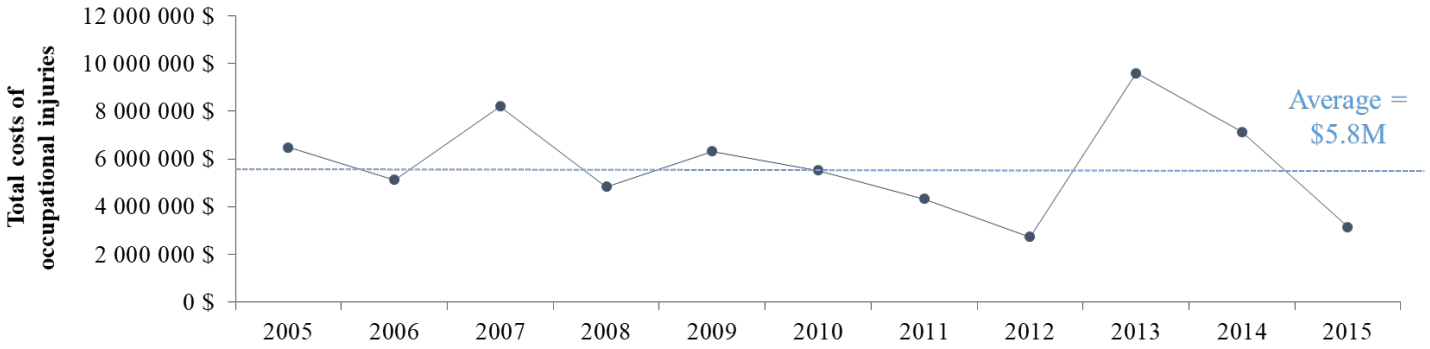
Graphic 4: Number of Occupational Injuries Resulting From a Fishing Vessel Accident in Québec (2005-2015)



The cost of these 335 injuries is estimated at $63.5 million ($M) in 2017 constant dollars. This represents an average of $5.8 million per year and approximately $189,400 per injury[11].

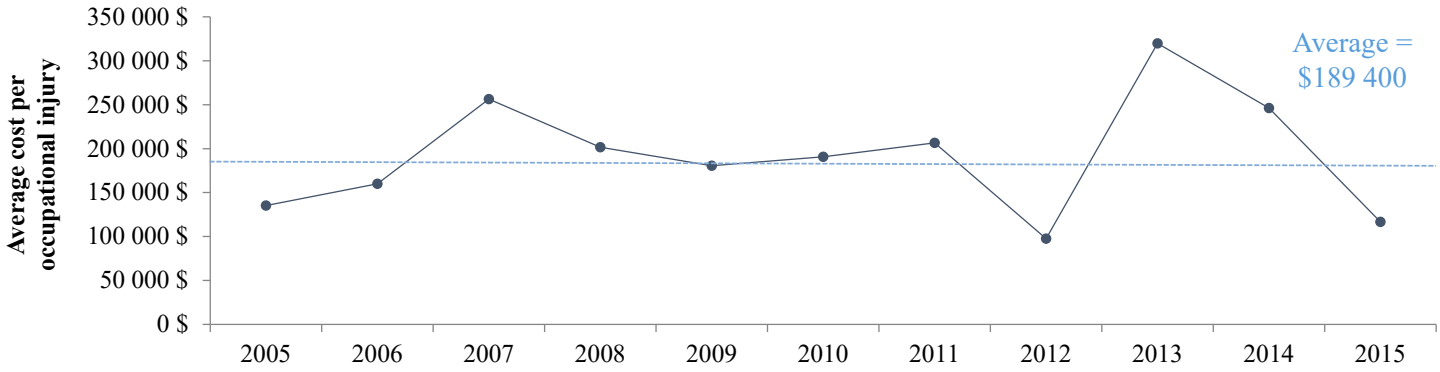
The evolution of total costs per year and average cost per injury shows significant volatility (Figures 5 and 6). This volatility is explained, in part, by the low number of accidents per year as well as the high costs of fatalities.

Graphic 5: Evolution of the Total Costs of Occupational Injuries Related to Fishing Vessel Accidents, Québec (2005–2015, in 2017 dollars)



[11] For example, the average cost of a work injury in Québec, over the same period and using the same methodology, is approximately $52,000, all industries combined.

Graphic 6: Change in the Average Cost per Occupational Injury Related to Fishing Vessel Accidents, Québec (2005–2015, in 2017 dollars)



Fatalities accounted for 31% of the total estimated costs of $19.5 million. Each fatality costs Québec society an average of $3.2 million.

Human costs account for 67% of the total costs of fishing accidents. They are followed in order by salary costs and lost productivity (29%), medical and rehabilitation costs (3%) and administrative costs (1%) (Figure 4).

Figure 4: Distribution of Costs of Occupational Injuries Related to Fishing Vessel Accidents, Québec (2015-2015)

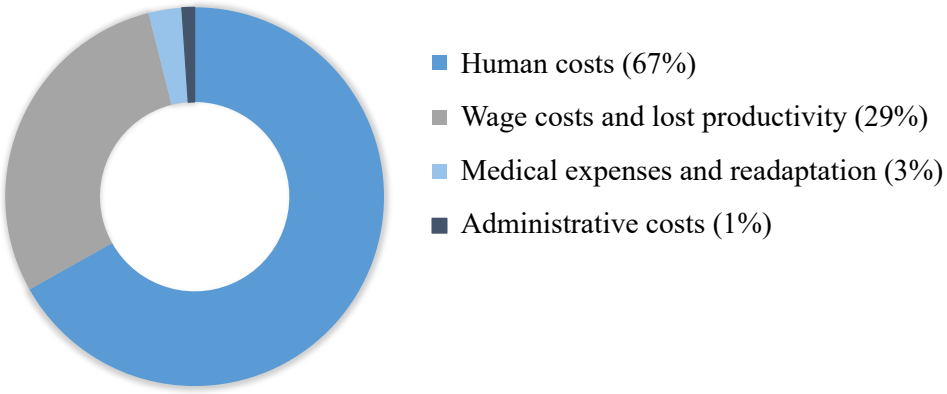


Table 9 shows that accidents involving fishermen 45 years of age and older account for 68% of the total costs of fishing vessel accidents, or approximately $43.3 million. In fact, five of the six fatalities that occurred between 2005 and 2015 involved fishermen 45 years of age and older. Table 9 also suggests that the average cost of an occupational injury increases with age (excluding the fatality of a fisherman between 15 and 19 years of age). This is also seen when the six deaths are excluded from the analysis.

Table 9: Costs of Occupational Injuries Related to Fishing Vessel Accidents by Age, Québec (2005–2015, in $2017)

Age Group	No. of injuries	No. of deaths	Average cost per injury	Total costs
15-19	9	1	$577,200	$5,194,700
20-24	17	0	$72,300	$1,228,700
25-44	148	0	$92,700	$13,725,200
45-54	93	2	$228,500	$21,250,500
55 and +	68	3	$324,300	$22,051,200
Total	**335**	**6**	**$189,400**	**$63,450,300**

Table 10 shows that the type of accident that resulted in the highest costs over the study period was being stuck or crushed ($10.8 million). The main causal agents in this type of accident are drums, pulleys, sheaves, cables, winches, ropes, and hoisting accessories. The next largest category is transportation accidents ($10.7 million), which includes collisions, explosions, shipwrecks, falls overboard and other falls related to vessel movement. In third place is excessive effort in lifting (mainly lobster traps) ($7.8 million). Lower-level falls ($6.7 million) and same level falls ($6.1 million) follow in fourth and fifth place.

Table 10: Costs of Occupational Injuries Related to Fishing Vessel Accidents According to the Ten Most Costly Types of Accidents, Québec (2005–2015, in $2017)

Type of accident	No. of injuries	Average cost per injury	Total costs	Rank
Stuck or crushed	44	$246,500	$10,845,500	1
Transportation occurrence	21	$509,500	$10,699,000	2
Excessive effort when lifting	31	$251,900	$7,808,400	3
Lower level fall and jump	24	$280,600	$6,733,400	4
Same level fall, slip, trip	42	$146,200	$6,139,300	5
Struck by	42	$112,200	$4,710,800	6
Other excessive effort	19	$172,700	$3,281,300	7
Repetitive movement	14	$134,700	$1,885,300	8
Noise exposure	9	$81,200	$731,100	9
Other reaction of the body	9	$63,400	$571,000	10
All other types of accidents	80	$125,600	$10,045,200	-
Total	**335**	**$189,400**	**$63,450,300**	-

The five most costly types of injuries were, in order, drowning ($11.8 million), open wounds (e.g., cuts) ($10.0 million), sprains and strains (mostly back, knee and ankle) ($9.7 million), fractures (mostly hand) ($8.7 million), and musculoskeletal disorders (mostly shoulder) ($6.4 million) (Table 11).

Table 11: Costs of Occupational Injuries Related to Fishing Vessel Accidents According to the Ten Most Costly Types of Injuries, Québec (2005–2015)

Nature of the injury	No. of injuries	Average cost per injury	Total costs	Rank
Drowning	4	$2 941 300	$11,765,200	1
Open wound	21	$476,600	$10,007,800	2
Sprain-strain	90	$107,600	$9,683,600	3
Fracture	65	$134,100	$8,716,100	4
Musculoskeletal problem (except in the back)	40	$159,300	$6,371,500	5
Other disease	11	$375,200	$4,127,100	6
Mental disorder	7	$410,700	$2,875,200	7
Back problems	11	$161,500	$1,776,800	8
Bruise-contusion	39	$44,400	$1,729,700	9
Multiple injuries	7	$138,400	$968,600	10
All other types of injury	40	$135,700	$5,428,800	-
Total	**335**	**$189,404**	**$63,450,300**	-

The five sites of injury with the highest total costs are the hand (e.g., fractures and cuts) ($12.2M), body system (e.g., drowning, nervous shock) ($11M), shoulder (mainly due to repetitive movements) ($7.1M), the chest (e.g., bruises, contusions, fractures, heart attacks) ($7.1 million), and the back (mostly related to over-exertion in lifting and falls) ($6.2 million) (Table 12).

Table 12: Costs of Occupational Injuries Related to Fishing Vessel Accidents According to the Ten Most Costly Injury Sites, Québec (2005–2015)

Site of injury	No. of injuries	Average cost per injury	Total costs	Rank
Hand	56	$218,300	$12,227,500	1
Body system	9	$1,226,000	$11,033,600	2
Shoulder	25	$286,000	$7,149,800	3
Thorax	15	$475,500	$7,132,200	4
Back	69	$89,600	$6,181,900	5
Multiple sites	18	$244,800	$4,406,300	6
Cervical vertebra	5	$583,400	$2,917,100	7
Ear	11	$263,100	$2,894,000	8
Knee	25	$89,300	$2,232,500	9
Foot	13	$107,400	$1,395,600	10
All other injury sites	89	$66,100	$5,879,800	-
Total	**335**	**$189,400**	**$63,450,300**	

Table 13 shows that shrimp fishery ($16.4 million) and lobster fishery ($14.3 million) are the two sectors (according to the target species) that generated the highest total costs between 2005 and 2015. They are also at the top of the list for the number of occupational injuries accepted over the period, with 63 and 69 injuries, respectively. These two sectors account for 40% of injuries and 48% of costs. Snow crab fishing ($8.5 million) ranks third

in terms of total costs, followed by fishing vessels in transit (who were not fishing at the time of the accident) ($2.9 million) and Greenland halibut fishing ($1.4 million)[12].

Table 13: Costs of Occupational Injuries Related to Fishing Vessel Accidents According to the Ten Most Costly Target Species, Québec (2005–2015)

Target species	No. of injuries	Average cost per injury	Total costs	Rank
Shrimp	63	$261,100	$16,449, 400	1
Lobster	69	$206,500	$14,250,100	2
Snow crab	54	$157,100	$8,485,900	3
In transit	14	$208,500	$2,919,000	4
Greenland halibut	15	$94,400	$1,416,500	5
Mackerel	5	$187,200	$936,000	6
Herring	2	$326,200	$652,500	7
Cod	6	$79,500	$477,200	8
Scallop	7	$63,100	$441,600	9
Rock crab	4	$67,600	$270,500	10
All other target species	96	$178,700	$17,151,600	-
Total	**335**	**$189,400**	**$63,450,300**	-

The five fleets for which occupational injuries generated the most costs over the period under study are shrimpers ($16.5 M), multifisheries ($11.9 M), Magdalen Islands lobster boats ($10.2 M), Area 12 crabbers ($4.9 M) and Baie-des-Chaleurs lobster boats ($2.8 M) (Table 14).

Table 14: Costs of Occupational Injuries Related to Fishing Vessel Accidents According to the Ten Fleets with the Highest Costs, Québec (2005–2015)

Fleet	No. of injuries	%	Average cost per injury	Total costs	%	Rank
Shrimper	66	19.7	$250,200	$16,511,700	26.0	1
Multifisheries	54	16.1	$221 635	$11,968,300	18.9	2
Lobster boat - Magdalen Islands	36	10.7	$283,500	$10,206,900	16.1	3
Crabber - Area 12	24	7.2	$205,600	$4,934,200	7.8	4
Lobster boat - Baie-des-Chaleurs	6	1.8	$459,000	$2,754,200	4.3	5
Groundfish	9	2.7	$192,500	$ 1,732,700	2.7	6
Lobster boat - South of Gaspésie	27	8.1	$55, 500	$1,498,600	2.4	7
Crabber - Area 16	19	5.7	$68,200	$1,296,100	2.0	8
Crabber - Area 17	4	1.2	$116, 800	$467, 400	0.7	9
All other fleets	90	26.7	$134,200	$12,080,300	19.2	-
Total	**335**	**100.0**	**$189,400**	**$63,450,300**	**100.0**	-

[12] Note that further analysis showed that there were no significant differences in the type of accident by target species (or fleet), in part due to the small numbers of cases. For instance, a comparison of the accidents listed for the three species at the top of the list in Table 5 (shrimp, lobster, snow crab) shows that for all three categories, the accidents were mainly falls, excessive effort and being trapped or crushed. However, a slightly higher number of same-level falls, slips and stumbles are detected among shrimpers and a slightly higher number of over-exertion while lifting among lobster fishermen.

The data concerning the number of fishing vessels by fleets, presented in Table 15, helps qualify the cost analyses by fleet found in the previous table. In particular, shrimpers, who represent only 3.8% of all fishing vessels in Québec, account for 19.7% of all occupational injuries and 26.0% of total estimated cost[13]. Conversely, lobster boats in the Magdalen Islands, which account for 26.5% of fishing vessels, generate 10.7% of injuries and 16.1% of costs. However, it should be noted that the number of fishermen per boat as well as the hours worked can vary considerably from one fleet to another and from one vessel to another. Caution should therefore be exercised in interpreting these results.

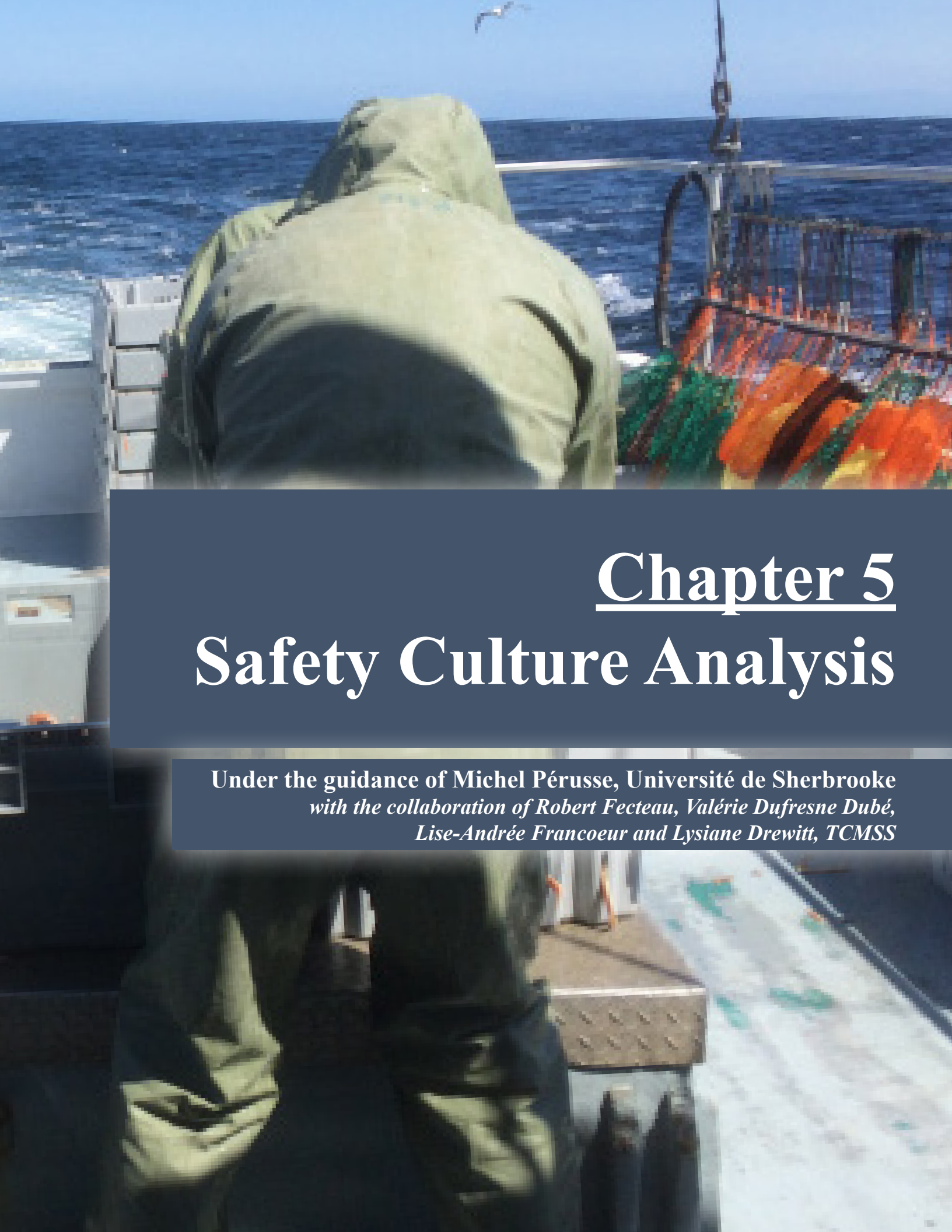
Table 15: Number of Fishing Vessels by Fleet, Québec, 2015

Fleet	No. of vessels	%
Lobster boat - Magdalen Islands	324	26.5
Multifisheries	322	26.3
Groundfish	88	7.2
Lobster boat - South of Gaspésie	81	6.6
Lobster boat - Baie-des-Chaleurs	76	6.2
Crabber - Area 12	65	5.3
Crabber - Lower North Shore	57	4.7
Lobster boat - Lower North Shore	48	3.9
Shrimper	47	3.8
Crabber - Area 16	39	3.2
Scallop vessel and other molluscs/bivalves	29	2.4
Crabber - Area 17	22	1.8
Lobster boat - Anticosti	14	1.1
Lobster boat - Mid North Shore	6	0.5
Lobster boat - North of Gaspésie	4	0.3
Total	**1 222**	**100.0**

The analysis of the costs and characteristics of occupational injuries sustained during the practice of commercial maritime fishing reveals crucial information in order to intervene in a precise and enlightened manner on the problems experienced by Québec fishermen. First of all, it should be noted that the injuries that afflict fishermen aged 45 and over are the costliest. Five of the six fatalities recorded over the period under study affected fishermen in this age group. It was also shown that occupational injuries in the harvesting sector appear to be more serious than in other industries, since they result in an average cost per injury that is more than three times higher than that of all injuries in Québec, all industries combined.

The costliest injuries in this sector are mainly related to falls on the boat and overboard, overexertion, and the fact that some workers are crushed or trapped by certain equipment. The consequences include drowning, open wounds, sprains, strains, and fractures. The costs related to these injuries, which are expressed in both human and wage costs, but also in lost productivity, represent major financial losses for maritime communities and especially for fishermen and their families. A decrease in the number of injuries related to an accident involving a fishing vessel would therefore have a decisive influence on increasing the profitability and productivity of Québec fishing businesses and on the economic prosperity of the many coastal communities that depend on this industry.

[13] It should be noted that the data concerning the number of fishing vessels per fleet represent the situation in 2015 and not for the entire period under study. However, for the purposes of this analysis, it is assumed that they are representative of the situation from 2005 to 2015 since the number of vessels per fleet does not vary much over time.



Chapter 5
Safety Culture Analysis

Under the guidance of Michel Pérusse, Université de Sherbrooke
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5.1 Theoretical Framework

The commercial fishing industry is one of the most dangerous industries not only in Canada (TSB, 2012), but also worldwide (Food and Agriculture Organization, 2018). A study conducted jointly by Statistics Canada and The Globe and Mail in 2017 published its results in an article whose evocative title reflects this reality: "It can now be called the deadliest sector in Canada" (Grant, 2017). In fact, the Transportation Safety Board (TSB) biennial Watchlist, which contains key safety issues that need to be addressed to improve transportation safety, has since 2010 targeted commercial fisheries safety as the major deficiency in marine transportation. It states that "[the] fishing industry […] has a long history of proportionately high numbers of accidents and fatalities" (TSB, 2018: 1). In fact, the organization's *statistical summary of marine occurrences 2016* notes that accidents involving fishing vessels still account for more than 40% of all recorded marine accidents today (TSB, 2016).

In 2012, this independent organization published a major report entitled "Safety Issues Investigation into Fishing Safety in Canada", in which it stated that "despite the efforts of the Board and others in government and the private sector, many of the causes of fishing accidents today are the same as those identified by the TSB two decades ago". (TSB, 2012: 3) The TSB also states that '[t]he safety regulatory approach alone is not sufficient to promote and ensure the use of good work practices". (TSB, 2012: 97) As a result, the TSB concludes from this extensive survey that departments need "improved resources and mechanisms to identify, understand, analyze and communicate risks in order to **advance the safety culture** and facilitate the development of safe work practices that mitigate these risks". (TSB, 2012: 106)

In the same vein, Kurtz (2020) points out that patching the gaps in the regulatory framework is not enough to prevent disasters. He argues that any operation necessarily involves a rather long chain of stakeholders, and that it is the culture of these stakeholders that dictates their decisions, particularly in terms of safety.

This is why this project was set up, with the objective of **drawing up a report of the current situation to better understand accidents and incidents in the commercial fishing sector and to identify actions to be taken**. In the longer term, this will also make it possible to measure the effect of the actions that have been put in place. This situational profile will also help to define the notion of safety culture, to measure it at the present time in the industry and to follow its evolution.

This report therefore presents the various approaches that have led to:

1) A review of the literature on organizational culture, business culture and safety culture.
2) The proposal for a definition of safety culture in the commercial fishing industry.
3) The development of a conceptual framework and typology of the stages of maturity of culture in commercial marine fisheries.

4) The identification of artefacts allowing the observation of the components of the safety culture in the industry.
5) The development of a triangulation methodology to calculate the level of safety culture for each of the artefacts identified in the project..
6) The development of three measurement tools to assess safety culture: a questionnaire for masters, a questionnaire for crew members and a vessel observation form.
7) The creation of a database to collect information from 72 vessel visits and interviews with 101 captain-owners and 52 crew members.
8) The conduct of semi-structured interviews (discussion workshops) with groups of fishermen according to their fleet affiliation, two groups of officials and a group of industry stakeholders to understand their perception of certain beliefs and artefacts used in this research.
9) The analysis of the results made it possible to define the stage of maturity for each of the fleets according to their level of safety culture and thus obtain an overall portrait of Québec.

5.1.1 A Definition

The first step is therefore to clearly formulate an operational definition that will serve as a platform for subsequent steps. For this purpose, the fundamental concepts will be examined in four stages. Firstly, since a safety culture is often recognized as a declination of organizational culture, it is important to define the latter. This first component will already provide concepts that will prove useful in subsequent steps.

The concept of organizational culture applies much better in medium or large organizations. However, in the marine fishing industry, we are generally dealing with micro-business. Therefore, as a second step, the concept of occupational culture (also called professional culture) will be the subject of particular attention. Note that, in the particular context that interests us, the concept of occupational culture adheres more closely to reality.

Thirdly, there are nevertheless similar dimensions between the first two concepts, dimensions whose specific connotations of a safety culture will be examined. Finally, the application of the definition of a safety culture to the marine fishing industry will be discussed.

a) Organizational Culture

1. Definitions

There are many definitions of organizational culture. To avoid getting lost in unnecessary terminological or ideological debates, this section will focus on some of the best known and most common definitions. Edgar Schein is probably one of the best-known authors in this field. According to him, organizational culture is characterized by “a pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration that has worked

well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems". (Schein, 2010)

The definition proposed by Uttal (1983) has been taken up by several other authors, including Goh (2018), Transport Canada (in its Guide to Establishing and Improving Railway Safety Management Systems, 2010), and research conducted by the University of Alberta (Lefsrud *et al*., 2017).

This definition specifies that organizational culture includes "the shared values (i.e., what really matters) and beliefs (i.e., how things should be done) that are coupled with the structures and controls within the organization, which form the basis for standards of behaviour (i.e., how things are done)".

2. Functions and Utility

In short, organizational culture is the DNA, the "personality" of the organization. This frame of reference includes a set of beliefs, values, attitudes, norms, behaviours, and artefacts shared by members of the same organization. It conditions the way the organization perceives itself (O'Toole, 2002), behaves and adapts to its financial, social, and human environment (*external adaptation*).

Culture represents a collective learning process that fosters the emergence and application of best practices. Then, since these best practices are recognized as winning approaches, they are taught to new members of the organization, both leaders and employees. It is the culture that will ensure the sustainability of these best practices as well as the results derived from them (Pérusse, 2017).

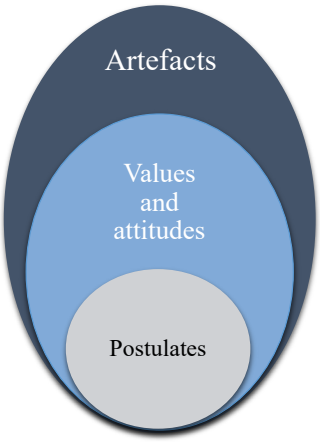
Finally, this framework defines the values that underlie living together and that are taught, explicitly or tacitly, to members of the organization, especially newcomers (*internal integration*). The internal integration function also includes the transmission of knowledge.

3. Structure

Every organization has an organizational culture, whether it is aware of it or not. A significant portion of the culture—i.e., postulates, beliefs, and values—is tacit and unconscious. In contrast, behavioural norms, behaviours, and artefacts are more often at the conscious level, but all of these aspects are still influenced by basic beliefs.

This is illustrated in Figure 5, proposed by Guldenmund (2000), and inspired by Schein's (1986) model, which illustrates the three levels of content of an organizational culture.

Figure 5: Multi-Level Model of Culture



(Source: adapted from Guldenmund, 2000)

The heart, the core of the model, includes premises, basic beliefs about all sorts of things: human nature, fate (e.g., the inevitability of accidents), truth (e.g., the importance of basing decisions on facts), time, space, and so on. These beliefs are largely at the pre-conscious level, but they are presumed to be true and proven. Although they are usually implicit, members of the organization can infer them by observing their influences on organizational decisions and behaviours.

Artefacts are the bulk of the third and final level of a culture. We first think of all the physical objects (tools, equipment, vessels, and furniture, etc.) that characterize the organization. The category of artefacts also includes visible manifestations of culture: this includes behavioural norms, rules and procedures, visible behaviours, dress code, specific jargon, and any other tangible form of culture found in a significant number of members of the home group. Artefacts are the easiest signs to observe when trying to understand an organization's culture. This point will be covered in more detail in the section on measuring culture.

4. Intensity

Some cultures are strong, others are rather embryonic. What distinguishes them from each other? In fact, two factors characterize a strong culture. First, the larger the body of beliefs, values, norms, and artefacts that are shared by members of the organization, the stronger the culture is and permeates the organization. Second, the more members of the organization that share these common values and norms, the stronger the culture.

Both of these considerations are important when seeking to characterize the safety culture in the marine fishing industry. First, it is necessary to ascertain whether there is an identifiable and shared body of beliefs, values, etc. Next, it is important to verify which portion of the study population actually shares these culture elements.

This section on organizational culture has raised some important concepts that will be useful in the next sections. However, the overall concept of organizational culture seems to apply only to organizations of a certain size, i.e., legal entities, formal, structured entities with well-defined geographic or administrative boundaries and governed by collective operating rules shared by the members. The reality of the marine fishing industry hardly corresponds to such a definition of an organization.

A declination of the organizational culture, i.e., occupational culture, seems more appropriate to the nature of the sector under study; it too has components that could also prove useful for the purposes of this project. This will be discussed in the next section.

b) Occupational Culture

Also referred to as professional culture, occupational culture would include a set of "values, norms, procedures, practices, tools, knowledge, skills, etc.". To begin with, one can therefore characterize "occupational culture" as a "hat" concept to designate everything that makes up the basis of a professional activity (Viegas Pires, 2008). Thévenet (2010) considers occupational culture as one of the subcultures of organizational culture.

Here again, we find the components of a culture in the form of values and norms. The same applies to procedures, practices, and tools, which are considered artefacts in the broader definitions of organizational culture. There is also an important segment of the definition that helps the focus of this report. The notion of "specificity of a professional activity" directs the questioning towards the identification of the components of culture specific to an occupation (the occupation of the fisherman, in the case that interests us) that distinguish it from other occupations. It should then be relatively easy to identify specific aspects (e.g., artefacts, tools, equipment, lifestyle, specific jargon and language, certain basic beliefs, etc.) that are specific to the field. This point will be taken up later.

One of the functions of any culture is the transmission of knowledge. This is part of what Schein (2010) calls *internal integration*. The above definition allows us to broaden the definition of knowledge to include know-how; the latter is particularly important when it comes to occupational culture. The modes of transmission of knowledge and know-how (formal education, companionship, etc.) then become important to identify.

However, occupational culture covers all sorts of aspects of the profession. Some of these aspects have an impact on occupational health and safety, others do not. In order to distinguish between them, it is important to examine what constitutes a safety culture. This will be discussed in the next section.

c) Safety Culture

From the outset, clarification is needed. Several authors (Goh, 2018; Parker *et al*., 2006; Clarke, 1999; Pérusse, 2017) consider safety culture as a specific declination, a particular manifestation of organizational culture. Since every organization has an organizational culture (as explained earlier), this means that every organization also has a safety culture. Raluca (2003) mentions that the concept of safety culture has been initially formulated by the International Atomic Energy Agency (IAEA) in the aftermath of the Chernobyl disaster. Antonsen (2009) mentions that the concept has been the subject of much debate since its original formulation, but Grebensek and Kosel (2015) argue that it has become much clearer over the last decade. What is it exactly?

1. Definitions

As with organizational culture, there are several definitions of safety culture. It would be impossible, if not unnecessary, to go through them all. The first two definitions have therefore been chosen on the basis that they summarize most of the other existing definitions, and that they stem, among other things, from specific reviews of literature on the subject.

The first is as follows: "Applying the definition of organizational culture[14] to safety, safety culture can be defined as a system of shared values and beliefs that interact with a company's people, organizational structures, and control systems to produce safety-related behavioural norms" (Goh, 2018: 135).

Daniellou *et al.* (2010 : 99), for their part, propose the following definition:

> The term *Safety culture* is used to refer to that component of the corporate culture that addresses safety issues in workplaces with significant risks.
>
> More precisely, *we can define safety culture as being the set of practices developed and repeated by the main actors concerned, to control the risks of their profession*.

It should be noted that Goh's definition (2018) refers to values and beliefs, on the one hand, and practices (control systems, behavioural norms) on the other hand, while that of Daniellou *et al.* (2010) mainly focuses on practices. As mentioned earlier, practices and behaviours, which fall under the cultural category of artefacts, are the most easily observed manifestations of a culture.

A third definition is chosen for the following reasons: it is applied to an industry rather than to a specific company or organization and is formulated by the Transportation Safety Board of Canada (TSB) in its report on the Lac-Mégantic disaster. After using the definition of Uttal (1983) cited above, the TSB adds the following definition: "The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (TSB, 2014: 79).

Drawing on Reason (1997) and Transport Canada's guide on safety management systems (Transport Canada, 2001), the TSB adds:

> An effective safety culture includes proactive measures to identify and manage operational risks. It is characterized by an information culture in which people understand the hazards and risks in their operations and continually work to identify and eliminate safety threats. It is a fair culture where staff know and agree on what is acceptable and what is not. It is a culture of reporting safety concerns, where they are documented and analyzed, and corrective action is taken. It is also a learning culture, where safety is improved based on lessons learned (TSB, 2014).

[14] The definition of organizational culture to which the author refers is that of Uttal (1983) previously cited.

The elements of definition provided by the TSB highlight two things:

- First, the fact that the practices and standards of behaviour to be discussed are related to hazard identification, risk assessment, hazard elimination and risk control; this point was already reflected in the definition of Daniellou *et al*. (2010);

- Then, and this point is very important, the practices and behaviours in question are not only those of individuals, but also those of the organization as such (collective behaviours).

2. Culture and Safety Climate

Before going any further, a clarification is necessary. We find in the literature two notions that are so similar that they are sometimes confused or used as synonyms by certain authors.

The concept of safety climate is sometimes considered equivalent to the concept of safety culture. However, the two concepts are distinct, although interrelated (Mearns and Flin, 1999).

While health and safety culture refers broadly to social norms, values, and structures (Parker *et al*., 2006; Cooper, 2000), safety climate refers specifically to people's descriptions of their everyday experiences (Cooper, 2000); it is in fact employees' perception of their organization's efforts in occupational health and safety (Zohar and Luria, 2005; Johnson, 2007).

A good occupational health and safety climate would therefore be characterized by a commitment to collective care and concern for self and others, based on similar positive perceptions and attitudes about occupational health and safety (Cooper, 1997).

In short, a good safety climate would be an outcome, a consequence, a feeling of satisfaction resulting from a safety culture, just as good results in the prevention of occupational injuries would be.

However, measuring climate is sometimes useful as one way to measure safety culture. Besides, some authors, like Sugden *et al.* (2009) make climate measurement a component of culture measurement; this will be discussed later in the section on measurement.

3. Safety Culture Dimensions

In order to formulate a definition that is both relevant and precise, it is useful to "map" important dimensions that need to be considered both in the formulation of the definition and in the development of instruments to measure the culture thus defined.

The previous sections have provided several indications of what constitutes a safety culture. In addition to these elements, it is necessary to consult with authors who provide a list of what they consider to be dimensions of a safety culture. The literature on the subject is also quite extensive. In order to avoid overburdening the text, to illustrate the point, only the dimensions listed in two representative searches are presented below, but several other authors will be cited in the resulting summary table (Table 16 on page 67).

Thus, Lefsrud *et al.* (2017) propose the following elements: "major incident risk, communication and use of the procedure, operations, two-way communication, workforce involvement, learning culture, relationship with contractors, safety management systems, manager/team leader respect, tolerance to risk, management commitment to safety, production/cost vs safety".

As for Sugden et al. (2009), they propose the following dimensions: "organizational commitment to safety, health and safety oriented behaviour, health and safety trust, usability of procedures, engagement in health and safety, peer group attitude to health and safety, resources for health and safety, accident and near-miss reporting".

In order to organize all these elements into a coherent whole, one can use the multi-level model of a culture as shown in Figure 5 (page 61). First, at the very heart of the notion of culture are the postulates. This is what the authors (Uttal, 1983; Goh, 2018) call beliefs (this is the term that will be used for the rest of the report). We think of beliefs as fatality or the inevitability of accidents, for example. This aspect of safety culture is poorly documented.

In Figure 5 (page 61), the second stratum of what constitutes a culture consists of values and attitudes. These include values such as the importance of the lives and safety of others and the importance of safety over production, for instance.

It should be noted that values, like beliefs, are complex to collect. Most often, the instruments used to do this are questionnaires. Despite all the biases generally inherent in this type of perceptual measurement, the fact remains that the measurement of a safety culture necessarily involves the measurement of perceptions (TSB, 2014; Fleming, 2017).

As with beliefs, no definitive list of values and attitudes could be identified. However, in the previous examples, the learning culture, respect, risk tolerance, commitment to occupational health and safety (OHS), the importance of safety over the cost or production, and group trust and attitude towards OHS are particularly evident.

Finally, what is generally easiest to identify is what Fleming (2017) calls "[…] capturing the markers left by [the] safety culture on daily operations". In Figure 5 (page 61), this layer of culture is called artefacts. Unsurprisingly, this is the level of safety culture where the greatest number of possible sub-dimensions and examples can be found (probably because these manifestations are directly observable), and where the need for structure is therefore the greatest.

To provide structure to all of the elements mentioned below, the artefacts referred to by the authors cited so far can be grouped into three categories.

A first category, called "organizational behaviour", includes artefacts that relate to the organization as a whole: structures, systems, modes of operation and collective behaviour.

Two other categories of artefacts relate to individual behaviours. Individual behaviours, in turn, can be further divided into two categories:

- Prevention behaviours, i.e., all practices used to identify hazards, assess risks, develop measures to eliminate hazards or control associated risks (referred to below as behavioural—risk management);

- Behaviours related to the safe performance of work, such as appropriate work methods, communication, and mutual aid within the team, and so on (referred to as behavioural—safe work practices from now on).

Table 16 on the next page illustrates this typology based on the elements provided by the authors cited so far.

Several comments are necessary regarding this table.

First, the list of dimensions in each artefact category is not exhaustive. Second, some of these dimensions are formulated more generically than specifically.

For these two reasons, it was important when designing the measurement tools to break down these dimensions into more specific, operational, and observable or measurable elements.

Table 16: Safety Culture Artefacts

Artefact Category	Components/dimensions	Sources
Organizational behaviour	Organizational structures, control systems, OSH management system, allocated resources	Goh, 2018; Lefsrud *et al.* , 2017; Sugden *et al.* , 2009
	Collective behavioural patterns, style and competence of the organization in OHS matters	BST, 2014; Raluca, 2003
	Information, training and learning culture	BST, 2014 ; Lefsrud *et al.* , 2017 ; Raluca, 2003
	Culture of reporting accidents and incidents	BST, 2014 ; Sugden *et al.* , 2009
	Attention to safety issues	Raluca, 2003
Behavioural - safe work practices	Safety behaviour standards, individual behaviour patterns	Daniellou *et al.* , 2010 ; Goh, 2018 ; BST, 2014 ; Sugden *et al.* , 2009 ; Raluca, 2003
	General communication, safety communications	Lefsrud *et al.* , 2017
	Conventions about behaviour, interactions and communication, norms of acceptability	BST, 2014 ; Antonsen, 2009
	Procedures and operations (utility, safety)	Lefsrud *et al.* , 2017 ; Sugden *et al.* , 2009 ; Raluca, 2003
Behavioural - risk management	The entire preventive approach, i.e., practices and activities to identify hazards, assess risks, eliminate hazards or control risks.	Daniellou *et al.* , 2010; BST, 2014; Kid and Wybo, 2007
	Understanding hazards and risks	BST, 2014
	Involvement of workers in prevention	BST, 2014 ; Lefsrud *et al.* , 2017
	Statement of concerns, reporting and analysis, corrective steps	BST, 2014

It should also be noted that the fishing industry is essentially a micro-business sector. This means that the organizational structures are reduced to their simplest form; the same applies to the OHS system. However, it can be considered that in these small structures, organizational behaviour is more or less reduced to the behaviour of the master, which has been documented as individual behaviour.

Collective behaviour can also be considered to be that of both the master and the crew members, in which case the individual behaviours of both parties are first compared separately and then aggregated to obtain a consolidated picture of the crew/vessel. In summary, the category “Organizational Behaviour” was not used as such, but all relevant and usable elements are found in either of the other two categories.

In addition, as noted above, the safety culture in the fishing industry is most likely influenced by the occupational culture of the industry. For this reason, it is important to add a category of industry-specific artefacts that are likely to interact with the level of safety.

In fact, an IRSST report clearly demonstrates the extent to which the equipment itself and the way it is installed or used can constitute a safety risk, and how modifications at this level can contribute to reducing accidents (Montreuil *et al.*, 2014). This is why a category of artefacts, called “Technical Artefact”, relating to equipment, its installation and maintenance, is therefore added.

Finally, one last category of artefacts has been added. The safety culture maturity models presented in the next section make compliance with laws, regulations, and standards a fundamental foundation, a minimum requirement of the culture. The TSB (2012) expressed concerns in this regard. This last category is called “Normative artefact”.

To sum up, Table 17 is structured according to the three strata of the multilevel culture model and integrates the elements and dimensions presented in this section. This model will be used both to develop our definition of safety culture in the fishing industry and for the development of the tools used to measure and characterize it.

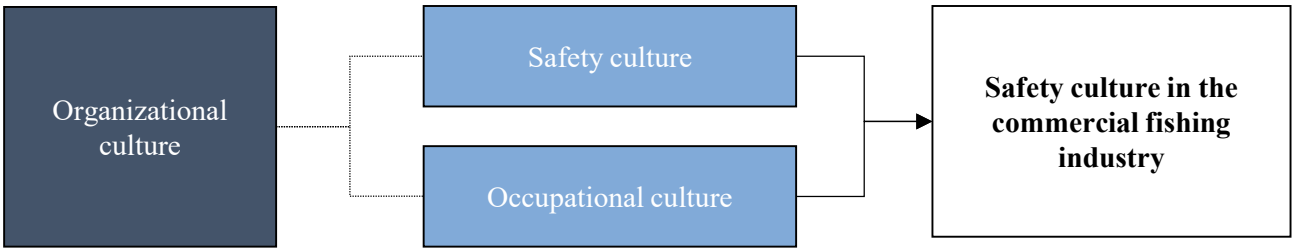
Table 17: Examples of Manifestations of the Dimensions of Safety Culture in the Commercial Marine Fishing Industry

Dimension of culture	Perceptible indications
Postulates, premises, beliefs	“Accidents form part of the fishing profession” “We all die of something at some point” “We are at the mercy of Mother Nature's rigors” “Accidents are inevitable” "Where there is a will, there is a way; you just have to work hard” “Human life is more precious than anything” Safety as a priority for the crew; predominance of safety over production or costs Concern for the health, safety or well-being of others The fishing master's involvement in security Confidence in the effectiveness of preventive measures The atmosphere within the team: civility, cooperation, team spirit, respect Etc.
Normative artefact	Vessel and crew compliance with applicable laws, regulations and standards (e.g. emergency equipment, training, facility security, etc.).
Technical artefact	Specialized language and vocabulary Operation codes The type of vessel On-board equipment, its use and maintenance Port equipment, their use and maintenance Etc.
Behavioural artefact - safe work practices	Security codes Knowledge transfer methods Standards of behaviour Safe behaviours: · Working methods; · Wearing PPE; · etc. Etc.
Behavioural artefact - risk management	Implementing the activities of the prevention approach: inspections, training, accident investigation, etc.

d) The Commercial Marine Fishing Industry

In order to effectively define what safety culture is in the marine fishing industry, it is necessary to apply the general concepts previously seen to the specific reality of the sector under study. Figure 6 below schematically illustrates the process. Although it is very broad and not necessarily the most appropriate for the purpose of this project, the notion of organizational culture was nevertheless used to identify some important milestones for the future. Two specific declinations of organizational culture, namely safety culture, of course, but also occupational culture, have made it possible to target increasingly precise components. The definition of safety culture in the marine fishing industry was therefore inspired more specifically by these two subcultures.

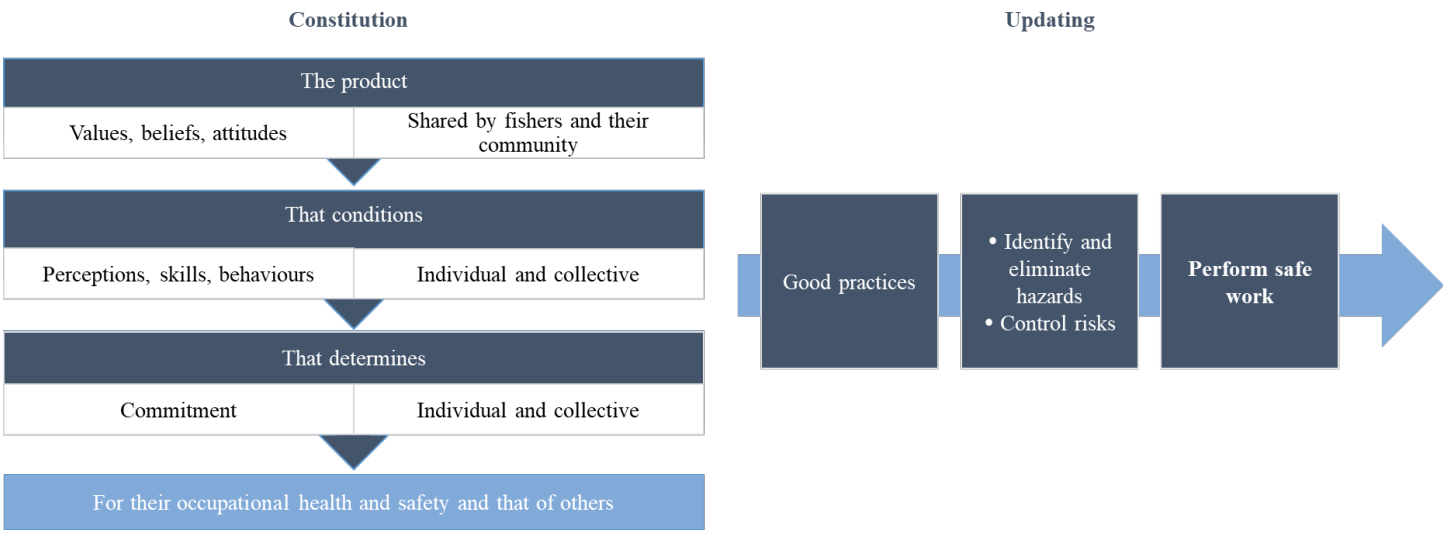
Figure 6: Foundations of Safety Culture



Based on the various definitions reviewed and incorporating the important aspects identified in the three culture types and the broad dimensions presented in the previous sections, the definition we propose is as follows:

> "The safety culture in the marine fishing industry is the product of the values, beliefs and attitudes shared by seafarers and their communities, which condition their individual and collective perceptions, skills and patterns of behaviour, and which determine their commitment, individual or collective, to their own health and safety and that of their colleagues; it is characterized by a set of good practices aimed at properly identifying and eliminating or controlling the hazards of the job, and at performing work in a safe manner, both at sea and on land."

Figure 7: Definition of Safety Culture



5.1.2 Evolution and Maturity of a Safety Culture

A number of studies have been carried out on safety in the marine world; however, these have focused on marine terminal operations (Lu and Yang, 2010), offshore oil exploration and exploitation (Antonsen, 2009; Cox and Cheyne, 2000; Mearns *et al.*, 1998, 2001), oil tankers (Håvold, 2010; Kurtz, 2020), and merchant shipping (Håvold, 2005; Håvold and Nesset, 2009; Kim and Gausdal, 2020; Knapp and Heij, 2020), but none of these have focused specifically on fisheries safety culture. Some of these works can provide interesting insights; however, none of them are fully applicable to the field we are interested in.

In order to make recommendations for the evolution of a safety culture, it is important to understand how it develops and evolves. Hence, it is the purpose of this section.

A culture, of any kind, is never completely static. It evolves over time, in response to social, cultural, economic, human, and other changes. When culture develops in a community, it is an emerging phenomenon; the rules of living together become clearer, beliefs are shared, ways of doing things that are permitted become more refined, more formal, even coded.

Nevertheless, in a hierarchical structure, such as in a factory or on a fishing vessel, the management plays a crucial part in the development and evolution of a culture, particularly a safety culture. Guldenmund (2015) clearly explains this process as follows: when events occur, regardless of what they are, the member of management (the master in this case) interprets them in a way that "makes sense". If this interpretation is plausible, let alone applicable to other events of a similar nature, this perception becomes part of the basis for subsequent decisions. Through interactions among group members, perceptions and interpretations are refined and mutually adjusted, to the point where they become group norms. The level of formalization of these norms is then one of the parameters for defining the level of maturity of the culture. This is how culture, as Schein (2010) points out, becomes a tool to help the organization adapt to its external environment and integrate its new members.

Evidently, in the case of a fishing vessel, the master has a crucial role to play in the development and evolution of the safety culture on board. Thus, the safety standards that constitute an important part of the culture and that are applied on board are often those of the master himself. The integration of new recruits is based on these standards, which is how the safety culture is maintained for this vessel. The master's leading role in the safety culture is the reason why many of our recommendations are addressed to them or concern them.

a) The Desired Ideal

What characterizes the safety culture of companies and organizations that are models in the field? According to the authors consulted, there are several distinctive features of a so-called ideal safety culture.

According to Reason (2000), there are four aspects of a safety culture that enable it to become a world-class culture. First, the culture is one of disclosure and reporting. Members of the organization are encouraged to report accidents, incidents, unsafe conditions, and risk factors. The ultimate goal is informed decision-making based on facts and reliable information.

Second, the desired culture is one based on justice. It is based on a set of safety rules and a clear definition of roles, responsibilities, and accountability. Members of the organization are treated as equals. They are fairly rewarded for their involvement in health and safety. They are sanctioned impartially and fairly in the event of failure to fulfill their duties. It is this foundation of justice that creates a climate of trust within the team.

Third, if a safety culture reaches a peak, it is because it is flexible (or adaptable). Its flexibility allows culture to take context into account and adjust as circumstances require. It is also this flexibility that allows the organization to be in a "continuous improvement" mode, both in terms of safety and other aspects of its operations.

Finally, in order to reap the benefits of continuous improvement, the culture must be a learning one. It must be capable of integrating new developments and innovations in a given area, such as safety or the ergonomics of fishing equipment, for instance. It must enable team members to deeply analyze the events that occur, draw all the necessary conclusions, and integrate these conclusions into their current mode of operation.

Because of their importance, these four aspects of the desired culture have been questioned in our measurement tools, particularly for the measurement of the "behavioural—safety methods" and "behavioural—risk management" artefacts. The sustainable development management model presented in the next section adds three additional characteristics to the highest level of safety culture (Pérusse *et al.*, 2012). Thus, the so-called "generative" culture is characterized by the involvement of the company itself (as opposed to its members) in its community. The business also seeks to spread its safety culture among its suppliers and customers.

Finally, the business is open to serve as a model, and willingly participates in these benchmarking initiatives. These characteristics concern the company's relations with its external stakeholders. Because of the specific nature of the micro-business studied, it seemed highly unlikely that these characteristics would be found in our study; this is why these aspects were not included in our measurement tools; this point is covered in the next section.

b) Models and Stages of Culture Maturity

At a particular point in time, however, it is possible to measure and characterize a culture, particularly its stage of development, also known as its maturity stage. This is, moreover, one of the fundamental objectives of this research. Various terminologies have been proposed to characterize the stages of maturity of a culture. The main terminologies are presented below, in order to determine which ones were used for the purposes of our research.

1. Sustainable Development Management

Published in 2011, the BNQ (Bureau de normalisation du Québec, 2011) 21000 standards for sustainable development (SD) addresses 21 issues divided into four categories: cross-cutting issues, environmental issues, economic issues, and social issues. Cadieux and Dion (2012) published a management manual to accompany this standard, which provides extensive details on its content.

Thus, for each issue, the standard defines five levels of maturity of the company's culture. At the lowest level is the "Little or no concern" stage, which describes companies that believe the issue in question does not concern them, and therefore have virtually nothing to do in this regard. The next stage, called "Reactive", describes companies that only do something about the issue if there is an emergency, or as a result of an unfortunate event. At the "Accommodating" stage, we find companies that are beginning to realize the importance of the issue at hand, that are striving to comply with legal requirements and even a little more, and that are beginning to implement some sort of management system. At the "Proactive" stage, we move on to another category of company; these companies have decided to take the issue in question in hand, to get organized, to set up a real management system, and to stay alert to see developments in this area so that they can constantly adjust to them. Finally, at the highest stage of maturity, known as "Generator", we find the world-class companies on the subject, those that have mastered the issue down to the last detail, to the point where they serve as models, or even as drivers for other companies around them.

Occupational health and safety (OHS) is one of the social issues covered by the standard. The same stages of maturity described above also apply to the OHS issue (Pérusse *et al*., 2012). Although a self-assessment guide accompanies the grids for the various issues, including OHS, the model does not, as such, propose a specific approach to measure and assess the various maturity levels in depth, at least not with the degree of detail required by this research. Our conceptual framework is largely inspired by this model; however, we have had to develop more advanced measurement tools and adjust the model to consider the sector specificities listed above.

2. Other Maturity Models

Probably the best known and most widespread model of the maturity of an OHS culture is known as the Bradley Curve, named after Vernon Bradley, an industrial psychologist employed by DuPont de Nemours. However, despite its great popularity, this model will not be used in this research, for several reasons. First, there are several versions and interpretations of this curve.

Second, precisely because there are several interpretations, this curve is the subject of some controversy (Ferron, 2017; Pérusse, 2017). Third, partly because of the vagueness in the various interpretations, the precise measurement of concepts is somewhat problematic. And finally, the different stages of this curve are mainly characterized by behavioural norms, whereas other models consider various other aspects and artefacts of the culture; moreover, the naming of the levels refers specifically to the nature of social interactions within the company and teams, rather than to the culture as a whole.

Other terminologies exist to categorize the maturity levels of a safety culture. For instance, in their research involving 1,294 respondents of various ages, occupational statuses and economic sectors, and focusing specifically on the maturity of safety culture, Lefsrud *et al.* (2017) propose five stages of maturity that closely resemble the five stages of Cadieux and Dion (2012), as can be seen in Figure 8 on the following page. The parallel is equally striking when one examines the terminology proposed by Grebensek and Kosel (2015). Almost all other terminologies (e.g., Parker *et al.*, 2006; Zwetsloot, 2000), for the most part, all point in the same direction as those presented here.

3. Conceptual Framework

The commercial marine fishing industry is governed by regulatory bodies—Transport Canada, Fisheries and Oceans Canada and CNESST—that act at the level of regulation, monitoring, training, and awareness. The conceptual framework selected allows the stages of maturity of the safety culture to be related to the main approaches of the State. The typology of the safety culture is then defined according to the following four stages of maturity: pathological, reactive, buyer and proactive. The terminology chosen reflects the stages of maturity as presented in the literature. This terminology is therefore relevant because it allows a correlation with the main literature trends and the different approaches that the State can implement.

The **pathological** stage (Grebensek and Kosel, 2015; inspired by Cadieux and Dion's "Little or no concern" stage, 2012) is characterized by a poor understanding of safety, while compliance is perceived as a source of expenditure. The main objective is therefore to minimize the costs related to this aspect. This stage is also characterized by the fact that there is no defined approach to safety management. The government's approach must be prescriptive in order to enforce regulatory requirements.

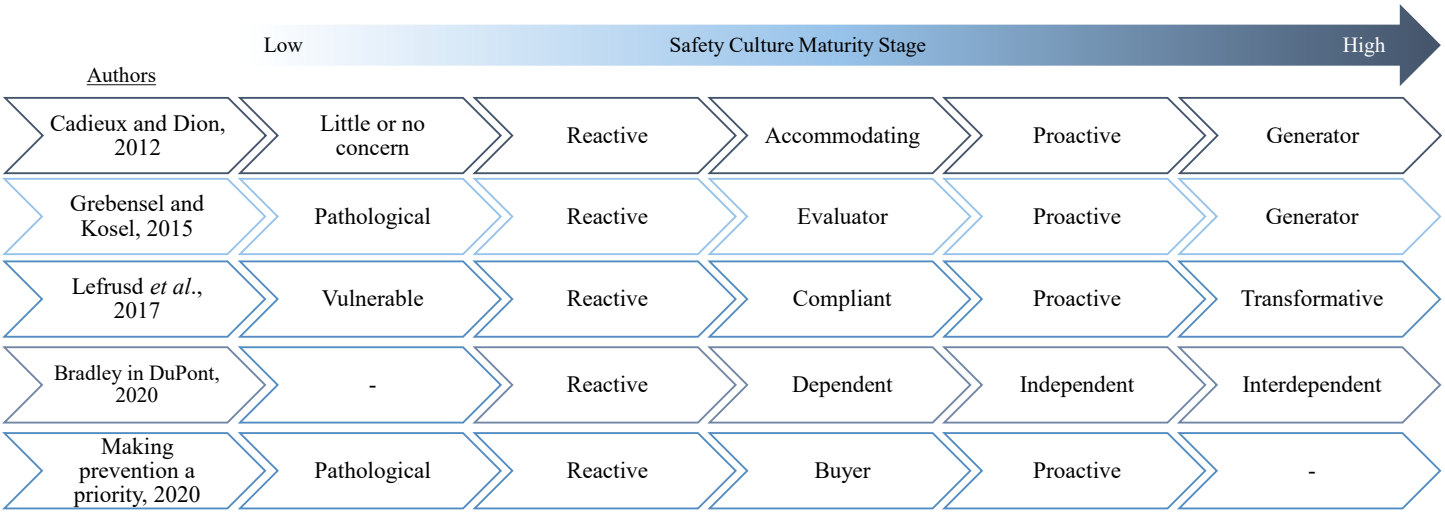
The **reactive** stage is the same in virtually all models. It is associated with an understanding of safety that is limited to compliance. The main objective is therefore to avoid sanctions, and the strategy adopted is to comply with the requirements and thus minimize the costs related to safety management. The government's approach must then focus on monitoring and controlling compliance with existing requirements.

The **buyer** stage is defined by an understanding of safety that goes beyond compliance with requirements and recognizes the need for risk management. The attitude towards safety encourages changes in practices and behaviours to reduce risk. The preferred strategy is the implementation of a safety management system to ensure that measures are effective. The government's approach must then focus on education and surveillance.

The **proactive** stage is also present in almost all models. It stands out for the integration of safety concepts into its daily practices. Safety is no longer perceived as a requirement that must be complied with, but as an intrinsic value of the company, common to all its members. The behaviour adopted can then serve as a reference since it is a manifestation of best practices. The strategy is based on an active and effective safety management system. The government's approach can then consist of ensuring monitoring by setting up programs that fall under some form of self-regulation.

This categorization consists of four levels. In fact, considering that it is difficult to conceive that a fishing micro-business could reach such a level of maturity that it would become an international OHS model, and for reasons explained previously, we did not consider it relevant to include a fifth stage (Generator/Transformer) as found in several models.

Figure 8: Summary of Safety Culture Maturity Stages in the Literature



This literature review has therefore made it possible to define a typology adapted to the reality of Québec's commercial marine fisheries. Thus, the model used in this study for the purposes of analyzing the stage of maturity of the safety culture of Québec commercial fish harvesters results from the integration of the concepts of the various authors into a categorization of stages reflecting the reality of this industry.

Regarding the State's approaches, it is important to recall that, until 2007, the Government of Canada's approach to ensure the safety of fishermen and their vessels consisted of developing a regulatory framework and monitoring it through inspections of fishing vessels. In 2007, with the implementation of the *Canada Shipping Act, 2001*, a transfer of state responsibility to the private sector took place. Responsibility for vessel compliance now falls on authorized vessel representatives. This has resulted in a change in the approach to compliance monitoring by the regulatory authority, Transport Canada. Transport Canada, which calls this a "culture change", has moved from a prescriptive to a more systemic approach, ensuring that authorized representatives and masters have a clear understanding of their responsibilities and the risks inherent in their operations and that they manage them in a structured manner. (Transport Canada, 2007)

Although Transport Canada continues its regulatory work while maintaining a certain prescriptive approach, through inspections and vessel verifications, it has had no choice but to review the provision of its programs to ensure a better approach to its new surveillance role. As a result, Transport Canada has added to its existing monitoring of compliance a surveillance component for regulated and delegated entities. Transport Canada has also given more formal recognition to its role in educating and raising awareness among stakeholders while implementing safety management systems and voluntary compliance programs, elements that involve some degree of self-regulation. (Transport Canada, 2009)

As the Government of Canada's safety approaches are now more diverse, they are becoming easier to associate with the different stages of maturity of the safety culture of regulated entities. Table 18 below summarizes the key characteristics of each of the stages of maturity in our framework and defines the approach to be adopted when establishing intervention strategies. This connection is a relevant decision support tool, as it highlights the approach that should be recommended in order to foster the development of a strong safety culture according to the levels of maturity observed in the various fleets.

Table 18: Summary of Safety Culture Maturity Stages and Government Approaches

Maturity stage	Pathological	Reactive	Buyer	Proactive
Understanding safety	Compliance is an expense	Safety is compliance	Safety is risk management	Safety is embedded in practices
Vision and attitude	Minimize compliance costs	Avoid penalties	Change practices and behaviours	Demonstrate best practices
Approach to safety management	None	Compliance strategy	Implementation of a safety management system (SMS)	Active and efficient safety management system
State approach	**Prescribe and enforce**	**Compliance monitoring and control**	**Education and monitoring**	**Self-regulation**

The interpretation of the results related to safety culture in commercial marine fisheries will therefore be based on this conceptual framework of the stages of maturity of the safety culture. As will be discussed in the methodology section, the maturity levels will be calculated by integrating the scores obtained by masters, their crew members, and vessels for each of the four types of artefacts measured. In addition, it is assumed that safety culture maturity levels vary across fleets. The analyses performed allowed us to verify this hypothesis, and to determine the magnitude of these differences. These results have been crucial in making recommendations to change the safety culture in the fishing industry.

5.1.3 Measuring a Safety Culture

There are various tools available to measure a safety culture. These include the *Safety Culture Planning Tool* (Fleming, 2017), or the *Safety Climate Tool* developed by the British *Health and Safety Executive* (Sugden e*t al.*, 2009). However, as noted in an earlier section, the definition of safety culture reflects the complexity of the concept. It would therefore be unrealistic to think that a single measure could address it. There is a strong consensus in the scientific literature (Wiegman *et al.*, 200; Antonsen, 2009; Grebensek and Kosel, 2015; Jespersen *et al.*, 2016; Fleming, 2017; Schöbel *et al.*, 2017; Nyarugwe *et al.*, 2018) that a multi-method approach should be used in order to adequately measure a safety culture.

Of what does such an approach consist? Jin and Chen (2013) provide a very good description and identify three milestones. First, they advocate the use of both qualitative measures (such as observations, focus groups and case studies) and quantitative measures (interviews, surveys, questionnaires, etc.). Therefore, as discussed below, our measurement instruments included observations and focus groups (qualitative measures), as well as interviews and questionnaires (quantitative measures).

Second, Jin and Chen (2013) note that in order to get a fair appreciation of safety culture, it is important to look at it from different perspectives. They suggest examining attitudes and perceptions (including questionnaires), examining safety behaviours (they provide checklists and observations for doing so) and documenting situational characteristics (through observations, peer reviews and audits/inspections).

Once again, our measurement strategy meets this requirement, with one nuance. Given the characteristics of the industry, it would have been preferable to make substantial behavioural observations; however, our questionnaires included items measuring two behavioural artefacts (risk management and safety methods). For the other two components, our questionnaires measured attitudes and perceptions, and our observation/inspection grid allowed an in-depth examination of the work environment.

Thirdly, still following the logic of examining the culture in depth, Jin and Chen (2013) recommend obtaining the views of more than one category of people involved. We therefore applied this triangulation principle by administering questionnaires to masters and fishermen helpers; we organized focus groups for community and industry members, in addition, of course, to the observations of the assistant inspectors in the field. The following paragraphs describe in more detail the approach and instruments we used to measure the maturity stages of safety culture in commercial fisheries.

To get started, it was necessary to consider the context of the organization and its constraints, other than safety. We have already mentioned micro-business to refer to the "fishing enterprises" that make up the industry. Generally, a significant portion of the industry is made up of captain-owners who operate their business (fishing boat) with between zero and five employees, with the captain-owner sometimes being the only one on board. The captain-owner is considered the highest level of the "organization", while the fisherman's helpers and other employees report directly to the captain-owner.

These characteristics specific to the Québec commercial marine fishing industry allowed us to target the captain-owner and a crew member as the representative sampling unit of the "organization". In accordance with our triangulation strategy, the questionnaires developed to survey professional fish harvesters were therefore written in two versions, one for the captain-owner and the other for the crew members. Since commercial marine fishing activities cannot be dissociated from the use of a fishing vessel, we also developed an observation form for the fishing vessel and its safety equipment.

The visible manifestations of a safety culture in commercial fisheries have already been presented. As a reminder, the artefacts are divided into four categories: **technical artefacts, normative artefacts, behavioural artefacts—work methods and behavioural artefacts—risk management**.

These artefacts consist of observable and therefore potentially measurable elements. To obtain a measure of the safety culture for each artefact, it was therefore important to define the parameters that allow the characterization of the observable elements in relation to a whole that refers to the safety culture in the commercial marine fishing industry. The four categories of artefacts were subdivided according to their dimensions and determinants.

Dimensions refer to a specific characteristic that allows us to define artefacts. The technical artefact is divided into three dimensions: the vessel, its safety equipment, and its fishing equipment. The normative artefact is composed of three dimensions: institutional training, regulation, and stability. The behavioural artefact relating to safety methods is divided into two dimensions: work practices and management of work practices. Finally, the behavioural artefact relating to risk management is composed of four dimensions: risk control, hazard elimination, risk analysis and prevention.

Determinants are the key factors that tell us whether the artefacts are positive or negative manifestations of the safety culture. For instance, the maintenance of a vessel may be above or below the acceptable threshold, depending on what is being examined. Since our objective is to "measure" safety culture, a list of observable elements based on determinants for each of the dimensions of the artefacts has been defined. We have summarized in tabular form the determinants and observable elements for each of the artefacts (Table 19).

Table 19: Summary of Artefact Dimensions, their Determinants, and Observable Components

Artefact	Dimension		Determinant	Observable elements
Technical	1	Vessel	Maintenance	General cleanliness, storage system, workstation ergonomics, maintenance record
	2	Safety equipment	Presence on board	Accessibility of equipment, equipment maintenance (general condition, expiry date, etc.), adequate quantity
	3	Fishing equipment	Proper installation	Safe and ergonomic installation
Normative	4	Institutional training	Activities and proof of training	Training certificates (MED, first aid, ROC-MC), certificates, courses taken, continuous training
	5	Regulation	Compliance and knowledge	Number of defects found during the last inspection
	6	Stability	Concern and knowledge	Stability or data booklet
Safe work practices	7	Work practices	Training and instructions	Assessment of written operating procedures, group discussions, instructions
	8	Practice management	Use of PPE	Application of instructions, wearing of PPE
Risk management	9	Risk control	PPE	Presence on board of: safety boots, safety glasses, PFDs, safety helmets, hearing protection, harnesses, gloves. Training/instruction on PPE wearing, maintenance, ensuring PPE is appropriate/functional
	10	Hazard elimination	Preventive maintenance	Carrying out inspections, checking the existence of a risk logbook, performing analyses, preventive maintenance routines
	11	Analysis	Accident follow-up	Learning and prevention
	12	Prevention	Emergency measures	Exercises, procedure verification (complexity, details, etc.), frequency, logbook verification

The dimension (1) concerning the vessel is evaluated according to the cleanliness of the premises, the storage system (free deck, etc.), and the ergonomics of the workstations (non-slip covering, well-designed workstations, etc.) as well as the verification of the maintenance record.

The dimension (2) concerning safety equipment is analyzed by assessing the equipment (accessibility, maintenance, etc.) and compliance (number of life jackets, rafts, survival suits, etc.) on board the vessels. It is important to note that safety equipment requirements vary according to the type of trip made (or the distance travelled from shore) and the length of the vessel. Therefore, conformity assessment must take these variations into account. We have therefore identified four categories based on the applicable requirements for survival suits and life rafts. The four categories are: life raft and suits required; only suits required; only one life raft required and no requirements.

Finally, the assessment of fishing, handling, and processing equipment (ergonomics, protection, etc.) refers to their safe and ergonomic installation and is associated with the proper installation of fishing equipment on the vessel. This is what allows the analysis of the dimension (3) concerning fishing equipment.

Dimension (4) concerning institutional training implies that the crew members have carried out learning activities. To evaluate this, we will refer to the training certificates that crew members have (marine emergency training, first aid courses, etc.), their certificates, courses taken and continuing education activities. This involves determining the number of people working on the vessel and their qualifications, but also verifying that the certificates are up to date and in compliance with requirements.

Dimension (5) concerning regulations refers to the elements that provide a framework for activities in the commercial marine fishing sector. Determining whether requirements are met is done by verifying compliance and knowledge of the regulations for each “fishing enterprise” analyzed.

The dimension (6) concerning stability is a crucial concept when referring to safety in commercial marine fisheries. Very simply, vessel stability can be defined as the equilibrium of the vessel and its behaviour in the water. The latter is then subjected to a number of forces such as its weight, buoyant force, etc. In an ideal setting, the behaviour of the vessel (its stability) is studied and/or well understood in order to be able to adopt safe navigation practices. The knowledge of stability, as well as the attention that the fisherman devotes to it and the importance it has for him, are observable elements that make it possible to evaluate this dimension.

The behavioural artefact related to safe practices can be summarized in two dimensions: work practices and management of work practices. The dimension (7) relating to work practices refers to the initial training of crew members and the master and the work instructions that exist within the crew. Evaluation of written operating procedures can be achieved by verifying the presence on board of work instructions, work procedures and the conduct of familiarization exercises for new crew members.

The dimension (8) relating to the management of work practices refers to the application of instructions and the wearing of personal protective equipment (PPE).

The behavioural artefact related to risk management is divided into four dimensions: risk control, hazard elimination, risk analysis and prevention. Verification of personal protective equipment (PPE), including its condition and number, verification of the existence of a maintenance record, and a visual examination of the condition of the PPE are the observable elements of the dimension (9) concerning risk control. Dimension (10), elimination of hazards, is supported by, among other things, verification of the preventive maintenance that is performed. The observable elements of this dimension are the existence of a maintenance record and, where applicable, the frequency with which such maintenance is performed. The dimension (11) concerning risk analysis is observable by referring to actions taken in the past when crew members or masters have faced an accidental occurrence as well as the reporting of discussions following accidents. Verification of the existence of written procedures for risk management (their complexity, their level of detail, etc.), validation of the frequency of emergency exercises and verification of the risk register (if applicable) are observable elements relating to the dimension (12) concerning prevention.

5.2 Research Approach

A rigorous methodology was used to conduct this research. This section therefore outlines the main aspects of the methodology used, including the measurement instruments that were used, the training of the research officers who carried out the field activities, the collection and entry of the data collected, the statistical analyses that were carried out, and the ethical considerations that were respected in the conduct of our research.

5.2.1 Measuring Tools

Three measurement tools were developed to measure safety culture in the field: a questionnaire (two versions), an observation/inspection grid and a semi-structured interview grid for focus groups. Each of these tools is described below.

a) The Questionnaire

First, a questionnaire was developed in two versions: one for masters (see Appendix G) and another for crew members (see Appendix H). A first section included ten questions aimed at collecting socio-demographic data in order to conduct certain verifications, including the existence of potential differences between fleet types or between communities. A second section, entitled “Safety on the Vessel”, consisted of 34 questions in the master’s version and 30 in the crew’s version. The questions addressed both factual and perceptual aspects of safety on vessels. This section of the questionnaire, combined with the observation grid described hereinafter, was used to measure the four types of artefacts selected: technical, normative, behavioural—safety methods, and behavioural—risk management. The third section of the questionnaire was entitled “We want your opinion”. This section consisted of 19 questions in each of the two versions. As the title suggests, this section measures opinions, beliefs, and attitudes.

The questionnaire elements were drawn from either of the research cited above. The first version was submitted to three people in the industry to verify the time required to administer and the ease of understanding.

However, the short timeframe because of the beginning of the fishing season prevented other types of validations from being carried out. Researchers administered the questionnaire verbally at the work site, on board ship or in port and recorded the responses in writing, except in exceptional cases. The administration of the questionnaire generally lasted between 45 and 55 minutes and responses were obtained from 101 masters and 52 crew members.

b) The Observation/Inspection Grid

The second measurement tool consisted of an observation/inspection grid used by the research officers in conjunction with administering the questionnaires. This grid made it possible to verify the compliance of the vessel, its equipment and crew with the various regulatory requirements under the *Canada Shipping Act, 2001*. Moreover, the officers used this grid to record their assessment of the vessel and certain elements previously identified so that they could later confirm or refute the crew's statements on their practices, particularly those relating to maintenance and record keeping. As can be seen in Appendix I, the "Vessel Observation Form" consists of five sections:

A. Vessel Information
B. Document Verification
C. Safety Equipment Inspection
D. PPE Inspection
E. General Assessment of the Vessel

While making the observations, it was important to be cautious and to make it clear, in order to reassure the participants and avoid their withdrawal, that this was not an inspection in the regulatory sense of the term, and that no sanctions would be taken after the visit. Officers were able to conduct a full inspection of 72 vessels and a partial inspection of 15 others.

c) Semi-structured Interview Grid for Focus Groups (Research Stations)

Within the framework of the symposium of the Comité permanent sur la sécurité des bateaux de pêche du Québec (CPSBPQ) held in Rimouski from February 4 to 6, 2020, an activity entitled "Research Stations" was organized. It consisted of grouping by community masters, crew members and their spouses in workshops, while the other participants (insurers, government, or agency representatives, etc.) were grouped in separate workshops (Table 20).

Table 20: Distribution of Workshop Participants by Community

Participant	English speakers	Bas-Saint-Laurent	Indigenous	North of Gaspésie	South of Gaspésie	MI and NS*
Master	2	4	5	11	13	7
Fisherman's helper	0	0	0	6	3	1
Spouse	0	0	0	0	0	1
Other	0	1	9	0	0	2

* MI: Magdalen Islands, NS: North Shore

The 28 officials were divided into two groups, while the other industry representatives (finance, sales, and consultants) were kept in a single group of eight. As the numbers are obviously small, it was necessary to be cautious while interpreting the results. However, as will be discussed later, there were some significant differences that shed some interesting light on the results obtained from other sources.

The sequence of events was as follows. Prior to the workshops, the participants had the opportunity to view a documentary by filmmaker Richard Lavoie on the sinking of the ship "Nadine" in the Magdalen Islands in 1990; a detailed analysis of this accident was then presented by Hugues Thibault, a marine safety inspector at Transport Canada.

Once grouped in workshops, participants discussed questions about the "Nadine" case; most of these questions also dealt with perceptions of the beliefs or artefacts used in this research. The list of questions can also be found in Appendix J.

Responses to the questions were compiled electronically using the Mentimeter tool, and comments made during the discussions were recorded by the workshop facilitators. Electronic polling was the third measurement tool. Summaries of the comments were used to assist in the qualitative understanding of the quantitative results.

A few observations about the conduct of the research stations are worth noting:

- The number of responses for each question may vary. This is due to the fact that some cell phones ran out of batteries before the end, not everyone had time to answer before the next question was displayed on the screen, or some people, for unknown reasons, chose not to answer one or more questions;

- The participation rate is a difficult factor to assess since there are many reasons why a participant may not have been at the research station (they were at their booth, they were assigned to another task, etc.);

- When a weighted average is presented, it is a result calculated by the Mentimeter tool (the polling software);

- Some participants criticized the live display of responses, saying that it is a factor that influences the responses of other people present who have not yet decided on their choice;

- Obviously, some questions do not correspond perfectly between fishing communities (Indigenous, Bas-Saint-Laurent, North of Gaspésie, South of Gaspésie, English-speaking, Magdalen Islands and North Shore) and other groups (industry, officials 1 and officials 2), which was considered when interpreting the questions.

5.2.2 Research Officer Training

Since the data was collected by several different people, there was a need for standardization and uniformity. Therefore, two steps were taken. First, seven days of training were held in Rimouski, from June 4 to 12, 2019, for the research officers who administered the questionnaires and carried out the observations/inspections. Second, since there were nine research stations simultaneously at the CPSBPQ symposium in February 2020, the standardization of the organization of the workshops and the questions for discussion was the subject of four meetings of the research team (face-to-face or online) between October 2019 and January 2020. In addition, a half-day training session was organized online for the nine facilitators and nine workshop assistants on January 28, 2020.

5.2.3 Data Collection and Entry

With the beginning of the fishing season, as part of their normal duties, the assistant inspectors toured all the fishing regions of Eastern Québec in order to visit as many vessels as possible per fleet. The objective was to obtain answers from a master and at least one crew member and to conduct vessel observations of all participants compiled in the database. The final distribution by fleet and fishing areas of the participants according to the instruments used was summarized in tabular form.

Table 21: Sampling of Participants According to the Tools Used

Fleet and fishing area	No. of participants	No. of ship observations	No. of fishing masters	No. of crew members
Crabbers	**32**	**21**	**31**	**17**
Lower North Shore (LNS)	14	7	13	9
Area 12	7	5	7	3
Area 16	6	5	6	2
Area 17	5	4	5	3
Shrimpers	**6**	**3**	**6**	**0**
Lobster boats	**32**	**28**	**32**	**25**
Baie-des-Chaleurs	11	10	11	11
North of Gaspésie	1	0	1	0
South of Gaspésie	6	5	6	4
Magdalen Islands	14	13	14	10
Multifisheries	**26**	**17**	**25**	**12**
Groundfish	**4**	**2**	**4**	**0**
Scallop vessel and other molluscs	**1**	**1**	**1**	**0**
Grand total	***101***	***72***	***99***	***54***

When present in a particular port, research officers would take the opportunity to approach masters and, when a master agreed, they would question the master, observe/inspect the vessel, and seek the participation of at least one crew member as well.

Once completed, the questionnaires and observation forms were sent to the Transport Canada office in Rimouski. To ensure consistency, all data were entered by the same person and the resulting database was given to the lead researcher for analysis. The names of participants and vessels were never recorded.

5.2.4 Statistical Analyses and Data Processing

Once the questionnaires and observation form data entry was completed, the following statistical processing was conducted. First, descriptive statistics were calculated on the socio-demographic data. Second, from the "We want your opinion" section of the questionnaires, two principal component analyses were performed on beliefs and values, one for masters and the other for crew members. Third, scores had to be calculated for each of the four artefacts (technical, normative, behavioural—safety methods, and behavioural—risk management).

The calculation to obtain the level of safety culture was done in two steps. First, percentage scores by dimensions were calculated by triangulating the corresponding elements in the vessel observation form, the master's questionnaire, and the crew's questionnaire.

Next, the dimension scores were aggregated, again in percentages, to form the scores for the four artefacts. Finally, a profile of the level of safety culture of each fleet was constructed from the four artefacts. The methodology used to measure safety culture, developed, and applied in this research, is fully explained in Appendix K.

The preliminary results of the first phase of analysis allowed us to refine the database in light of the findings collected. Since the correlation analyses revealed very low variance between responses among the study groups, we adjusted the missing data by assigning them the mean value.

For observations where no crew member was encountered, it was assumed that the responses obtained would have been equivalent to the average of all responses already entered. In the case of vessels for which the responses of two crew members were collected, an average of the responses was used to calculate the artefact score.

By applying these modifications, 72 triads of data could be used to calculate the scores for the fleet analysis using a triangulation method.

Finally, regressions and correlations were calculated between beliefs and artefacts. Since nothing significant was identified at the outset, more specific correlations were calculated with their scatter plots.

With few exceptions, means and standard deviations, dimension and artefact scores, and histograms were calculated using Excel. Weighted averages of responses to questions at the research stations were calculated by Mentimeter, the polling software. All other statistical analyses (principal component analyses, regressions, correlations, and scatter plots) were performed using SPSS version 25.

5.2.5 Ethical Considerations

Before administering the questionnaire, the assistant inspectors gave a brief explanation of the project, informed the interviewee that they could end the interview at any time, had the interviewee sign a consent form (see Appendices L and M), and provided the researcher's contact information if they wished to withdraw from the project at a later date.

In order to protect confidentiality and anonymity, the names of individuals and vessels were never requested or recorded. In order to allow for cross-referencing for triangulation purposes, each form was identified by a unique code corresponding to a vessel, home port, time of the interview, and respondent number.

This information would have made it possible to eliminate the data if an individual had requested it after the fact, but this never happened.The documents and data are kept in a secure location in the Transport Canada offices in Rimouski for a minimum of 10 years.

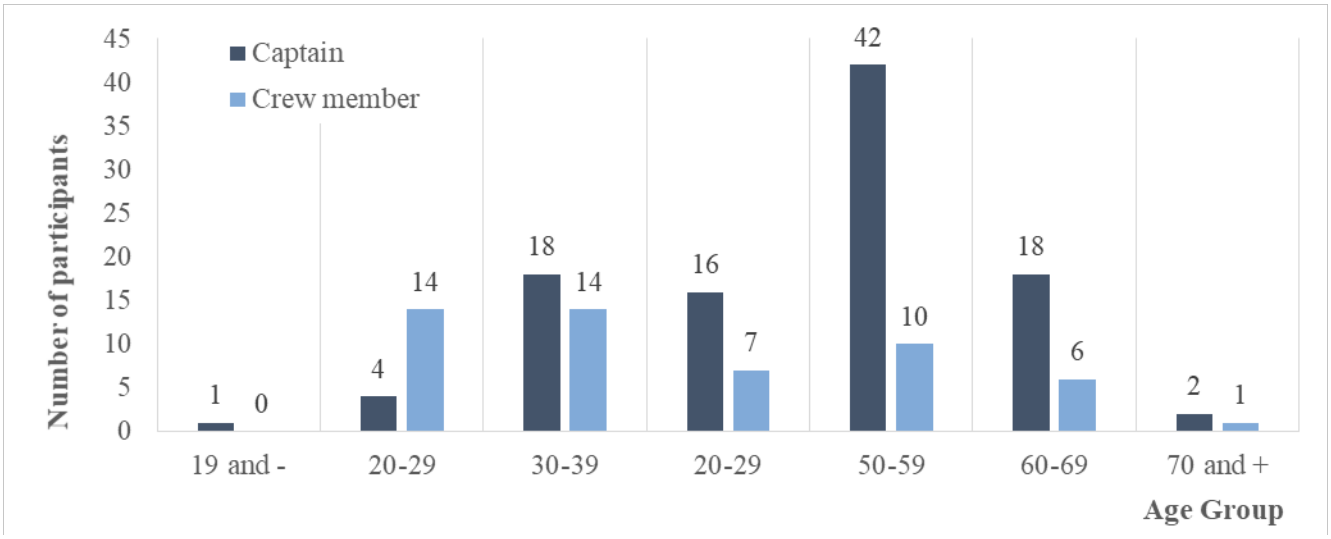
5.3 Results

This section presents the results of the statistical analyses performed. The results are not only presented, but also discussed, including data obtained from the research stations held during the CPSBPQ symposium.

5.3.1 Socio-demographic Data

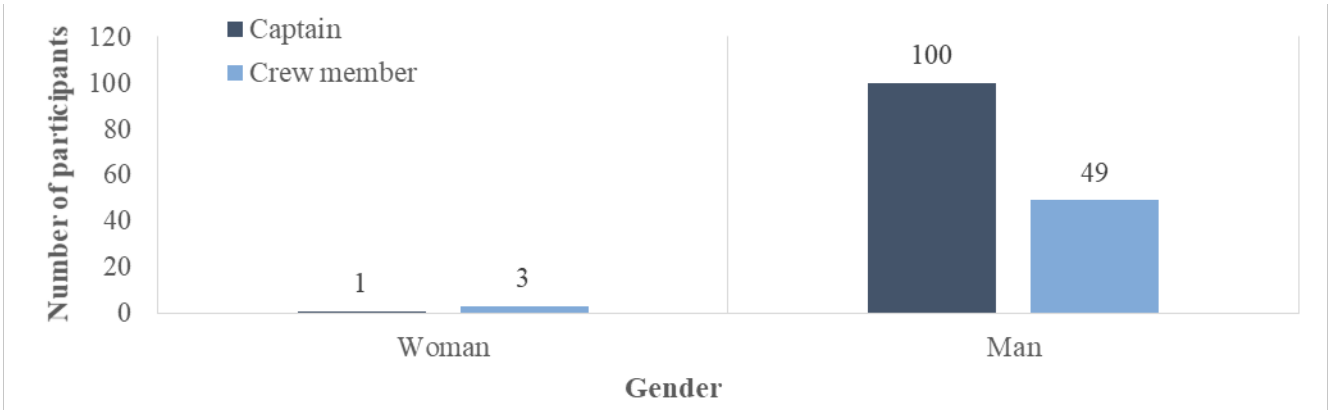
Key points are as follows. Figure 7 below shows that, unsurprisingly, the age of masters is generally higher than the age of crew members. In fact, 60% of masters are between 50 and 69 years of age, while 54% of crew members are between 20 and 39 years of age.

Graphic 7: Distribution of Respondents by Age



The data in Figure 8 also reveal that this is a predominantly male occupation. Among the 153 respondents, there is only one female master and four female crew members.

Graphic 8: Distribution of Respondents by Gender



Finally, we note that the group of respondents includes only one master of indigenous origin and two other indigenous people as crew members; therefore, the sample is essentially composed of non-native people. It would have been interesting to be able to count more indigenous people among the respondents, so as to be able to compare certain aspects of the safety culture between non-natives and natives.

5.3.2 Beliefs and Attitudes

a) Descriptive Statistics

First, descriptive statistics were compiled based on the responses to the belief and attitude elements of the questionnaire. Appendix N presents the results of these analyses. A Likert scale was used to develop the questions in this part of the questionnaire. This scale, which is specifically designed to measure the attitudes, opinions, or perceptions of individuals, is an ordinal scale whose responses are numerically coded, meaning that the numerical value assigned to each response does not position it hierarchically in relation to the other responses. The value 5 is therefore no higher than 1 and does not indicate that one response is better than another (Jamieson, 2013).

A few preliminary comments are warranted. First, it is interesting to note that the views of masters and crew members are closely aligned. As a matter of fact, for 10 of the 19 items, the difference in means (in either direction) is 0.1 or less on a 5-point scale, whereas for four other items the difference is between 0.11 and 0.39 (i.e., less than half a point). The five main questions for which the difference was more significant were summarized in tabular form, with a difference between the means of almost half a point or more.

Table 22: Top Five Questions on Beliefs (Largest Differences in Means)

No.	Question wording	Master	Crew member	Difference
M61/CM57	Our fate depends heavily on Mother Nature	2.92	4.06	-1.14
M59/CM55	I'm always worried when we go out to sea.	2.05	1.52	0.53
M58/CM54	Alcohol and drug use is widespread in our industry.	3.16	2.67	0.49
M57/CM53	The laws and regulations that apply to our operations make the work more complicated or difficult.	2.68	2.27	0.41
M60/CM56	Accidents form part of the fishing profession	3.02	3.42	-0.40

One issue in particular is the question of Mother Nature's role in the fate of fishermen. According to the responses to this question, masters are less inclined to consider that their fate depends on Mother Nature; in fact, while the opinion of masters is rather moderate on this subject, crew members tend to agree with this statement.

The other questions that show differences reveal that masters are less likely to think that accidents are part of the fishing profession. At first glance, therefore, they appear to be less fatalistic than their crew members.

On the other hand, they tend to be more concerned about going to sea, they are more aware of the use of alcohol and drugs in the industry, and they are more likely to see laws and regulations as hindering operations.

1. Rotated Principal Component Analysis

Second, two rotated principal component analyses were conducted on the responses to the beliefs and values questions, one for masters and another for crew members. These analyses allow us to verify the extent to which the questions studied explain the answers provided by masters and crew members.

Six factors were identified for both masters and crew members. Appendix O presents the details of each of the factors, in particular the items in the questionnaire that are related to the factor and their respective load[15]. Before explaining each of the factors in detail, we summarized in tabular form the six factors for which the percentages of variance were the largest and therefore the most significant. Taking these results into account, we can explain 60.5% of the variance for masters and 68.9% of the variance for crew members.

Table 23: Beliefs and Values—Summary of Factors and Percentage of Variance Explained

Factor	Question wording - Masters	%	Question wording - Crew members	%
1	OHS as a core value (or OHS beliefs)	23	OHS as a core value (or OHS beliefs)	24
2	Attitudes towards laws and regulations	10	Attitudes towards laws and regulations	13
3	Fatalism/external locus of control	9	"Where there is a will, there is a way"	10
4	Risk is part of the job	7	External locus of control (as a sailor I have little control)	9
5	Worry/stress	6	Fatalism	7
6	Paid season	6	Paid season	6
Total explained variance (%)		**61**		**69**

• First Factor

The first factor identified refers to health and safety (OHS) as a core value or belief in OHS. First, it is interesting to note that the results are essentially the same for masters and crew members. This first factor seems to convey the idea that the health, safety, and well-being of individuals are fundamental values for the respondents. For both masters and crew members, the averages of the responses are all above 4.5—except for question 55 for crew members, which relates to concern about going out to sea, which has an average of 1.52.

The five main elements are found in both groups of respondents. We must remain cautious with this interpretation since these very positive attitudes do not seem to automatically result in positive actions.

[15] *loading* is equivalent to the correlation between the element and the factor

• Second Factor

Factor 2, also common to both groups of respondents, is somewhat puzzling. On the one hand, the averages for the elements that make up the factor suggest that overall attitudes towards laws and regulations are quite positive. On the other hand, results from the research stations appear to confirm mixed results. Two questions dealt with Transport Canada's regulatory requirements. In response to question 9, "Do you believe that Transport Canada should require MED for all crew members?", a strong majority of respondents favoured a more stringent requirement. Would they be open to a change in the regulations? 87% of respondents from fishing communities answered yes to this question, while this percentage rises to 97% when industry and officials' responses are considered. For question 15, "Do you think that inspectors should be more demanding on the accessibility of safety equipment?" it's a whole different story. The opinion of respondents from both the industry and government groups is in favour of increasing the requirements, with 97.1% of participants responding yes. However, responses from fishing communities are unfavourable, with 63.3% of participants answering "No" or "Certainly not!"

It is clear that fishing communities prefer to make their own judgments and decide as they please. This attitude is not bad in itself since, when they are at sea, they are the ones who are ultimately responsible for their safety. Some decision-making autonomy is also a sign of confidence in the fishermen and an approach based on monitoring compliance with the regulations through this project has every interest in vessel on this autonomy. It would therefore be important to take it into account when formulating recommendations and choosing the measures to be implemented. Adding the fact that certain regulatory dimensions of safety culture produce rather low percentages, it must be concluded that the positive attitudes expressed above do not necessarily lead to concrete actions.

• Other Factors

Factors 3 and 4 for masters indicate a certain fatalism, a feeling of powerlessness or lack of control. As a result, factor 5 contains only one element that indicates the concern of masters when setting out to sea. Factor 6 is very difficult to interpret. By contrast, among crew members, factor 3 reflects the belief that accidents can be prevented; factors 4 and 5 convey their perception that, as sailors, they have relatively little control. Interestingly, unlike masters, concern when going at sea is found in the first factor with a negative correlation, which seems to reflect a certain level of confidence. As for masters, factor 6 is difficult to interpret.

A final comment is required at this point regarding factors related to beliefs and attitudes. As can be seen in Table 24, the total variance explained is not very high in the two groups. This can mean two things. The first hypothesis is that the majority of elements produced little variability in participants' responses. The fact that there are strong similarities in the responses of the two groups would support this hypothesis. Seven questions for masters and six questions for crew members had standard deviations of 1 or more, which is substantial for a five-point scale. This first hypothesis is therefore insufficient. According to the second hypothesis, there may be other beliefs and attitudes to explain the variance. By definition, this hypothesis is difficult to disprove or confirm, so we remain cautious in interpreting these results.

b) Research Stations: General Questions on Safety Culture

At the research stations, four questions addressed the general safety culture in the industry. We first summarized in tabular form the questions—and their possible answer choices—to which we refer in this section.

Table 24: Research Stations—General Questions and Possible Response Options

N°	Question	Answer options
1	Over the past 30 years, have we changed our habits and addressed the safety issues that led to the "Nadine" tragedy?	Yes, no, I don't know
2	After seeing the presentations on the "Nadine", do you feel that the causes of the shipwreck are clear?	Yes, no
3	Where do you think the safety culture in the commercial fishing industry in Quebec stands?	Scale of 1 = low to 5 = high
4	What changes do we still need to make to improve the safety culture in the industry?	Tag cloud

The results are presented by distinguishing the responses obtained in two groups. The first group refers to the fishing communities, namely the English speakers, the Bas-Saint-Laurent, the Indigenous, the North of Gaspésie, the South of Gaspésie and the Magdalen Islands and the North Shore. The second group refers to the two groups of officials and the industry.

To the question, "In the past 30 years, have we changed our habits and solved the safety issues which have led to the tragedy of the 'Nadine'?" 90% of respondents from the fishing communities answered yes, compared to only 31% of respondents from the government and industry groups, as shown in Table 25.

Table 25: Research Stations—Answers to the Question: "In the past 30 years, have we changed our habits and solved the safety issues which have led to the tragedy of the 'Nadine'?"

Communities	No. of respondents	Yes	%	No	%	I do not know	%	Total (%)
English speakers	2	1	50	0	0	1	50	100
Bas-Saint-Laurent	5	5	100	0	0	0	0	100
Indigenous	13	12	92	0	0	1	8	100
North of Gaspésie	14	11	79	3	21	0	0	100
South of Gaspésie	15	15	100	0	0	0	0	100
MI and NS*	9	8	89	0	0	1	11	100
Total - Fishermen	**58**	**52**	**90**	**3**	**5**	**3**	**5**	**100**
Industry	8	3	38	4	50	1	13	100
Officials 1	17	4	24	12	71	1	6	100
Officials 2	10	4	40	5	50	1	10	100
Total - Others	**35**	**11**	**31**	**21**	**60**	**3**	**9**	**100**
Grand total	**93**	**63**	**68**	**24**	**26**	**6**	**7**	**100**

* MI: Magdalen Islands, NS: North Shore

The gap between the perception of fishing communities and that of other groups is striking. While community representatives seem to overwhelmingly believe that the safety issues that led to the "Nadine" tragedy have been resolved, officials and industry members overwhelmingly believe that they have not. This difference of opinion must be interpreted with caution since the groups interviewed are stakeholders or regulators of the environment being referred to. It is important to remember that fishing communities really perceive a change in their environment, whereas officials and industry representatives do not really see any improvement over the last 30 years.

Moreover, for the question asked at the beginning of the research stations ("After the presentations about the 'Nadine', do you think that the causes of the shipwreck are clear?"), responses also differed between fishing communities and those of officials and industry. While 59% of respondents from the fishing communities answered no to this question, 73% of respondents from the government and industry category answered yes, as shown in the table below.

Table 26: Research Stations—Responses to the Question: "After the presentations about the 'Nadine', do you think that the causes of the shipwreck are clear?"

Communities	No. of respondents	Yes	%	No	%	Total (%)
English speakers	2	2	100	0	0	100
Bas-Saint-Laurent	4	0	0	4	100	100
Indigenous	14	2	14	12	86	100
North of Gaspésie	17	2	12	15	88	100
South of Gaspésie	16	15	94	1	6	100
MI and NS*	10	5	50	5	50	100
Total - Fishermen	**63**	**26**	**41**	**37**	**59**	**100**
Industry	8	8	100	0	0	100
Officials 1	17	9	53	8	47	100
Officials 2	12	10	83	2	17	100
Total - Others	**37**	**27**	**73**	**10**	**27**	**100**
Grand total	**100**	**53**	**53**	**47**	**47**	**100**

* MI: Magdalen Islands, NS: North Shore

Interestingly, the percentage of fishermen —59 percent—who think the causes of the sinking are unclear (Table 26) is about the same as the percentage of other participants —60 percent—who think the issues are not resolved (Table 25). A comment on these statistics is necessary before moving on to the next point.

After seeing the documentary and the Transport Canada inspector's presentation of the investigation report, a 100% "Yes" response would have been expected. This is true for industry representatives, who seem to demonstrate a solid understanding of complex cases; it is almost the same for South of Gaspésie group representatives (15 out of 16) and Officials 2 (10 out of 12). For the communities and the group of officials who deviate from this result, it may indicate poor understanding, difficulty in assimilating complex cases, or a lack of knowledge. These may also indicate mental blocks affecting professional fishermen following the shipwreck of the "Nadine", leading to traumas that persist to this day.

The general belief that habits have changed is widely present. However, some still believe that things have not improved and that safety issues have not been addressed. While it is true that some things did change, the current situation is not much different from what it was 30 years ago. Although the safety culture seems to be improving, many areas still need to be reinforced.

For the question: "According to you, where do the safety culture in the fishing industry in Québec stands?", the response options were identified on a scale of 1 = low to 5 = high. Once again, as indicated by the results in the table below, the opinions of participants in the other groups are milder than those of fishermen.

Table 27: Research Stations—Responses to the Question: "According to you, where do the safety culture in the fishing industry in Québec stands?"

Communities	No. of respondents	Weighted average	1	%	2	%	3	%	4	%	5	%	Total (%)
English speakers	2	4.5	0	0	0	0	0	0	1	50	1	50	100
Bas-Saint-Laurent	5	3.2	0	0	1	20	2	40	2	40	0	0	100
Indigenous	13	3.69	0	0	0	0	5	38.5	7	53.8	1	7.7	100
North of Gaspésie	13	4,00	0	0	0	0	3	23.1	7	53.8	3	23.1	100
South of Gaspésie	14	4.21	0	0	0	0	1	7.1	9	64.3	4	28.6	100
MI and NS*	10	3.6	0	0	0	0	4	40	6	60	0	0	100
Total - Fishermen	**57**	**-**	**0**	**0**	**1**	**1.8**	**15**	**26.3**	**32**	**56.1**	**9**	**15.8**	**100**
Industry	8	3.25	0	0	0	0	6	75	2	25	0	0	100
Officials 1	15	2.13	2	13.3	9	60	4	26.7	0	0	0	0	100
Officials 2	10	2.9	1	10	1	10	6	60	2	20	0	0	100
Total - Others	**33**	**-**	**3**	**9.1**	**10**	**30.3**	**16**	**48.5**	**4**	**12.1**	**0**	**0**	**100**
Grand total	**90**	**3.5**	**3**	**3.3**	**11**	**12.2**	**31**	**34.4**	**36**	**40**	**9**	**10**	**100**

* MI: Magdalen Islands. NS: North Shore

The weighted averages of all but one fishing community (Bas-Saint-Laurent) are above the overall weighted average of 3.50, while the other three groups are below. The results generally confirm that everyone acknowledges that efforts are still needed to improve the safety culture.

One final question was asked only to the other three groups. The question was: "What changes do we still need to make to improve the safety culture in the industry?". Participants responded with words that were collected and displayed in a tag cloud. Analysis of this cloud shows that the predominance of sensitization is easily visible. There are other possible solutions. Overall, according to industry representatives and both groups of officials, the drivers behind actions lie in awareness, training, and education, as well as in the regulatory framework. We have grouped the words presented in the following table into three pillars of action.

Table 28: Summary of Other Participants' Responses to the Question About What Need to be Changed

Lever 1: Awareness	Lever 2: Training	Lever 3: Regulation
Culture	Support	Reminder of the consequences
Proactivity	Example and follow-up	Severe consequence
Influence of relatives	Practice	Validation
Spousal involvement	Mentor, sharing	Compel
Information sharing	Education	Sanction
Support	Teach	Adjust legislation
Break taboos	Comprehension	Regulatory amendment
Responsibility	Demonstration	Rewards
Collaboration	Use technological means	Demand, punish
Be united, raise awareness	Practical tools (video)	Regulatory acceleration

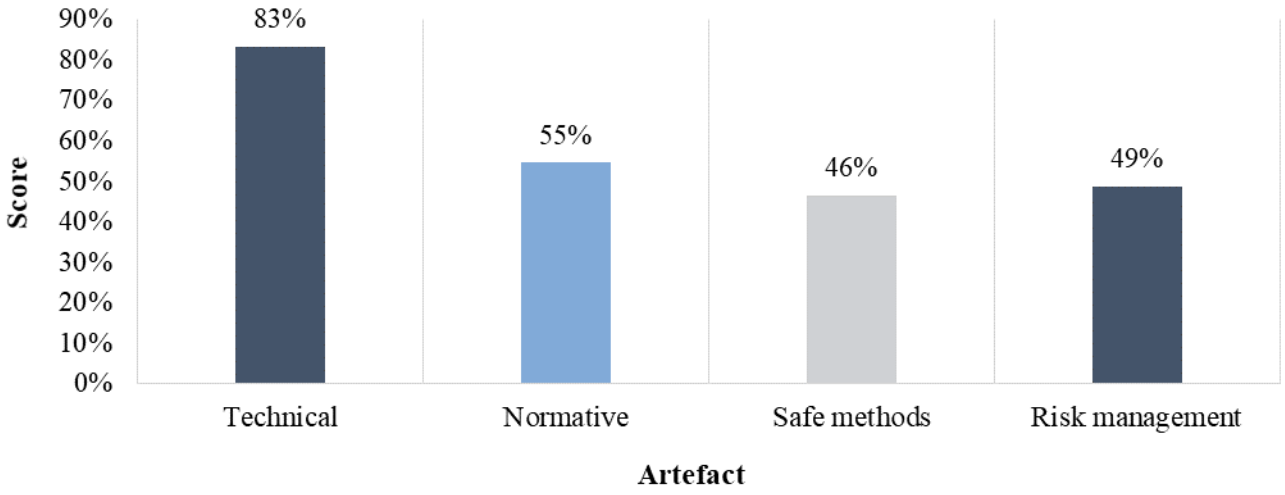
These words can sometimes be objective or concepts; they offer clues, but these clues require some formatting, a conversion into specific actions. They are not necessarily complete. The results obtained must be analyzed in light of the findings of the statistical and cost components of this study and will therefore be discussed in more detail in the recommendations section.

5.3.3 Artefacts

a) Average Score of the Four Artefacts

As previously indicated, the subsequent step involved triangulating the scores for the twelve dimensions and then aggregating them to produce the scores for the four artefacts. The following chart illustrates the averages of the scores obtained for the four groups of artefacts.

Graphic 9: Histogram of Average Artefact Scores



This data provide interesting initial insights. The average for the technical factor is 83%, while the averages for the three other artefacts are below 55%. It is not surprising that the technical factor obtains such a good average. This is the artefact most closely tied to the fishermen's livelihood. Table 29 provides a summary of the scores obtained for each of the dimensions of the artefacts. The following sections examine each of the artefacts in greater detail.

Table 29: Average Scores for Artefact Dimensions

Artefact	Dimension		Determinant	Score
Technical	1	Vessel	Maintenance	75%
	2	Safety equipment	Presence on board	80%
	3	Fishing equipment	Proper installation	95%
Normative	4	Institutional training	Activities and proof of training	61%
	5	Regulation	Compliance and knowledge	45%
	6	Stability	Concern and knowledge	57%
Safe work practices	7	Work practices	Training and instructions	67%
	8	Practice management	Use of PPE	26%
Risk management	9	Risk control	PPE	50%
	10	Hazard elimination	Preventive maintenance	56%
	11	Analysis	Accident follow-up	86%
	12	Prevention	Emergency measures	33%

1. Technical Artefact

During a closer examination, we noticed that the dimension "Installation of fishing and handling equipment" presents the highest average of the entire questionnaire, at 95%. This is followed closely by the "Safety equipment" dimension with 80%; a little further down the line is the "Maintenance" dimension with 75%. It would appear that, while the fishing season is in full swing, the urgency of production relegates the maintenance of the vessel to the background, which seems to be considered a non-productive and time-consuming activity. The answers to some questions from the research stations enable us to refine our interpretations. We have summarized in tabular form the questions—and their possible choices of answers—to which we refer in this section.

Table 30: Research Stations—Questions Pertaining to the Technical Artefact

Target	Questions	Answer options
Fishermen	Are there water level sensors aboard your boat?	Yes, No, I don't know, I don't have any anymore.
Other groups	According to you, what percentage of the fleet has water level sensors?	Scale of 0% to 100%
Fishermen	Are your boat's water level sensors tested regularly?	Yes, No, I don't have any, N/A.
Other groups	Why do some fishermen not equip their boats with water level sensors?	Too expensive, Not mandatory, Often faulty, Disturbing alarms, Unnecessary
Fishermen and other groups	Do you consider the safety equipment on your boat to be easily accessible and ready for immediate use?	Scale of 1 to 5 (Raft / Ovatek, Immersion suits and PFD)
Fishermen	Do you maintain or have the following equipment maintained on an annual basis?	Immersion suits, PFD 0 or 1 and Weigh. av.
Other groups	Do you consider the maintenance of vessels and equipment conducted by fishers to be adequate?	Answer on a scale of 1 to 10 (Vessel, Equipment)

To begin with, participants were asked two questions about water level sensors, a piece of equipment whose absence seems to have been a critical factor in the sinking of the "Nadine". The answers to the question "On board your vessel, is there water-level detectors?" are summarized in Table 31

Table 31: Research Stations—Answers to the Question: "On board your vessel, is there water-level detectors?"

Communities	No. of respondents	Yes	%	No	%	I do not know	%	I no longer have any	%	Total (%)
English speakers	2	2	100	0	0	0	0	0	0	100
Bas-Saint-Laurent	5	4	80	1	20	0	0	0	0	100
Indigenous	14	13	93	0	0	1	7	0	0	100
North of Gaspésie	16	13	81	2	13	0	0	1	6	100
South of Gaspésie	16	11	69	4	25	1	6	0	0	100
MI and NS*	10	8	80	2	20	0	0	0	0	100
Total	**63**	**51**	**81**	**9**	**14**	**2**	**3**	**1**	**2**	**100**

* MI: Magdalen Islands. NS: North Shore

For the other groups, the question was as follows: "According to you, what percentage of the fleet has water level detectors?". Respondents were asked to rate their answers on a scale of 1 to 10, and the results are summarized by the weighted averages of each group's responses. The industry group reports that 41% of the fleet has water level sensors, while the two groups of officials report that 39% and 46% of the fleet has water-level sensors, respectively.

The first significant finding is that 81% of fishermen state that the vessel they work on is equipped with water-level sensors. This average is interesting for two reasons.

First, since there are no regulations requiring this safety equipment, this data suggests that the influence of safety culture is not only related to regulations but can also be implemented by professional fishermen when they understand the risks and choose to protect themselves accordingly.

Second, percentages of the fleet equipped with sensors as reported by the other groups are substantially lower than those of the communities. Thus, industry representatives, generally close to the fishing communities, assign a score that is almost half of the score assigned by the communities themselves.

Either the communities overstated their responses (effect of the live display of responses on the screen), or the other groups understated theirs. Comments such as that of a master, who says "It's the most important thing on board a vessel" (Bas-Saint-Laurent station) suggest the communities' point of view; however, comments such as "If the pump starts, there's water, if it doesn't start, there's nothing" (also Bas-Saint-Laurent station) would rather give credibility to the score given by the industry representatives. This may in fact be an indication of great variability between vessels or between fleets.

The next question under consideration, addressed to the communities, was: "Are the water-level detectors on your vessel regularly tested?" and the breakdown of responses is presented in the following table.

Table 32: Research Stations—Answers to the Question: "Are the water-level detectors on your vessel regularly tested?"

Communities	No. of respondents	Yes	%	No	%	I no longer have any	%	n/a	%	Total (%)
English speakers	2	2	100	0	0	0	0	0	0	100
Bas-Saint-Laurent	5	4	80	0	0	1	20	0	0	100
Indigenous	13	8	62	5	39	0	0	0	0	100
North of Gaspésie	15	14	93	0	0	0	0	1	7	100
South of Gaspésie	16	8	50	4	25	2	13	2	13	100
MI and NS*	11	7	64	4	36	0	0	0	0	100
Total	**62**	**43**	**69**	**13**	**21**	**3**	**5**	**3**	**5**	**100**

* MI: Magdalen Islands. NS: North Shore

The other groups were asked: "Why do some fishermen not equip their vessels with water-level detectors?" and the table below summarizes the detailed responses.

Table 33: Research Stations—Answers to the Question, "Why some fishermen do not equip their vessels with water-level detectors?"

Other groups	No. of respondents	Too expensive	%	Not mandatory	%	Often faulty	%	Disturbing alarms	%	Unnecessary	%	Total (%)
Industry	8	0	0	7	88	0	0	1	13	0	0	100
Officials 1	17	0	0	16	94	0	0	0	0	1	6	100
Officials 2	12	1	8	11	92	0	0	0	0	0	0	100
Total	**37**	**1**	**3**	**34**	**92**	**0**	**0**	**1**	**3**	**1**	**3**	**100**

We note that most respondents (69%) perform maintenance on the detectors. On the one hand, there is a strong agreement between the percentage of positive responses to this question and the overall average for the maintenance dimension of the technical factor. On the other hand, the question arises as to whether this maintenance is carried out correctly; a participant in the Magdalen Islands and North Shore station made the following comment: "Most do not test them properly; they check that the light is working without knowing if the pump is actually working." The overwhelming majority of participants in the other groups believe that it is because detectors are not required that vessels are not equipped with them; however, this belief appears to be misguided, as a majority of vessels are equipped with them even though they are not subject to regulation.

Two other questions from the research stations concerned safety equipment. To the question: "Do you believe that safety equipment on your vessel is easily accessible and ready for immediate use?" the responses are broken down as shown in Table 34 for the three pieces of equipment concerned. The response scale from 1 to 5 ranges from hardly accessible to easily accessible.

Table 34: Research Stations—Answers to the Question: "Do you believe that safety equipment on your vessel is easily accessible and ready for immediate use?"

Communities	No. of respondents	Weighted av.	1	%	2	%	3	%	4	%	5	%	Total (%)
Results for Raft/Ovatek													
English speakers	2	5.00	0	0	0	0	0	0	0	0	2	100	100
Bas-Saint-Laurent	5	4.40	0	0	0	0	1	20	1	20	3	60	100
Indigenous	13	4.38	0	0	0	0	1	8	6	46	6	46	100
North of Gaspésie	12	4.75	0	0	0	0	1	8	1	8	10	83	100
South of Gaspésie	15	4.47	1	7	0	0	0	0	4	27	10	67	100
MI and NS*	10	4.60	0	0	0	0	0	0	4	40	6	60	100
Total - Fishermen	**57**	**-**	**1**	**2**	**0**	**0**	**3**	**5**	**16**	**28**	**37**	**65**	**100**
Industry	7	4.14	0	0	0	0	1	14	4	57	2	29	100
Officials 1	17	3.47	0	0	3	18	5	29	7	41	2	12	100
Officials 2	10	3.50	0	0	1	10	4	40	4	40	1	10	100
Total - Others	**34**	**-**	**0**	**0**	**4**	**12**	**10**	**29**	**15**	**44**	**5**	**15**	**100**
Results for immersion suits													
English speakers	2	5.00	0	0	0	0	0	0	0	0	2	100	100
Bas-Saint-Laurent	5	4.40	0	0	0	0	0	0	3	60	2	40	100
Indigenous	12	4.17	1	8	0	0	1	8	4	33	6	50	100
North of Gaspésie	14	4.71	0	0	0	0	0	0	4	29	10	71	100
South of Gaspésie	14	4.00	1	7	1	7	1	7	5	36	6	43	100
MI and NS*	10	3.70	1	10	1	10	0	0	6	60	2	20	100
Total - Fishermen	**57**	**-**	**3**	**5**	**2**	**4**	**2**	**4**	**22**	**39**	**28**	**49**	**100**
Industry	8	2.75	1	13	3	38	2	25	1	13	1	13	100
Officials 1	17	2.65	0	0	7	41	9	53	1	6	0	0	100
Officials 2	10	2.60	1	10	4	40	3	30	2	20	0	0	100
Total - Others	**35**	**-**	**2**	**6**	**14**	**40**	**14**	**40**	**4**	**11**	**1**	**3**	**100**
Results for personal flotation devices (PFDs)													
English speakers	2	5.00	0	0	0	0	0	0	0	0	2	100	100
Bas-Saint-Laurent	5	4.80	0	0	0	0	0	0	1	20	4	80	100
Indigenous	12	4.58	0	0	0	0	1	8	3	25	8	67	100
North of Gaspésie	14	4.79	0	0	0	0	0	0	3	21	11	79	100
South of Gaspésie	15	4.47	0	0	0	0	1	7	6	40	8	53	100
MI and NS*	10	4.10	0	0	0	0	1	10	7	70	2	20	100
Total - Fishermen	**58**	**-**	**0**	**0**	**0**	**0**	**3**	**5**	**20**	**34**	**35**	**60**	**100**
Industry	8	2.38	2	25	2	25	3	38	1	13	0	0	100
Officials 1	17	3.00	0	0	6	35	5	29	6	35	0	0	100
Officials 2	10	3.30	0	0	2	20	4	40	3	30	1	10	100
Total - Others	**35**	**-**	**2**	**6**	**10**	**29**	**12**	**34**	**10**	**29**	**1**	**3**	**100**

* MI: Magdalen Islands, NS: North Shore

Summing up choices 4 and 5, it can be seen that rafts are considered fairly accessible at 93%, immersion suits at 88% and personal flotation devices (PFDs) at 94%. These results are higher than the "Safety equipment" dimension of the present artefact; however, the score for this dimension is based solely on the agents' observations, which is probably a little closer to reality.

While the industry scores for raft accessibility are close to the community scores and the overall average for the "Safety equipment" dimension, all other group scores are more conservative.

Therefore, the industry and officials have a different perception of survival gear. The lower scores may be explained by the fact that immersion suits are often kept in the bunks or in the cabin where the fishermen sleep rather than on the deck, in the wheelhouse or in a place accessible without having to climb down to a lower level of the fishing vessel. For both industry groups and officials, this is clearly not considered the ideal location, and this information should be validated for professional fishermen. The definition of an "easily accessible" location is a matter for reflection here, as the term is open to interpretation (and therefore to a separate application).

Responses to the question that also dealt with safety equipment, which stated: "Is maintenance of the following equipment done annually, by yourself or someone else?" are presented in the table below.

Table 35: Research Stations—Answers to the Question: "Is maintenance of the following equipment done annually, by yourself or someone else?"

Communities	No. of respondents	Weighted average	Yes	%	No	%	Total (%)
Results for immersion suits							
English speakers	2	1.00	0	0	2	100	100
Bas-Saint-Laurent	5	0.60	2	40	3	60	100
Indigenous	11	0.64	4	36	7	64	100
North of Gaspésie	13	0.85	2	15	11	85	100
South of Gaspésie	14	0.71	4	29	10	71	100
MI and NS*	10	0.80	2	20	8	80	100
Total	**55**	**-**	**14**	**26**	**41**	**75**	**100**
Results for personal flotation devices (PFDs)							
English speakers	2	1.00	0	0	2	100	100
Bas-Saint-Laurent	5	0.40	3	60	2	40	100
Indigenous	13	0.69	4	31	9	69	100
North of Gaspésie	13	0.85	2	15	11	85	100
South of Gaspésie	14	0.64	5	36	9	64	100
MI and NS*	10	0.70	3	30	7	70	100
Total	**57**	**-**	**17**	**30**	**40**	**70**	**100**

* MI: Magdalen Islands, NS: North Shore

Once again, we find that it is one thing to have specific equipment, but it is another to maintain them. The percentages of positive responses (26% and 30%) are significantly lower than the percentages relating to the presence or availability of such equipment. These results are also close to the percentage obtained for the "Maintenance" dimension, the weakest dimension of this artefact and probably one of the most critical, according to the statistical report of this study.

2. Normative Artefact

For the normative artefact, which relates to compliance with laws and regulations, it is the "Institutional training" dimension that represents the highest score with 61%, followed by the "Stability" dimension with 57% and finally the "Regulation" dimension with a score of 45% (Table 29 on page 93).

Significantly, the three artefacts (normative, behavioural—safe work practices, and behavioural—risk management) that are not directly related to the main activity score lower. This explains the concern of the authorities for an enhanced safety culture in this industry.

As discussed in the previous section, there is a stark contrast between the broadly favourable attitudes expressed, on the one hand, and significant gaps in enforcement on the other. This is another indication that there is something acting as a brake, a barrier between beliefs and attitudes and concrete actions.

Therefore, it seems that improving the level of safety in the marine fishing industry does not necessarily require more regulation, but rather an incentive to better implement and comply with existing laws and regulations.

3. Behavioural Artefact—Safe Work Practices

The overall average for this artefact is clearly impacted by the poor rate at which personal protective equipment (PPE) is worn. In fact, this dimension presents a score of 26%, while the "Work practices" dimension scores 67% (Table 29 on page 93). Again, what is considered directly useful to the core activity (Procedures and instructions) receives more attention than what is considered as peripheral, or even cumbersome, like the use of PPE. Interestingly, respondents to the questionnaires only slightly disagreed with the question "The laws and regulations that apply to our operations make the work more complicated or difficult." (Masters: 2.68; crew: 2.27).

At the research stations, two questions pertained to a procedure that, if performed, would have potentially changed the course of events and would have been critical in the case of the "Nadine". The question for the fishing communities was as follows: "On your vessel, do you close water tightly all the openings after use?". The breakdown of responses is presented in the following table.

Table 36: Research Stations—Answers to the Question: "On your vessel, do you close water tightly all the openings after use?"

Communities	No. of respondents	Yes, always	%	Yes, when the weather is bad	%	Yes, if loading is complete	%	No, never	%	Total (%)
English speakers	2	1	50	1	50	0	0	0	0	100
Bas-Saint-Laurent	4	2	50	2	50	0	0	0	0	100
Indigenous	14	11	79	1	7	2	14	0	0	100
North of Gaspésie	16	14	88	2	13	0	0	0	0	100
South of Gaspésie	16	10	63	3	19	2	13	1	6	100
MI and NS*	11	7	64	4	36	0	0	0	0	100
Total	**63**	**45**	**71**	**13**	**21**	**4**	**6**	**1**	**2**	**100**

* MI: Magdalen Islands, NS: North Shore

The results obtained show that all fisher communities seem to have good practices with respect to sealing openings when at sea. Still, it is of concern that 21% say they close them only when exposed to bad weather. In fact, when the other groups are asked if they think fishermen close openings after use, as can be seen in the table below, the overall picture is somewhat different. "Always" responses are much less frequent, and the conditional responses are significantly higher.

Table 37: Research Stations—Answers to the Question: "On their vessel, when do you think fishermen seal the openings after use?"

Other groups	No. of respondents	Yes, always	%	Yes, when the weather is bad	%	Yes, if loading is complete	%	No, never	%	Total (%)
Industry	8	0	0	2	25	6	75	0	0	100
Officials 1	17	1	6	4	24	12	71	0	0	100
Officials 2	12	0	0	4	33	8	67	0	0	100
Total	**37**	**1**	**3**	**10**	**27**	**26**	**70**	**0**	**0**	**100**

The next question was: "Do you have written procedures to prevent downflooding?". Below are the responses to this question summarized in tabular form.

Table 38: Research Stations—Answers to the Question: "Do you have written procedures to prevent downflooding?"

Communities	No. of respondents	Yes	%	No	%	No idea	%	Total (%)
English speakers	2	0	0	1	50	1	50	100
Bas-Saint-Laurent	5	5	100	0	0	0	0	100
Indigenous	14	10	71	2	14	2	14	100
North of Gaspésie	16	5	31	11	69	0	0	100
South of Gaspésie	16	5	31	11	69	0	0	100
MI and NS*	11	3	27	8	73	0	0	100
Total	**64**	**28**	**44**	**33**	**52**	**3**	**5**	**100**

* MI: Magdalen Islands, NS: North Shore

The answers to this question, clearly, are quite different from the answers to the previous question. Overall, most people would apply a proper procedure, even if they do not have one in writing. This would seem to suggest that procedures and practices are more likely to be passed on orally or by example. These findings are supported by the observations of the inspectors as well as the expertise of the commercial fisheries stakeholders.

However, it is important to note that the answers to this question are somewhat distinctive. Whereas, for the previous questions, all communities opted for the same answer, here, two communities, namely the Indigenous group and the Bas-Saint-Laurent community, claim to have a written procedure, while the opposite is true for all the other communities.

The absence of written procedures could reflect a certain doubt as to their usefulness. Comments gathered in industry representatives' station are along these lines:

- "Written procedures can help, but is it enough? It's better than nothing."
- "Without responsibility logistics, procedures are useless."

When officials and industry representatives are asked "To what extent can written procedures help prevent downflooding?", answers are not very strongly affirmative, and even seem to reflect doubt, as can be seen in the table below. Participants were asked to answer the question by rating their response on a scale ranging from completely useless (1) to very effective (5).

Table 39: Research Stations—Answers to the Question: "To what extent can written procedures help prevent downflooding?"

Other groups	No. of respondents	Weighted av.	0	%	1	%	2	%	3	%	4	%	5	%	Total (%)
Industry	8	4.13	0	0	0	0	0	0	2	25	3	38	3	38	100
Officials 1	17	3.18	0	0	0	0	6	35	6	35	1	6	4	24	100
Officials 2	12	3.33	0	0	0	0	2	17	6	50	2	17	2	17	100
Total	**37**	**-**	**0**	**0**	**0**	**0**	**8**	**22**	**14**	**38**	**6**	**16**	**9**	**24**	**100**

With respect to the notion of "familiarization", the following question was asked to the participants at the research stations: "For which reason do you believe that fishermen do not do exercises more often?". In response to this question, the reasons given by the fishermen and those given by the other groups can be found in the following table.

Table 40: Research Stations—Answers to the Question: "Why do you think the majority of fishermen do not give familiarization?"

Communities	No. of respondents	Not necessary	%	Discomfort	%	Lack of time	%	Don't know how	%	Other	%	Total (%)
English speakers	2	0	0	0	0	2	100	0	0	0	0	100
Bas-Saint-Laurent	5	0	0	0	0	3	60	1	20	1	20	100
Indigenous	13	0	0	0	0	8	62	1	8	4	31	100
North of Gaspésie	15	0	0	1	7	6	40	1	7	7	47	100
South of Gaspésie	16	1	6	2	13	3	19	5	31	5	31	100
MI and NS*	10	0	0	1	10	6	60	1	10	2	20	100
Total - Fishermen	**61**	**1**	**2**	**4**	**7**	**28**	**46**	**9**	**15**	**19**	**31**	**100**
Industry	8	0	0	4	50	2	25	2	25	0	0	100
Officials 1	17	2	12	1	6	0	0	3	18	11	65	100
Officials 2	10	1	10	3	30	0	0	5	50	1	10	100
Total - Others	**35**	**3**	**9**	**8**	**23**	**2**	**6**	**10**	**29**	**12**	**34**	**100**

* MI: Magdalen Islands, NS: North Shore

For fishing communities, "Lack of time" (46%) would be the main reason for not conducting familiarization, followed by "Other" (31%) and "Don't know how" (15%). For the other groups, the main reason is "Other" (34%), followed by "Don't know how" (29%) and "Discomfort" (23%). Unfortunately, notes taken during the discussions do not shed any light on the "Other" category, the second most common response for fishermen and the most common for other respondents. In discussions with fishermen, it would appear that the main obstacle to undertaking familiarization is the lack of understanding of how to do it and why it is important.

4. Behavioural Artefact—Risk Management

The behavioural artefact—Risk management deals with the implementation of prevention activities. It is the artefact with the greatest difference in the averages of its dimensions. On the one hand, the "Analysis" dimension has the highest average, with 86%. The "Hazard elimination" dimension received a score of 56%, followed by the "Risk control" dimension with 50% and finally the "Prevention" dimension with a low score of 33% (Table 29 on page 93).

The "Analysis" dimension scored significantly higher than the other three, but this result must be interpreted with caution. To begin with, the number of responses analyzed is less than the number of responses to the other questions, since not all respondents (fishermen) were exposed to an accident in the course of practising their occupation. We can conclude that when fishermen encounter such a situation (accident), their propensity to follow up is very high. Caution must be exercised, as the hypothesis of potential underreporting of occupational injuries remains to be verified for the commercial marine fishing community. Moreover, the notion of accident may also be subject to interpretation, as what one fisherman may consider an accident may not be considered an accident by another fisherman.

On the other hand, the dimension with the lowest average is "Prevention" at 33%. Three questions addressed this topic at the research stations. The responses again illustrate the gap between intentions and actions. The first question addressed to participants was: "Do you think that a single emergency exercise at the beginning of the season is enough?". The results of the responses are presented in Table 41.

Table 41: Research Stations—Answers to the Question: "Do you think that a single emergency exercise at the beginning of the season is enough?"

Communities	No. of respondents	Yes	%	No	%	Total (%)
English speakers	2	1	50	1	50	100
Bas-Saint-Laurent	5	0	0	5	100	100
Indigenous	13	5	39	8	62	100
North of Gaspésie	15	9	60	6	40	100
South of Gaspésie	16	9	56	7	44	100
MI and NS*	10	2	20	8	80	100
Total - Fishermen	**61**	**26**	**43**	**35**	**57**	**100**
Industry	8	0	0	8	100	100
Officials 1	17	8	47	9	53	100
Officials 2	10		0	10	100	100
Total - Others	**35**	**8**	**23**	**27**	**77**	**100**
Total	**96**	**34**	**35**	**62**	**65**	**100**

* MI: Magdalen Islands, NS: North Shore

Thus, it can be seen that a small majority of fishermen and group 1 officials consider that a single exercise is insufficient, but the Industry and Officials 2 respondent groups are more categorical.

Discussions at the research stations were relatively lively. Some argue that one exercise is sufficient for a short season (e.g., a five-week season). In reality, a single exercise is considered insufficient. This is why so many "Yes" responses are of concern, so much so that explanations, training, and awareness are needed, as much for the commercial fishing community as for industry stakeholders and even officials (surprisingly, eight people answered "Yes" in the Officials 1 group).

Although a majority of respondents agreed that one annual exercise is insufficient, when asked, "On your vessel, how many exercises do you do each season?" a large majority of fishermen, as shown in the following table, report doing only one (67%)—or even none (15%)—even though most respondents agree that it is not enough.

For instance, one master stated: "One a year, but it's not enough and I know it's not enough." Despite this, the number of emergency drills conducted on fishing vessels in Québec remains insufficient.

Table 42: Research Stations—Answers to the Question: "On your vessel, how many exercises do you do each season?"

Communities	No. of respondents	None	%	1	%	2	%	3 and +	%	Total (%)
English speakers	2	0	0	2	100	0	0	0	0	100
Bas-Saint-Laurent	5	0	0	2	40	1	20	2	40	100
Indigenous	13	0	0	11	85	2	15	0	0	100
North of Gaspésie	15	1	7	12	80	2	13	0	0	100
South of Gaspésie	16	8	50	8	50	0	0	0	0	100
MI and NS*	10	0	0	6	60	4	40	0	0	100
Total	**61**	**9**	**15**	**41**	**67**	**9**	**15**	**2**	**3**	**100**

* MI: Magdalen Islands, NS: North Shore

Finally, to the question, "For which reason do you believe that fishermen do not do exercises more often?", the reasons given by the fishermen and those given by the other groups can be found in the following table.

Table 43: Research Stations—Answers to the Question: "For which reason do you believe that fishermen do not do exercises more often?"

Communities	No. of respondents	Lack of time	%	Awkwardness, discomfort	%	Don't know how	%	Unnecessary	%	Other	%	Total (%)
English speakers	2	0	0	0	0	0	0	0	0	2	100	100
Bas-Saint-Laurent	5	3	60	0	0	1	20	0	0	1	20	100
Indigenous	13	7	54	1	8	0	0	4	31	1	8	100
North of Gaspésie	15	14	93	0	0	0	0	0	0	1	7	100
South of Gaspésie	16	6	38	3	19	1	6	1	6	5	31	100
MI and NS*	10	6	60	3	30	0	0	0	0	1	10	100
Total - Fishermen	**61**	**36**	**59**	**7**	**11**	**2**	**3**	**5**	**8**	**11**	**18**	**100**
Industry	8	0	0	0	0	3	38	5	63	0	0	100
Officials 1	17	3	18	1	6	0	0	3	18	10	59	100
Officials 2	10	1	10	0	0	5	50	2	20	2	20	100
Total - Others	**35**	**4**	**11**	**1**	**3**	**8**	**23**	**10**	**29**	**12**	**34**	**100**

* MI: Magdalen Islands, NS: North Shore

Once again, the "Other" category attracted a lot of responses without it being possible to find out more. In terms of the other response choices, the main reasons given for providing so little familiarization are the same as those given to the question about emergency response exercises.

On the one hand, it is conceivable that when the fishing season begins, the work pace is extremely intense and that, in these circumstances, time is scarce. On the other hand, better work organization and time management (for example, earlier when preparing for the fishing season, or by using downtime or quieter time on trips of a few days) could provide good opportunities for exercise or familiarization.

As in the case of familiarization, here again, it would seem that the main reason would be that fishermen do not know how to conduct emergency drills and how to encourage their crews to participate in them.

The "Hazard elimination" and "Risk control" dimensions show split averages with significant gaps between the maximum and minimum scores. Overall, this artefact has the lowest overall average. Had it not been for the "Analysis" dimension, the overall average would have been of even greater concern.

It is also this artefact that, overall, has the lowest minimum values. All in all, these values indicate that there is still a lot of work to be done in terms of carrying out prevention activities. It is interesting to note that for some dimensions, the maximum score of 100% was achieved. At the other end of the scale, there were also 0% scores. This indicates that there is considerable variability in culture between vessels. The next section precisely explores this variability.

b) Correlations Between Beliefs and Artefacts

As mentioned in the section on defining a safety culture, it consists of a combination of beliefs, values, and artefacts. Normally, behaviours (which make up the artefacts in this case) are influenced by beliefs and values. Therefore, two types of regressions were calculated to test the extent to which beliefs and values correlate with scores on the four artefacts.

First, regressions were calculated between the six master and crew factors, on the one hand, and the scores on the four artefacts on the other. To avoid unduly overloading the text with statistics, it is sufficient to say that practically no significant correlations were detected. Only a few weak trends ($0.10 < p < 0.20$) were found. This observation in itself is intriguing. When behaviours are not aligned with basic beliefs and values, something is interfering between the two. Practical, pragmatic, or circumstantial considerations take precedence over values and condition behavioural orientation. Therefore, subsequently, correlations were calculated between the same parameters, i.e., between the six belief factors (but only for the masters this time) on the one hand, and the four artefacts, on the other hand. The table below presents the results of these correlations.

Table 44: Correlations Between Beliefs and Artefacts

Artefact	Value	Factor 1 OHS as value	Factor 2 Attitudes towards legislation	Factor 3 Fatalism	Factor 4 Risks of the profession	Factor 5 Concern	Factor 6 Profitable season
Technical	r =	0.131	0.136	0.036	0.039	0.089	-0.267
	p =	0.228	0.210	0.739	0.725	0.416	**0.013**
	N =	86	86	86	86	86	86
Normative	r =	-0.030	0.040	-0.199	0.139	-0.087	-0.171
	p =	0.782	0.715	**0.068**	0.204	0.430	0.118
	N =	85	85	85	85	85	85
Behavioural (Safe work practices)	r =	0.055	0.009	-0.116	0.072	-0.083	-0.291
	p =	0.586	0.930	0.249	0.475	0.410	**0.003**
	N =	100	100	100	100	100	100
Behavioural (Risk management)	r =	-0.020	-0.066	-0.064	0.022	-0.089	-0.363
	p =	0.846	0.515	0.527	0.831	0.379	**0.000**
	N =	99	99	99	99	99	99

This time, four significant correlations (identified in blue in Table 44) were detected, and not necessarily those that might have been expected. One would have expected that factor 1, the belief that OHS is a core value, would influence behaviour in each of the four artefacts; however, this was not the case. It is equally surprising that Factor 2, i.e., attitudes towards laws and regulations, is not correlated with the normative factor that relates to compliance with laws and regulations.

Some results, nonetheless, are very interesting. For instance, we notice that the more fatalistic masters are ("risks are part of the job", dependence on Mother Nature), the less inclined they are to respect laws and regulations. It's as if they were telling themselves: "Laws and regulations don't understand anything about the reality we're living, so what's the point?".

Even more interesting, factor 6, which focuses on the importance of having a profitable season, is correlated with three of the four artefacts; only the normative factor is not correlated with this factor, and again, with a probability of 0.118, there is a trend in this direction. In short, the more masters believe that it is important to have a profitable season, the less their vessel receives a good score on the technical factor, the less inclined they are to implement safe work practices and the less likely they are to carry out prevention activities (risk management artefact). As mentioned, there is also a tendency for the belief in the importance of a profitable season to lead to less compliance with laws and regulations.

A clarification is needed before going any further. While it is true that the question about the importance of a profitable season is the main question of the masters' factor 6, it is not the only question of this factor; question 58 "Alcohol and drug use is widespread in our industry" is also part of it. Question 47 on the profitable season was then isolated, and the correlations between it and the four artefacts were recalculated. The table below indicates that two of the four correlations are still significant. As noted earlier, the more important a profitable season is for masters, the less inclined they are to apply safe work practices and conduct prevention activities.

Table 45: Correlations Between the Question, "It is very important for the master to have a profitable season." (M47) and the Four Artefacts

Statistics	Technical	Normative	Behavioural (Safe work practices)	Behavioural (Risk management)
r =	-0.142	-0.135	-0.167	-0.206
p =	0.191	0.218	0.097	0.041
N =	86	85	100	99

Although the correlations are significant, it was important to test whether the relationships were linear. For this reason, scatter plots were drawn to illustrate the correlation between question 47 and each of the four artefacts, considering the four maturity levels of safety culture. These graphs can be found in Appendix P.

An interesting observation arises from these graphs. Regardless of the extent to which they believe it is important to have a profitable season, those who are called proactive generally maintain their good results on the four artefacts. The situation is rather unclear for the other groups. For the reactive group, the more masters believe in the importance of a profitable season, the more their scores on all four artefacts deteriorate. It therefore appears that the economic pressure of the fishing season

represents an extremely practical consideration that sometimes prevents the values of fishermen from fully influencing their behaviour, particularly for certain groups or maturity levels.

Finally, regressions were also calculated to verify if other belief questions had an influence on the four artefacts. The complete results are presented in Tables 63 and 64 in Appendix P. Since the numbers were small in some groups, probability thresholds up to 0.15 (indicating a non-significant trend) were included.

The first finding is that questions about beliefs related to the artefacts are quite different between masters and crew members.

On the one hand, among masters, questions QM46 ("Fishing safety has improved significantly in recent years") and QM58 ("Alcohol and drug use is widespread in our industry") each predict three artefacts, and even represent two of the three questions that predict two artefacts: the technical artefact, and the behavioural artefact—safe work practices; the question about alcohol and drug use is found to be the main predictor for both behavioural artefacts.

Overall, however, these regressions are hard to interpret. One example of this: for the behavioural artefact—Risk management, it is understandable that the less masters believe that laws and regulations make work difficult or strenuous, the more prevention activities they undertake; however, the negative correlation between the artefact and the belief that laws and regulations make work safer is puzzling, especially since these two issues correlate negatively with each other. In any case, the recurrence of the QM46 question about improving safety over time demonstrates optimism on the part of masters that will be picked up and discussed in the overall assessment section below.

On the other hand, the two predominant questions among crew members are quite different. These are questions QCM51 ("The safety measures we apply are sufficient to prevent accidents") and QCM54 ("There is a lot of mutual help in our team"), which are asked twice each.

If we add questions QCM60 ("Caution can prevent most types of accidents"), QCM42 ("Fishing safety has improved significantly in recent years") and QCM59 ("It is possible to have fishing seasons without accident"), the general tone is optimistic and seems to reflect the belief that "if we are careful, we can succeed in preventing accidents", a belief confirmed by the negative correlation with the statement "Our fate depends heavily on Mother Nature." (QCM57)

In short, "it's up to us not to have accidents"; there is no reference here to laws and regulations or to the use of alcohol and drugs. Furthermore, great caution must be exercised in interpreting these results, since six of the eight components have probabilities of more than 0.05, four of which have probabilities of more than 0.1.

c) Specific Characteristics

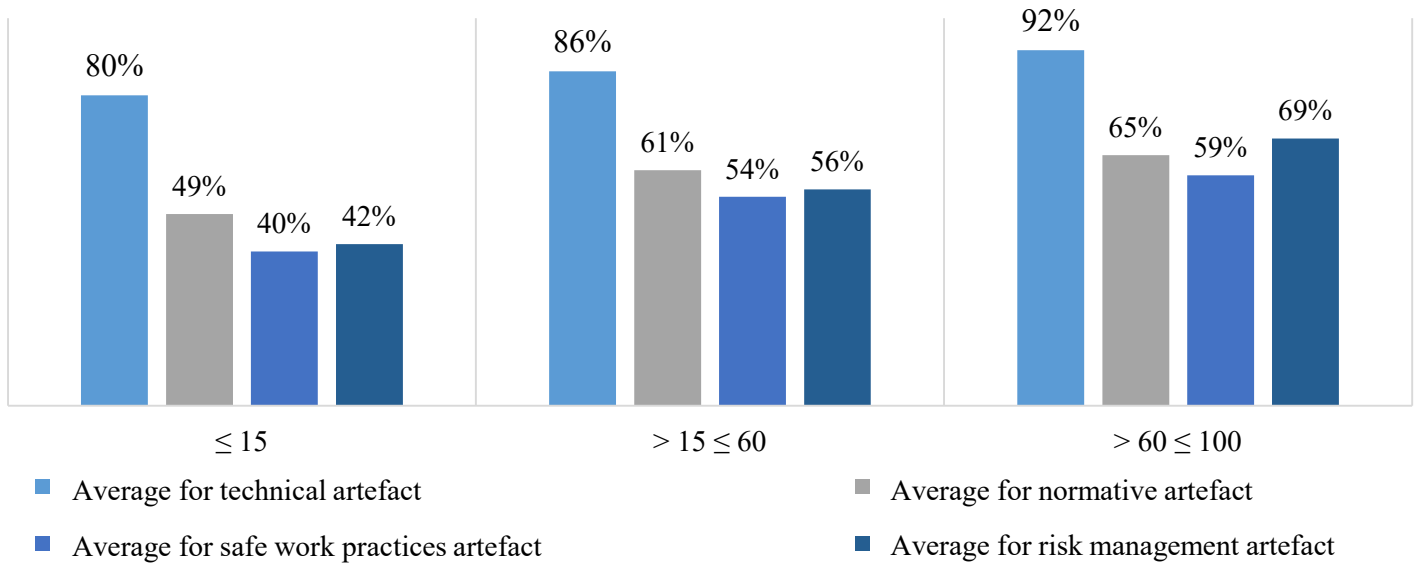
Specific characteristics refer to certain key elements that allow us to make distinctions in order to test certain basic assumptions. The results are presented in detail based on these specific characteristics.

First, the gross tonnage of a vessel is a factor that separates the fleet into two categories: vessels that are subject to mandatory inspections and those that are not. It is then a question of validating whether the obligation to inspect is a factor that positively influences the scores and, consequently, the safety culture.

"In accordance with the *Fishing Vessel Safety Regulations (FVSR)* (sections 9 and 10), small fishing vessels over 15 gross tonnage (GT) must hold an inspection certificate issued by the Minister in order to engage on a voyage." (Transport Canada, 2017: 2)

As shown in Chart 10, our basic hypothesis is confirmed by the measurements obtained. When we analyze the scores obtained according to three gross tonnage categories —15 and under, over 15 to 60 and under, over 60 to 100 and under—it is clear that the 15 and under category has the lowest scores for all artefacts.

Graphic 10: Average Scores per Artefact by Gross Tonnage

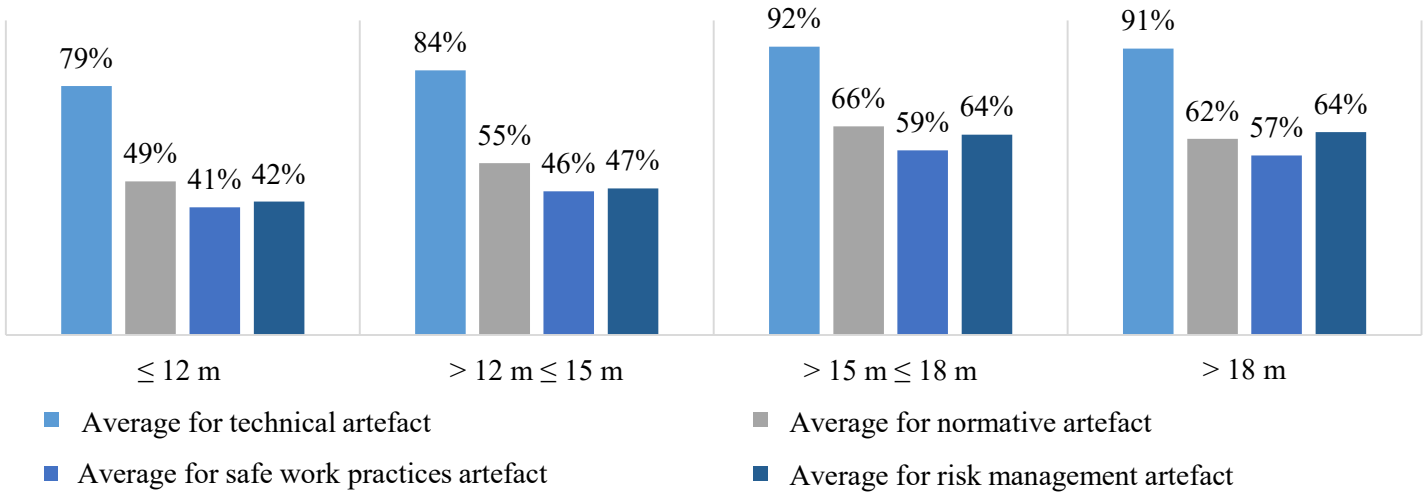


We believe that the observed results can be explained in part by the fact that the vessel with a gross tonnage of up to 15 is not subject to inspection. In other words, inspections are proving to be a driver behind the development of a strong safety culture. Strategies or measures to be implemented should not, however, be restricted solely to inspection activities, as they are only one of the many factors that can help change behaviours.

Overall length is the second factor considered. Our starting assumption is that the level of safety culture is proportional to the length of the vessel and, therefore, crews on larger vessels have a better safety

culture than those on smaller vessels. This would be partly explained by the types of voyages made. Larger vessels tend to make voyages of varying length, which can stretch over a few days. Furthermore, the distances travelled, and the risks faced by professional fishermen are greater for vessels engaged in mid-shore fishing, which excludes all vessels of 12 m and less.

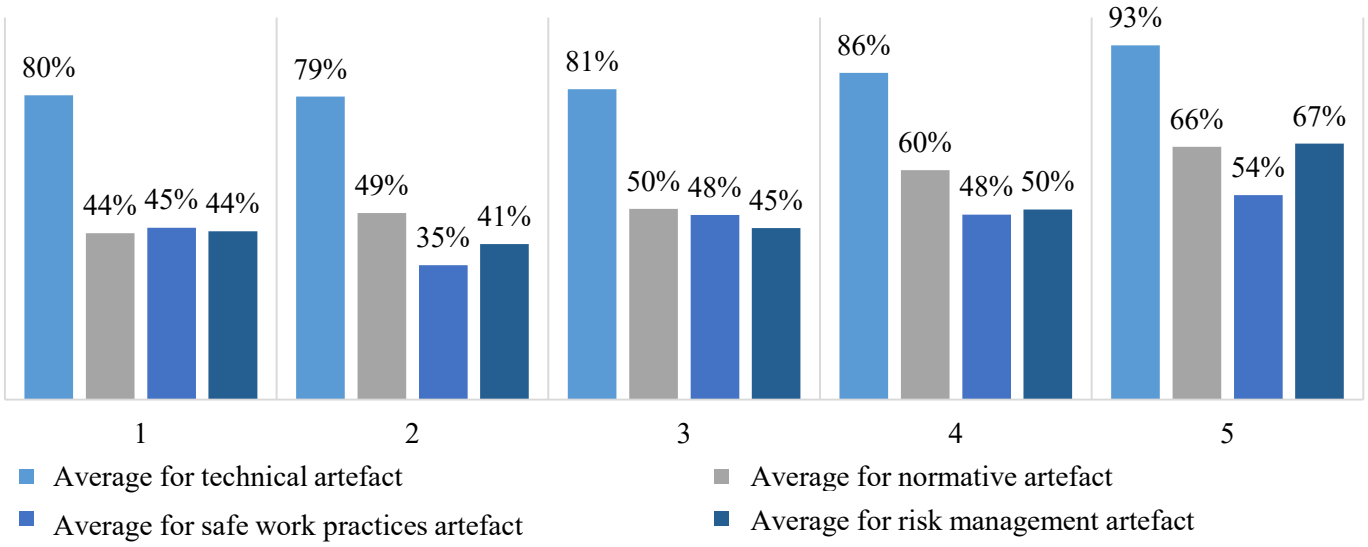
Graphic 11: Average Scores per Artefact by Overall Length



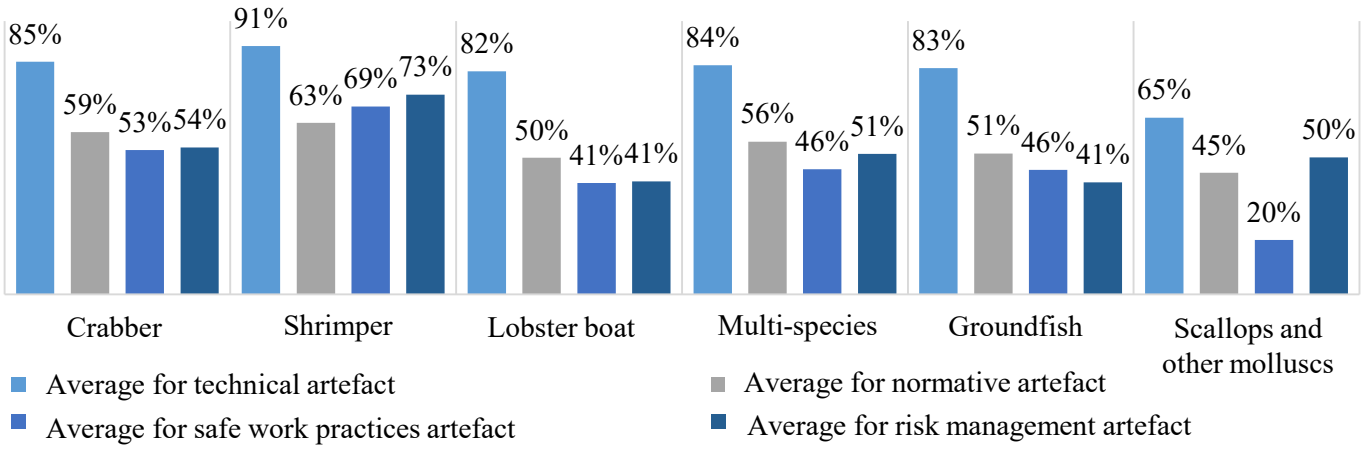
The results confirm our initial hypothesis that the longer the boat is, the greater the safety culture. This is easily observed when we compare the score obtained for the category "12 m and less" for the risk management artefact which is 42% while it is 64% for the category "more than 18 m".

Manpower refers to the number of people who are part of the crew of a vessel. The larger the manpower, the greater the need for "organization" to ensure that everyone is properly coordinated. The safety culture should be stronger when the manpower is larger. Again, the results confirm that the larger the manpower, the stronger the safety culture.

Graphic 12: Average Scores per Artefact by Number of Employees



Graphic 13: Average Scores per Artefact by Type of Fishing Fleet



Finally, the fleets can be distinguished based on the main species fished. Not only does the fishing gear required vary according to the target species, but the type of voyages and the duration of fishing voyages also vary greatly. Our hypothesis is that fleets exposed to greater risks should have a more developed safety culture. Based on the results shown on the previous page, our hypotheses seem to be validated once again. In fact, crabbers and shrimpers have a stronger safety culture, even though they are identified as the fleets most exposed to risk. Because variations exist between fleets, this is a key indicator for decision-makers to consider when developing and implementing strategies to foster a safety culture.

d) Culture Maturity Stages and Fishing Fleets

Calculating the averages of the artefact scores makes it possible to qualify the maturity level reached by the safety culture in the fishing industry. It is worth noting that, in our reference framework, the stages of maturity of the safety culture in the commercial fishing industry are (1) pathological, (2) reactive, (3) buyer, and (4) proactive. As a reminder, we can describe each of the stages as follows:

- The pathological stage is characterized by a narrow understanding of safety where compliance is seen as a source of expense;
- The reactive stage is associated with an understanding of safety that is limited to compliance;
- The buyer stage is defined by an understanding of safety that goes beyond compliance with requirements and recognizes the need for risk;
- The proactive stage stands out for the integration of safety concepts into its daily practices. Safety is then no longer seen as a requirement to be complied with.

We have therefore defined a scale based on the scores obtained as follows:

- Score from 0 to 29% = Pathological stage, represented by a black circle;
- Score of 30% to 49% = Reactive stage, represented by a red circle;
- Score from 50% to 69% = Buyer stage, represented by a yellow circle;
- Score of 70% and above = Proactive stage, represented by a green circle.

It is then possible to assess the maturity stages of the safety culture based on the four artefacts and the results are presented based on the type of fleet and the main fishing area.

Table 46: Dimensional Scores for the Technical Artefact, 2019

Fleet and fishing area	Dimension 1 Vessel (maintenance)		Dimension 2 Safety Equip. (presence)		Dimension 3 Fishing equip. (installation)		Technical artefact	
Crabber	🟢	**75%**	🟢	**86%**	🟢	**95%**	🟢	**85%**
Lower North Shore	🟡	62%	🟢	81%	🟢	90%	🟢	77%
Area 12	🟢	84%	🟢	93%	🟢	99%	🟢	92%
Area 16	🟢	72%	🟢	79%	🟢	97%	🟢	83%
Area 17	🟢	91%	🟢	93%	🟢	96%	🟢	93%
Shrimper	🟢	**95%**	🟢	**93%**	🟢	**85%**	🟢	**91%**
Lobster boat	🟢	**74%**	🟢	**75%**	🟢	**96%**	🟢	**82%**
Baie-des-Chaleurs	🟢	71%	🟢	74%	🟢	94%	🟢	80%
South of Gaspésie	🟢	74%	🟢	78%	🟢	98%	🟢	83%
Magdalen Islands	🟢	77%	🟢	74%	🟢	97%	🟢	83%
Multifisheries	🟢	**74%**	🟢	**84%**	🟢	**93%**	🟢	**84%**
Scallops and other molluscs	🟡	**68%**	🔴	**41%**	🟢	**85%**	🟡	**65%**
Groundfish	🟢	**76%**	🟢	**72%**	🟢	**100%**	🟢	**83%**
Overall average	🟢	***75%***	🟢	***80%***	🟢	***95%***	🟢	***83%***

In general, the scores for the technical artefact are quite positive and indicate that several fleets have reached the proactive stage. Shrimpers have a better average on the "maintenance" dimension (95%) than other fleets (average for others of 73%). Lower North Shore crabbers and Gulf scallops and other molluscs vessels show the lowest scores with an average of 62% and 68% respectively.

The "Safety equipment" dimension is used to assess the presence or absence of required equipment on fishing vessels. On the one hand, all fleets show high scores, indicating that this aspect is acquired and well mastered. On the other hand, the results for the scallops and other molluscs fleet, with an average of 41%, stand out negatively, which is an indicator of the targets to be prioritized. The "Fishing equipment" dimension is used to evaluate the quality of the installation and the general appreciation of the workstations. The results are excellent for all fleets, which seems to indicate

that fishermen consider their working environment to be optimal. This finding was also confirmed by the observations of the agents.

A closer look reveals an interesting fact: among shrimpers, masters and crew members unanimously recognize that workstations are not optimal for performing safe work, which could be a sign of a need for assistance with innovation.

Table 47: Dimensional Scores for the Normative Artefact, 2019

Fleet and fishing area	Dimension 4 Training (activities and proof)		Dimension 5 Regulation (compliance and knowledge)		Dimension 6 Stability (concern and knowledge)		Normative artefact	
Crabber	🟡	**63%**	🔴	**46%**	🟡	**68%**	🟡	**59%**
Lower North Shore	🟡	55%	🔴	40%	🟡	68%	🟡	54%
Area 12	🟢	74%	🔴	42%	🟢	74%	🟡	63%
Area 16	🟡	53%	🟡	52%	🟡	68%	🟡	58%
Area 17	🟢	77%	🟡	56%	🟡	63%	🟡	65%
Shrimper	🟡	**62%**	🟡	**57%**	🟡	**69%**	🟡	**63%**
Lobster boat	🟡	**58%**	🔴	**39%**	🟡	**53%**	🔴	**50%**
Baie-des-Chaleurs	🟡	54%	🔴	38%	🟡	58%	🟡	50%
South of Gaspésie	🟡	61%	🔴	43%	🔴	45%	🔴	50%
Magdalen Islands	🟡	59%	🔴	39%	🟡	52%	🔴	50%
Multifisheries	🟡	**65%**	🔴	**49%**	🟡	**53%**	🟡	**56%**
Scallops and other molluscs	🟢	**72%**	🔴	**31%**	🔴	**30%**	🔴	**45%**
Groundfish	🟡	**57%**	🟡	**52%**	🔴	**46%**	🟡	**51%**
Overall average	🟡	***61%***	🔴	***45%***	🟡	***57%***	🟡	***55%***

The "Training" dimension indicates that, for all fleets, masters and crew members have completed the training required by the regulations. However, what decreases the score for this dimension is the fact that very few crews undertake continuous training.

Equally disturbing is the fact that in 40% of cases, masters do not seem to care about the skills and training of their crew members. Very few of them were aware of the training certificates held by their crew members during interviews. It should also be noted that the Area 12 and Area 17 crabber fleets posted the highest scores, with 74% and 77% respectively.

The "Regulation" dimension indicates that one observation is applicable to all fleets: knowledge of the regulations and the system of sanctions is generally very low. Without this element, the score for each of the fleets would have been much higher in this dimension, because the score for the "compliance with regulations" element was higher. In light of these results, there is reasons to question the relationship between knowledge of regulations and the ability to comply with them. Is it really essential for fishermen to know the regulations?

The "Stability" dimension reveals that, for all fleets as a whole, knowledge of the notions of stability is rather good. This result is surprising since most vessels with a gross tonnage of 15 or less do not have stability data.

We observe that when stability data is on board, the knowledge is better mastered. It is among Area 12 crabbers and among shrimpers that the notions of stability are best understood. This can be explained by the fact that Area 12 crabbers have a more complex stability, being sometimes equipped with seawater holds. For shrimpers, holds are frequently loaded to their maximum capacity and the crew must therefore be more attentive to stability.

Table 48: Dimensional Scores for the Behavioural Artefact—Safe Work Practices, 2019

Fleet and fishing area	Dimension 7 Work practices (training and instructions)		Dimension 8 Practice management (use of PPE)		Behavioural artefact - Safe work practices	
Crabber	🟢	**76%**	⚫	**29%**	🟡	**53%**
Lower North Shore	🟡	68%	🔴	32%	🔴	50%
Area 12	🟢	90%	🔴	30%	🟡	60%
Area 16	🟢	74%	⚫	16%	🔴	45%
Area 17	🟢	78%	🔴	40%	🟡	59%
Shrimper	🟢	**87%**	🟡	**51%**	🟡	**69%**
Lobster boat	🟡	**55%**	⚫	**27%**	🔴	**41%**
Baie-des-Chaleurs	🟡	59%	⚫	29%	🔴	44%
South of Gaspésie	🟡	61%	⚫	26%	🔴	43%
Magdalen Islands	🔴	49%	⚫	25%	🔴	37%
Multifisheries	🟢	**72%**	⚫	**20%**	🔴	**46%**
Scallops and other molluscs	🔴	**42%**	⚫	**-2%**	⚫	**20%**
Groundfish	🟡	**63%**	⚫	**29%**	🔴	**46%**
Overall average	🟡	***67%***	⚫	***26%***	🔴	***46%***

The "Work practices" dimension shows an overall average of 67%, which is a good score all in all. However, we noticed that there are contradictions in the responses, since in 40% of the cases where masters say they give clear instructions, crew members say they do not receive any. Furthermore, 43% of masters say that they call their crew members to order for non-compliance with instructions, while crew members say the opposite, clearly demonstrating a lack of communication of instructions and expectations.

In 61% of cases, written procedures are found on board vessels, a result that exceeded expectations, since this requirement is relatively new. However, in 32% of these cases, procedures are not followed. Here one would have expected to see a higher rate of non-compliance on smaller vessels, as their accommodations are less suitable for administrative tasks. However, gross tonnage does not explain the results of this dimension. Once again, the mid-shore fleets, i.e., the Area 12 crabbers and the shrimpers, are demonstrating best practices.

These results are probably related to the complexity of the work and the risks to which these fleets are more frequently exposed. Furthermore, the transit times in these types of fisheries allow more time for the master to maintain records and documents.

The dimension of "Practice management" refers to the use of personal protective equipment by both fishermen and masters. The extremely low overall average of 26% leads us to conclude that personal protective equipment is not used to a point where the situation is worrisome.

With the exception of the shrimpers that show the best score with an average of 51%, all the fleets have low results. As for lobster boats, their overall average of 27% indicates that the majority of masters do not wear PFDs, even though this is mandatory under CNESST regulations. Given the generally poor results, this element will be repeated in the section on final recommendations.

Table 49: Dimensional Scores for the Behavioural Artefact—Risk Management, 2019

Fleet and fishing area	Dimension 9 Risk control (PPE)	Dimension 10 Hazard elimination (maintenance)	Dimension 11 Analysis (accident follow-up)	Dimension 12 Prevention (emergency measures)	Behavioural artefact - Risk management
Crabber	**53%**	**59%**	**86%**	**40%**	**54%**
Lower North Shore	48%	54%	100%	36%	49%
Area 12	55%	73%	72%	53%	62%
Area 16	52%	48%	100%	23%	44%
Area 17	63%	61%	92%	50%	65%
Shrimper	**78%**	**68%**	**100%**	**58%**	**73%**
Lobster boat	**47%**	**50%**	**67%**	**25%**	**41%**
Baie-des-Chaleurs	47%	59%	N/A	27%	45%
South of Gaspésie	47%	44%	N/A	26%	39%
Magdalen Islands	47%	46%	67%	23%	40%
Multifisheries	**49%**	**60%**	**85%**	**35%**	**51%**
Scallops and other molluscs	**16%**	**71%**	**100%**	**13%**	**50%**
Groundfish	**45%**	**59%**	**N/A**	**19%**	**41%**
Overall average	***50%***	***56%***	***86%***	***33%***	***49%***

With the exception of shrimpers, who score 78%, the "Risk Management" dimension shows a low overall average of 50%. Considering the very low use of PPE, it is clear that the results for maintenance and training are also low or virtually non-existent. Far behind the others, the 16% score obtained by the scallops and other molluscs fleet is a worrisome indicator that deserves special attention.

The "Hazard elimination" dimension allows assessing the extent to which preventive maintenance is carried out on board vessels. Although most masters do not perform risk analysis and do not have risk logs or verification forms, several vessels are rated highly for their good practices in inspecting the vessel and its equipment.

The "Analysis" dimension shows a high average of 86%, which means that, for all fleets, fishermen report accidents. However, caution must be exercised in interpreting these results since they are based on a smaller sample than all the other aspects studied given that not all fishermen have experienced situations where an accident has occurred. Finally, the "Prevention" dimension refers to the practice of emergency measures.

With the exception of the shrimp vessels that appear to keep records, the comment that applies to the entire fleet is that the results are generally disappointing. All fleets conduct very few drills and crew members report feeling ill-prepared to carry out emergency procedures. This is particularly troubling since emergency measures are the last resort to prevent an accident from becoming a disaster.

The overall picture that emerges is that the safety culture in the commercial marine fishing industry in Québec is rather average. As observed during the research stations, fishermen tend to overestimate the maturity level of their industry in terms of safety culture. However, the low results obtained for three of the four artefacts tend to confirm the perceptions of the other participants, i.e., those of industry and officials. This demonstrates that, while the situation is not disastrous, much work remains to be done.

Table 50: Maturity Level by Fleet Scores, 2019

Fleet	Maturity stage	Artefact			
		Technical	Normative	Safe work practices	Risk management
Shrimper (Gulf)	Proactive	90.9%	62.8 %	68.7%	73.1%
Crabber (Area 17)	Proactive	93.2%	65.3%	58.7%	64.8%
Crabber (Area 12)	Proactive	91.7%	63.3%	60.2%	62.2%
Multifisheries (Gulf)	Buyer	83.9%	55.7%	45.8%	45.8%
Crabber (Lower North Shore)	Buyer	77.5%	54.3%	50.0%	50.0%
Groundfish (Gulf)	Buyer	82.8%	51.5%	45.5%	45.5%
Crabber (Area 16)	Buyer	82.0%	57.6%	45.0%	45.0%
Lobster boat (Baie-des-Chaleurs)	Reactive	79.6%	50.0%	43.9%	43.9%
Lobster boat (Magdalen Islands)	Reactive	82.7%	49.9%	37.3%	37.3%
Lobster boat (South of Gaspésie)	Reactive	83.2%	49.8%	43.3%	43.3%
Scallops and other molluscs	Pathological?	67.7%	44.5%	19.9%	19.9%

When comparing the scores obtained for each of the fleets, it is possible to distinguish them based on their culture level. Shrimpers are those with the highest scores and the highest level of maturity in safety culture, i.e., "Proactive". Given that shrimpers make one-week voyages, on average, fish in areas that are more exposed to the elements, travel greater distances and have an average crew of five, we believe that the risk factors to which they are exposed lead them to adopt safer behaviours (wearing PPE) or to organize themselves in a more structured manner (presence and updating of logs).

Crabbers in Area 17 and Area 12 also obtain very satisfactory scores. As with shrimpers, some safety deficiencies have been noted, but the stage of maturity of these fleets is described as "Proactive".

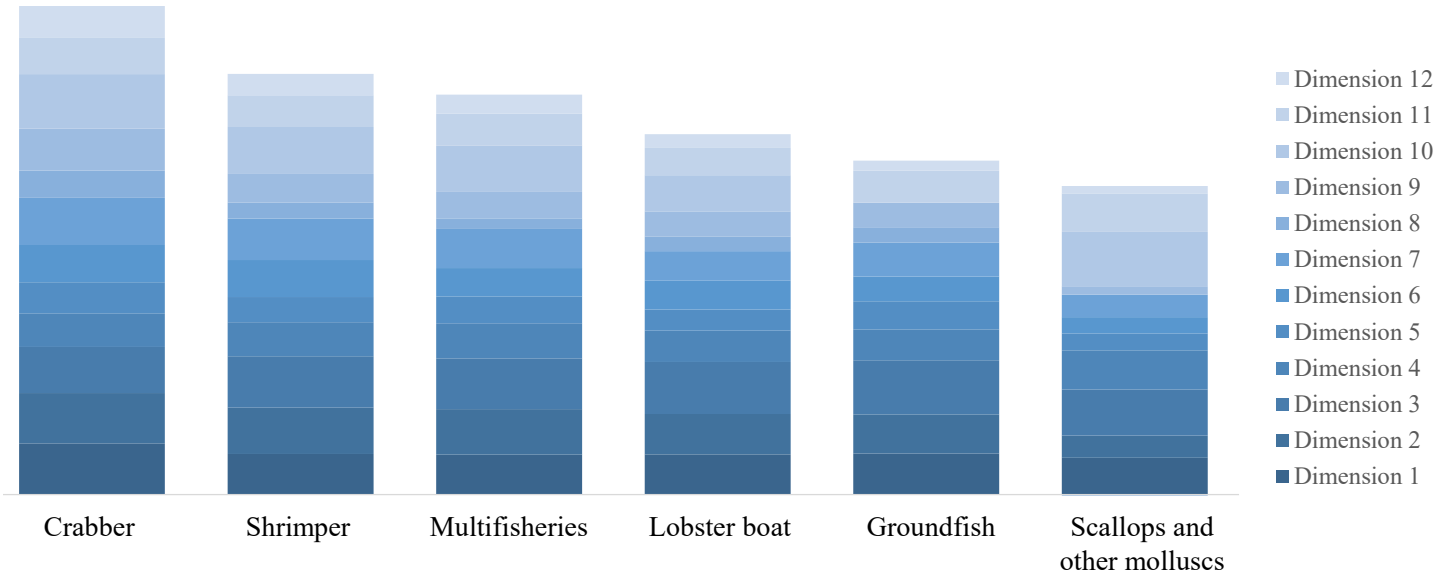
However, for Area 16 and Lower North Shore crabbers, there is a certain lag compared to their counterparts on the South Shore with respect to behavioural artefacts. In fact, this lag is observed on practically all vessels operating on the North Shore, all types of fishing combined. Is this due to their geographic isolation? Are the authorities less present and active on this territory? Further analysis would be necessary.

North Shore crabbers, groundfish and multifisheries fleets are fishing enterprises whose maturity stage is at the "Buyer" level. Therefore, this is a group that should move fairly quickly to the "Proactive" stage with a little more monitoring and, above all, with well-structured and coordinated information and awareness interventions.

All lobster boats, which represent 70.6% of the Québec fishing fleet (Table 6), are unfortunately in the "Reactive" stage. This is not surprising, however, given that almost all of these vessels have a gross tonnage of 15 or less and are therefore not inspected. It is clear that these fleets require better supervision by the authorities, i.e., more control by inspection and a lot of information and awareness-raising work to be carried out.

The only fleet identified as pathological is the scallops and other molluscs fleet. However, this result must be interpreted with caution, as the number of vessels in the sample is lower for this fleet. Nevertheless, we recommend increased the monitoring of this fleet.

Graphic 14: Overview of Safety Culture by Fishing Fleet, 2019



The figure above clearly shows that the safety culture in the commercial marine fishing industry varies among the Québec fleets.

Calculating the levels achieved for each of the dimensions identified in this research highlights the gaps and shortcomings for which it would be important to implement strategies adapted to the specific reality of each of the groups analyzed.

This safety culture overview summarized in graphical form is a new and innovative tool since no calculation method had been formulated until now. Since our research focused on the portrait of the culture in Québec, it seems relevant to us that this method be replicated for all Canadian provinces and be the subject of future research and development within the scientific community.

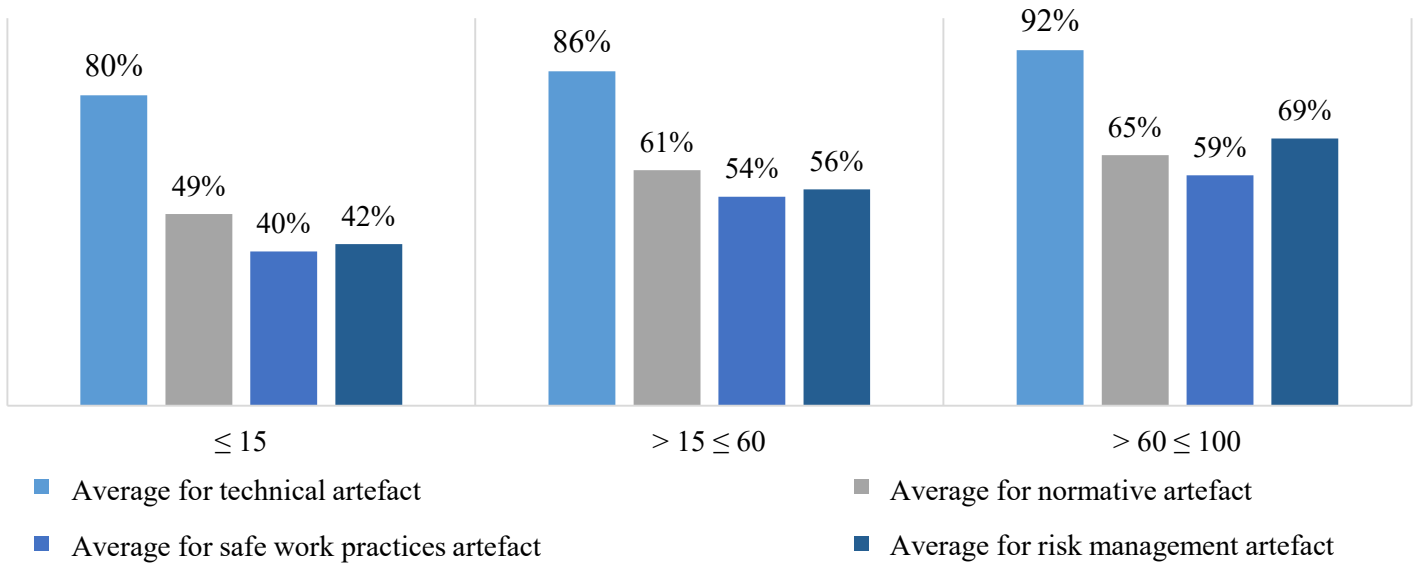
Chapter 6
Recommendations

This section presents the recommendations stemming from the results obtained from the analyses of the costs of occupational injuries, statistics on accidental events and the analysis of the safety culture in the commercial marine fishing industry. Some focus on specific aspects while others are more global in scope. In general, the recommendations formulated as a result of the analyses call for a better alignment between the approaches of the State and the specific reality of the fishing fleets, as well as the improvement of the processes for the collection and exchange of information on the fishing fleet in order to make decisions based on reliable data available in real time.

Recommendation 1: That Transport Canada review its current surveillance and inspection approach based on the gross tonnage of the vessel.

Statistics indicate that the rate of accidental events is higher for uninspected vessels. In fact, 60% of incidents (336/536) and 52% of accidents (100/192) occurred on vessels not more than 15 gross tonnage between 2005 and 2015. Furthermore, safety culture scores are lower for uninspected vessels than for vessels over 15 gross tonnage.

Graphic 10: Average Scores per Artefact by Gross Tonnage



The current approach to monitoring and inspection is different depending on the type of vessel being referred to, distinguishing vessels by gross tonnage. As such, vessels not more than 15 gross tonnage are not subject to Transport Canada's inspection scheme. For these vessels, a voluntary compliance program has been put in place (Transport Canada, 2018). For vessels over 15 gross tonnage, sections 8, 9 and 10 of the *Vessel Certificates Regulations* (Minister of Justice, 2007) stipulate that the vessel must hold an inspection certificate and that the authorized representative must ensure that the vessel undergoes the necessary inspections to obtain this certificate. Fishing vessels over 15 gross tonnage are therefore subject to mandatory inspections by Transport Canada at regular intervals (every 4 years).

So, it's an upside-down world. Current government approaches to inspection and compliance monitoring of fishing vessels are not targeting the right clients. We have shown that the vessels most at risk are certainly those with a weak safety culture and a high rate of accidental events. To address the identified deficiencies in the fleet of vessels not more than 15 gross tonnage, self-regulation in the form of a regulatory compliance program cannot be an effective solution. Take the example of a schoolchild with learning difficulties: the proposed solution will be based on a more rigorous framework.

If the objective is to reduce the risk of accidental events, the current framework must be reviewed in order to increase the rate of inspections of vessels with the greatest deficiencies, i.e., those with a gross tonnage of 15 or less. Similarly, for vessels that do not have deficiencies—the so-called "Proactive" fleets in terms of their level of safety culture, and particularly in terms of compliance—unannounced and/or random inspections may be sufficient. Since professional fishermen are familiar with the recurrence of inspections, it is likely that their efforts to comply with the regulations will increase as the time for inspection approaches. If the preferred approach is a random selection, the incentive to maintain compliance at all times is greater.

We recommend reversing the current approaches by applying self-regulation for vessels over 15 gross tonnage and implementing an inspection program for vessels not more than 15 gross tonnage. This inspection program should be designed to increase the presence on board these vessels of officials in order to verify compliance and, above all, to inform the fishermen of these fleets of the regulatory requirements applicable to them and to make them aware of good safety practices.

Recommendation 2: That presential activities on the North Shore and mainly on the Lower North Shore be intensified.

With regard to the crabbers' safety culture, we note that those in Area 12 (B, C, E, F) and Area 17 are at the highest stage, i.e., at the "Proactive" level. Crabbers in Area 16 and the Lower North Shore have a lower safety culture and are at the "Buyer" stage.

How can it be explained that within the same fleet—in this case the crabbers—the levels achieved in terms of safety culture vary? The results show that the North Shore crabbers' shortcomings are mainly at the level of behavioural artefacts and that the compliance score is also lower. Apart from the resources made available to crabbers throughout the administrative region, the other intrinsic or extrinsic characteristics of the crabbers do not allow for any other explanation than the need for support for crabbers in Area 16 and the Lower North Shore.

Since the results indicate that they are less strong in terms of compliance, to enable them to reach a higher level of safety culture, they must be offered support to make up for the discrepancies and reach the same maturity level as crabbers in Areas 12 and 17. We recommend increasing the number and/or frequency of visits made by TCMSS inspectors to crabbers in the Lower North Shore region in order to identify shortcomings and to provide guidance to professional fishermen in upgrading their compliance. Such a measure will also help them learn about the importance of safe work practices and risk management.

Table 51: Crabbers' Scores for Safety Culture

Fleet	Gross tonnage	Length	Score by artefact			
			Technical	Normative	Safe work practices	Risk management
Area 16	≤ 15	> 15 m ≤ 18 m	77%	62%	45%	36%
	> 15 ≤ 60	> 12 m ≤ 15 m	85%	68%	38%	45%
	≤ 15	> 12 m ≤ 15 m	79%	52%	21%	34%
	> 15 ≤ 60	> 12 m ≤ 15 m	79%	61%	60%	57%
	> 15 ≤ 60	> 12 m ≤ 15 m	93%	45%	61%	47%
Lower North Shore	≤ 15	> 12 m ≤ 15 m	84%	59%	39%	38%
	≤ 15	≤ 12 m	82%	33%	52%	53%
	> 15 ≤ 60	> 12 m ≤ 15 m	81%	69%	68%	48%
	> 15 ≤ 60	> 15 m ≤ 18 m	83%	52%	47%	48%
	> 15 ≤ 60	> 12 m ≤ 15 m	60%	43%	33%	47%
	> 15 ≤ 60	> 12 m ≤ 15 m	86%	62%	51%	58%
	> 15 ≤ 60	> 12 m ≤ 15 m	66%	62%	59%	47%
Area 17	> 15 ≤ 60	> 15 m ≤ 18 m	98%	84%	67%	67%
	> 15 ≤ 60	> 15 m ≤ 18 m	86%	61%	72%	59%
	> 60 ≤ 100	> 18 m	95%	59%	35%	54%
	> 15 ≤ 60	> 15 m ≤ 18 m	94%	57%	60%	80%
Area 12	> 60 ≤ 100	> 15 m ≤ 18 m	95%	67%	70%	66%
	> 60 ≤ 100	> 18 m	94%	61%	59%	86%
	> 60 ≤ 100	> 18 m	85%	73%	54%	68%
	> 100	> 18 m	90%	50%	54%	34%
	> 60 ≤ 100	> 18 m	95%	65%	64%	57%

Recommendation 3: That an analysis of the safety culture of the scallops and other molluscs fleet be replicated with a sample of at least 10 triads.

The results obtained for scallops and other molluscs vessels with respect to safety culture identify them as being at the "Pathological" stage. Although the sample size for scallops and other molluscs vessels is smaller than for the other fleets, this is a very worrisome indicator. These results are confirmed by the TSB's analysis of the accident that took place aboard a scallop dragger, the Alex B. 1, on September 29, 2001, which states:

> In this case, the vessel departed during unseaworthy; the transverse bulkheads were no longer watertight, the hull plating was insufficient for the fishing rigging used, and the overhaul had not been inspected by an approved authority. Furthermore, there were too many people on board […] the lack of safety culture among fishermen has been reported in other TSB investigation reports. (TSB, 2003: 15–16)

It is important to note that scallops and other molluscs fishing, carried out with a dredger, is an excessively demanding fishing activity for the vessel and its equipment (winch, hull, fishing rigging, etc.). As stated in the TSB report, "[…] the Alex B. 1 was not adequately rigged for dragging scallops and other molluscs, since the hull did not have additional protection from repeated contact with the fishing gear". (TSB, 2003: 19)

We recommend replicating the safety culture analysis with a larger sample size of at least 10 triads. The triads consist of an observation form of the vessel and its equipment, an interview with the authorized representative (master) and an interview with at least one crew member. This will make it possible to verify if the scallops and other molluscs are really at the "Pathological" stage and to identify the causes, if any.

Recommendation 4: That OHS-related training be developed.

Recommendation 4.1: That OHS leadership training for masters be developed.

The results show that the entire Québec fleet has shortcomings in terms of behavioural artefacts, for all levels of safety culture combined. Behavioural artefacts refer to safe work practices and risk management. We can conclude that there is generally some lack of knowledge, although this is easily explained by the fact that no one is born an OHS manager and specialist. In fact, the vessel, the master, and the crew members form a whole comparable to a micro-business. The highest hierarchical level is master since duties and obligations in commercial marine fishing activities are conferred to him. The master's role is therefore essential and central in a process of behavioural change. The analysis of the responses obtained in the research stations reveals that not all masters have the same abilities, as in any professional environment.

While for some, leadership is innate, others say they feel uncomfortable when it comes to providing training to the crew, requiring the wearing of personal protective equipment, demonstrating authority, etc. The responses provided show that leadership concepts related to occupational health and safety (OHS) represent the main challenge for masters. This leadership gap is also mentioned by the main stakeholders, i.e., professional fishermen and fishermen helpers.

Although training exists for those who wish to become masters of a fishing vessel (Master Class IV certificate), this is not the reality for the majority. It should be noted that the average age of masters is between 50 and 59 years, which indicates that most of them would have benefited more from the recognition of their experience as masters than from being part of the group of masters who received training to obtain their Class IV certificate. Our recommendation refers to two distinct intents to reflect this reality. The first intent is directed at masters who have received training leading to the Master Class IV certificate. Since this training already offers courses focused on safety management and quickly addresses the concepts of leadership, reviewing the content of the syllabus would make it possible to improve it in order to meet the needs identified in the context of our research project. The second intent relates to masters who have never benefited from structured training and who have instead developed their knowledge and skills "from father to son". The way to convince them to participate in

such a supervised training is not trivial. Added value creation is a key success factor in the implementation of a training strategy for professional fishermen and the sustainable development of the sector.

Since training tools are already available, the **first step** is to explore training opportunities in **partnership** with the authorities already involved such as the Bureau d'accréditation des pêcheurs et aides-pêcheurs (BAPAP), the Comité sectoriel de main-d'œuvre des pêches maritimes (CSMOPM), the École des pêches et de l'aquaculture du Québec (ÉPAQ) and the CNESST.

The **second step** aims at **creating added value to the training** to encourage the participation of captain-owners. Would a reduction in the CNESST's premium make it possible to create this value? Is the CNESST ready to put in place such an incentive? These are questions that need to be studied in partnership with all the organizations already involved and/or concerned.

The **third step** is based on r**esearch and development of training approaches, tools, and strategies.** We consider it pertinent to refer to measures and modes of intervention that have been studied, reviewed, corrected and potentially implemented, such as the initiatives of the Union des producteurs agricoles (UPA).

In fact, commercial fishing, agriculture, and forestry are sectors of the industry that share great similarities. They are all dependent on natural resources and harvesting activities take place in an environment that is inseparable from the production input (wood, fish, wheat, etc.). Although there are exceptions, in general, the enterprises are family owned or very small and can be characterized as micro-business. The workplace is also a living environment, although it may be temporary (e.g., a parcel of land, a ship) or permanent (e.g., a farm). The unique and common characteristics of the fishing, agriculture, and forestry sectors make comparisons between these industries relevant. While the sectoral reference is an interesting avenue for reflection, it is only one of the possible avenues for enhancing OHS leadership knowledge and training capacity, specifically for the commercial fisheries sector.

We recommend setting up OHS leadership training for captain-owners, in partnership with the authorities concerned. Such a measure will provide the necessary tools to develop the skills of masters and thus reach out to all professional fishermen by improving their behaviour and, by the same token, reducing the rate of accidental events in the commercial marine fishing sector. In the framework of our research, we were able to identify elements to be included or validated in a training curriculum to improve safety culture. As a guideline, we have summarized in the table form the elements that could be subject to review with potential partners.

Table 52: Elements to be Included in a Training Curriculum

Element	Recommendation for implementation
Maintenance of the vessel and its equipment	• Develop a checklist in partnership with the industry for the lowest "maintenance" factor. • Provide training to masters on how to customize this list • Develop a sales pitch on the profitability of preventive maintenance
Awareness	• Develop training for masters on laws and regulations (issues related to work accidents and the benefits of prevention) • Provide training outside of the fishing season
Leadership	• Train masters to conduct safety meetings/discussions with crew members • Offer training to masters on various ways and activities to enable a greater involvement of fishermen's helpers.
OSH	• Train masters in the application of positive discipline based on the empowerment of workers and a gradual and progressive approach • Develop a safety training curriculum for masters and crew members, starting with the fleets with the most problems. • Develop a standard calendar of prevention activities.

Recommendation 4.2: That OHS awareness training for crew members be developed.

In order for masters to be able to progressively implement an efficient OHS program on board their vessels, it is imperative that fishermen's helpers also receive OHS awareness training. To obtain their involvement and participation in a process aimed at improving risk management, safe work practices and behaviours, it is essential that they have a clear understanding of their roles and responsibilities in OHS as well as those of their masters and employers. This is why we recommend that OHS awareness training also be developed for crew members, i.e., fishermen's helpers.

Recommendation 5: That a preventive maintenance program be developed, in co-operation with the CCG and TC, for the Magdalen Islands lobster boats.

When we study the accidental event rates by fleets, the Magdalen Islands lobster boats stand out for the abnormally high number of incidents when the vessel is disabled. The causes analyzed include mechanical failures (engine, transmission, etc.), rudder failure, breakdowns of all kinds, etc., but the most common cause is mechanical failure.

Surprisingly, several incidents occur before the fishing season has even begun, indicating that preventive mechanical maintenance is not carried out in an optimal manner and that there is a need for support to correct this lack of preventive maintenance of the vessel and its equipment.

The regional reality is an important element to consider when implementing a strategy to reduce and/or eliminate accidental events. In fact, there is a Canadian Coast Guard search and rescue station in the Magdalen Islands, contrary to other regions where the distances to be covered from the nearest CCG station are too great for fishermen to call the CCG in case of mechanical problems. This regional reality could explain, in part, the higher number of interventions for vessels that have suffered "simple" mechanical failures, although this alone does not explain all the subtleties underlying these results.

Since the Canadian Coast Guard is already well established in the region, its contribution to the implementation of a preventive maintenance training program for the Magdalen Islands lobster boats would make it possible to take advantage of its experience in the fishing industry. The objective remains the reduction of accidental events in the commercial marine fisheries, but for the lobster boats of the Magdalen Islands, reducing by half the type of "boat disabled" events would result in a 12% decrease in accidental events in the commercial marine fisheries in Québec[16].

We therefore recommend the implementation, through collaboration between TC, the CCG, and other partners, of a preventive maintenance support program to be conducted at the beginning of the season. Despite the fact that it's not the subject of our research project, it is legitimate to claim that the CCG could experience a decrease in its operating costs if accidental events were to decrease.

Recommendation 6: That a deeper analysis of the causes of occupational injuries be conducted with respect to the shrimp fleet.

The shrimp fleet is one of the most advanced fleets in terms of safety culture, being in the "Proactive" stage.

Despite this more than satisfactory result, it is clear that shrimpers also have the highest rate of accidental events when considering the relative weight of the fleet. In fact, 4% of the Québec fleet are shrimpers, but they represent 20% of the total number of accidental events and 26% of the total costs of occupational injuries for the period studied, from 2005 to 2015.

Results should be nuanced according to the time spent at sea by this fleet. In general, the fishing season begins in April and ends in October. Fishing voyages are spread out over a week during which the hours worked alternately with rest periods, which are on average three consecutive hours.

This reality is hard to compare with that of lobster boats, for which the season lasts only nine (9) weeks and for which fishing activities at sea generally end on the same day they begin. Considering the total time spent at sea, the proportion of accidents would perhaps be the same for shrimpers and lobster boats.

[16] Total number of accidental events = 748. Number of disabled lobster boats fishing incidents in the Magdalen Islands = 181. Reduction by half (181/2)/48 = 12% reduction

However, since the number of accidental events and the costs of occupational injuries are higher among shrimpers, special attention is warranted. Finally, when we analyze the results obtained during the interviews, shrimpers represent the only fleet where the master and crew members recognize that workstations are not optimal.

We recommend further research on occupational injuries regarding shrimpers in order to identify key elements to reduce the number of accidental events. Priority targets are the analysis of workstation ergonomics, the study of the causal relationship between the health status of fishermen and the occurrence of injuries, and the impact of fatigue in commercial marine fishing activities.

Recommendation 7: That more detailed analyses be conducted for the multifisheries fleet to identify the trends according to the target species, the region of origin of the fishermen, the type of occupational injuries that are most prevalent and the period in which the accidental events occurred.

There is a wide variety among the vessels studied, but the results indicate that the multifisheries fleet is at the "Buyer" stage with respect to safety culture. With the objective of reducing accidental events, further analysis is needed to detect trends considering the specific characteristics common to fishing vessels within the fleet.

First of all, a distinction must be made between the different types of fishing, since the gear used varies between gillnet, longline, trawl, etc., which influences the way of working, among other things.

Secondly, the regional reality must be considered when analyzing the results, since the available resources are not the same everywhere. Then, the strategies to be implemented will depend on the nature of the injuries. Musculoskeletal injuries, cardiovascular problems, falls overboard are just a few examples that prove that solutions to occupational injuries cover a wide range of possibilities. The identification of priority issues necessarily involves a study that allows for the distinction between the types of occupational injuries.

Finally, the period in which the accidental event occurred is also an element to be included in the analysis. A better understanding of the causes, knowing if the accidents and incidents occur before the start of the fishing season, on return from a long fishing voyage, especially at night, rather in the fall than in the spring: these are all elements that can help prioritize targets.

We recommend that more thorough analysis of the multifisheries fleet be carried out by distinguishing groups of vessels according to the type of fishing they were doing at the time of the accidental event, according to the region of origin of the master, according to the type of occupational injuries and according to the time of the accident or incident.

Recommendation 8: That awareness and training activities be developed, in partnership with the CNESST, to encourage and promote the use of PPE and its maintenance.

The wearing of personal protective equipment (PPE), particularly personal flotation devices (PFDs)—which are required by the CNESST on board all lobster boats—is very low, making it a cause for concern for the entire Québec fleet.

Interview results indicate that some masters even state that they never wear their PFDs. This is a clear indication that the issue of low PPE use and maintenance still requires attention.

We recommend that, in partnership with the CNESST, awareness and training activities be developed in order to increase the use of PPE and to provide tools for professional fishermen to properly maintain PPE.

Recommendation 9: That awareness and training activities be increased with respect to familiarization and emergency response exercises.

An analysis of the results obtained with respect to familiarization and drills on the safety procedures shows that these exercises are not carried out even though they are regulatory obligations. Failure to conduct familiarization and emergency drills greatly exposes the liability of captain-owners and reduces the chances of crew survival in the event of a serious accident. When considering the risks to which masters are exposed when they fail to meet their obligations, the results tell us that there is a lack of understanding—and therefore management—of these risks.

We recommend that awareness and training activities be increased and that they focus primarily on liability and the consequences that a failure to comply can have for captain-owners.

Recommendation 10: That industry stakeholders support, encourage and promote scientific research initiatives in the commercial fisheries community and create opportunities for collaboration as expert advisors to the scientific community from all sectors and disciplines.

Recommendation 10.1: That case analysis be carried out for disasters.

Disasters are the most serious accidents, and the results show that their evolution is sporadic over the years, while maintaining a stable average per year. This indicates that the situation is not improving despite the objective of reducing this type of accidental event, which is also the costliest. Moreover, as regards disasters

even if they are fortunate, nearly 50% of them occur when the weather conditions are mild or favourable for fishing activities. Does the absence of visible danger cause a decrease in attention? Given that this was not the main focus of this research, no extensive case analysis was conducted on the disasters documented by the TSB. Nevertheless, this remains relevant in order to better understand the causes of this type of accident. Through testimonials and case studies, training on these elements could be implemented in order to reduce this type of accident. It's all about OHS culture.

We recommend that case analysis be conducted to better understand the tragedies that have occurred since 2005, which is an opportunity for future research, among other things.

Recommendation 10.2: That the analysis of the causes of accidental events in indigenous communities be deepened, working in partnership with them.

All things considered, the results reveal that indigenous users are more likely to be victims of human error, damage to the hull or other appendages and problems with cables and/or nets caught in propellers or appendages. As a reminder, to be proportional to the other groups for the same type of events, the rate of accidental events should be about seven, whereas it is 28 for this group, which means it is four times higher than the average. Such a situation is an indicator that there could be characteristics specifically to indigenous communities with regard to their problems and that they are different from other groups.

We recommend further analysis of accidental events involving vessels from indigenous communities by working in partnership with them. This approach would make it possible to validate the results obtained in the context of our research in addition to fostering collaboration with indigenous communities.

Recommendation 10.3: That research to find an effective mechanism against the entanglement of cables and/or nets in the propellers and/or appendages of a fishing vessel be encouraged.

We note a high rate of accidental events involving a cable or net caught in the propeller or appendages of the vessel. Although this problem is not new and has already been studied, it is clear that the issue is still present today.

Is the development of a guard for the propellers and/or appendages possible and feasible? More technical research will be required to answer this question, which is beyond the scope of this project.

We recommend that research initiatives for the development of a guard or other means to protect propellers and/or appendages (e.g., stabilizers) be encouraged and promoted. Merinov and the Canadian Coast Guard should be considered as potential research partners for projects to be developed, ideally in the near future.

Recommendation 11: That the processes for collecting and exchanging information on fishing vessels between the various departments be improved and harmonized, which would allow decision-making based on reliable data available in real time.

A meeting between stakeholders would be necessary to find a comprehensive solution to the different information flows between agencies. Our results help identify certain priorities. First, it was noted in the CCG database that occurrences involving smaller vessels (not more than 15) were less documented than those involving vessels over 15 gross tonnage. Proper documentation of all cases would be important. It was also difficult to classify the causes of the events and the chain of consequences. This project has allowed us to develop a list of causes and a chain of events that has proven to be very useful for data analysis and understanding of accidents. This methodology should be proposed to the CCG and TSB for consideration and with the goal of standardized implementation. A standard procedure for information collection and training related to completion is recommended.

We recommend that the analysis project be renewed at the same pace and time period as the censuses so that the data can be used more widely, particularly by Statistics Canada and the Institut de la statistique du Québec. Moreover, the establishment of an interdepartmental project to transfer information between the various organizations would make it possible to collect data in real time and to support evidence-based decision-making.

The project provided an initial overview of the situation. The difficulties encountered made it possible to identify gaps, particularly in data collection, and to detect the lack of harmonization between the information from each organization. In order to facilitate the transfer of information between different organizations such as TC, DFO, CNESST, IRSST and CCG, it would be imperative to find one to three unique standardized identification keys for vessels, owners, and users (renters) applying for fishing licences and subjected to an accidental event.

Chapter 7
Conclusion

Although the TSB's 2018 Watchlist reports an alarming situation for the safety of fishermen in Canada, this study shows that in Québec, serious and minor accidents involving fishing vessels are on the decline for the period from 2005 to 2015. This is a rather encouraging sign that shows a good improvement in the overall situation. However, further analysis will be required for the period from 2015 to 2020 to confirm this trend. On the other hand, our analyses also show that incidents, i.e., accidental events without serious consequences, are on the rise for the same period. Even if these incidents do not have a negative impact on human life or the environment, this fact deserves increased vigilance, since each of these incidents is a potential accident, or even a potential disaster if the problematic factors combine and manage to slip through the safety barriers during the event (Reason, 1997). However, this report proposes some very interesting solutions to reduce this trend, which is mainly due to a lack of preparation at the beginning of the fishing season, and more particularly, to a lack of preventive mechanical maintenance in certain regions.

The pooling of data from partners conducted within the framework of this research allowed us to assess the current situation with regard to accidental events in the commercial marine fishing industry in Québec. This portrait sheds light on certain trends, reveals observations and identify drivers for action.

This approach therefore constitutes a first strategic step in the improvement of the knowledge required to allow a real questioning of the approaches of all stakeholders in the field. This is an essential exercise aimed at putting in place concrete solutions to finally reduce the loss of human lives and professional injuries, as well as material and financial losses related to accidental events on board fishing vessels. What does this picture reveal?

First, for accidents and incidents, the type of information to be collected and recorded was defined and the resulting statistical analysis was carried out. This made it possible to identify the causes of accidental events, their prevalence in certain fleets and the categories of vessels most likely to suffer an accidental event.

Then, for the occupational injury component, the analysis method used not only made it possible to establish the overall financial and human costs generated by occupational accidents on board fishing vessels, but also made it possible to define the most frequent types of injuries and the fleets that are most affected. To follow and understand the evolution of these statistical assessments, it has been shown that the development of shared information systems must be initiated to allow for a detailed analysis of the risk factors at the origin of accidental events as well as the trends in the costs and characteristics of occupational injuries suffered by fishermen.

Next, with the notion of safety culture specific to the fishing industry now defined and the tools to measure it available, it is now possible to know the degree of maturity of the fishermen and their fleets and to understand the points that need to be addressed in order to lead them to change their behaviour and to think in prevention mode.

Furthermore, the development of the conceptual framework and the maturity scale will make it possible to measure the evolution of this safety culture and thus target the actions to be undertaken to promote its growth, in addition to monitoring the effectiveness of the measures implemented.

Some of the findings deserve special attention, as they indicate that a change in Transport Canada's approach to monitoring and regulation would be advisable. First of all, the statistical analyses carried out revealed that crews of fishing vessels not more than 15 have the poorest safety culture. These vessels are also the most likely to suffer damage at sea and are involved in more accidental events than any other class of fishing vessel.

However, these vessels are not inspected by the State, which relies instead on self-regulation, an approach to compliance that is not suited to the needs of this fleet. It is clear that the principle of monitoring and inspection put in place by the Ministry must be reversed. Analyses show that it would be appropriate to put in place a self-regulation process for fleets over 15 gross tonnage and to carry out unannounced inspections for fleets with a high rate of compliance and safety culture. On the other hand, more sustained supervision is imperative for small vessels, particularly for those showing a low level of safety culture and a lack of knowledge of the regulatory framework of their profession.

Another fundamental observation relating to the fleet as a whole is the acknowledged difficulty experienced by captain-owners in assuming proactive leadership in health and safety on board their vessels. To address this situation, we propose to work with the partners concerned to develop training so that masters are better equipped to exercise constructive authority with their crews in order to implement safety routines, make their crew members aware of the risks of the job and promote the wearing of personal protective equipment.

Many of the results obtained in this study require more detailed analysis, which opens the door to other essential research to improve the health and safety of fishermen. On the one hand, the cost analysis demonstrated the prevalence of certain occupational injuries within the shrimp fleet.

Solutions designed by health researchers could help reduce the occurrence of these injuries. On the other hand, results pertaining to the maturity level of the safety culture in the industry according to the different regions and fleets call for more thorough analyses to understand the origin of these disparities and to identify the best measures to be implemented to help these fishermen progress to a higher stage of maturity.

The main limitation of this research lies in its provincial nature. Obviously, it will help inform public decision-making in order to advance the health and safety of Québec fishermen, but since no similar situational portrait has been conducted in the other maritime provinces of Canada, this research cannot be used as a comparative basis for analyzing the situation from a pan-Canadian perspective. This study should therefore be reproduced at the national level as soon as possible to paint an overall picture of this economic activity, which is described as the deadliest industry in the country.

Another important limitation is the absence of a comparative variable such as full-time equivalent (FTE). Given that fishing is a seasonal occupation, that exposure to hazards is not always the same depending on the type of activity, and that data on working hours are not documented, we are not in a position to establish, proportionally, the real prevalence of injuries or accidental events involving certain fleets in particular, nor to compare the fishing industry with other industries, which could be very informative.

Nevertheless, thanks to this study, we now have a much better understanding of the risk factors at the root of accidental events in Québec harvesting industry. We better understand the technical failures and malfunctions of this socio-technical system that can produce fortuitous and undesirable events, i.e., accidents. As we have seen, there are many avenues to be explored to advance safety in the commercial marine fisheries. They are technical and normative. They are behavioural and cultural.

This research emphasizes the importance of supporting, encouraging and fostering scientific research initiatives in the commercial marine fisheries community and creating collaborative opportunities for the scientific community from all sectors and disciplines.

Hopefully, this research can inspire people who are passionate about this profession and the people who practise it and motivate them to innovate and implement the changes necessary to ensure that fishermen are able to practise their profession without putting their lives at risk.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Appendix A
Intersectoral partnership

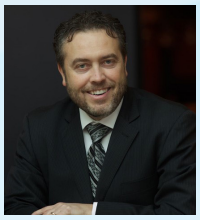
Management

Comité permanent sur la sécurité des bateaux de pêche du Québec (CPSBPQ). This non-profit organization that brings together more than 200 Québec commercial fishermen annually as part of the annual conference, provides the necessary forum to recruit fishermen for research. This discussion and consultation forum will also make it possible to disseminate the research topic, sparking off debate that will improve health and safety in the industry.

Transport Canada (TC). This federal department, in addition to being the main funding party of this research project, provided access to its incident, accident and inspection report data as part of the statistical analysis.

Researchers

Michel Pérusse, Ph. D. Occupational Health and Safety, **head of the safety culture component.** Michel Pérusse has been active in prevention for nearly 40 years. He holds a master's degree in industrial psychology and a Ph. D. in occupational health and safety (OHS). A teacher, researcher, consultant, and author of numerous specialized articles, he was also Vice-Dean of Continuing Education and External Relations and Director of the Centre Laurent Beaudoin in the Faculty of Administration of the Université de Sherbrooke.



Jean Cadieux, Ph.D. Mathematical Statistics, **head of statistical data analysis** Researcher and full professor in the Faculty of Administration of the Université de Sherbrooke, Mr. Cadieux conducted his research in various administrative fields, including on the evolution of occupational health and safety (OHS) in companies and on the development of a learning philosophy reflecting this evolution for the *Chaire d'étude en organisation du travail*.

Martin Lebeau, M.Sc. Finance, **co-head of economic analysis**. Researcher at the Institut de recherche Robert-Sauvé en santé et sécurité au travail (IRSST), Mr. Lebeau is interested in the economic aspects of occupational health and safety. Together with his fellow researchers, he has developed a research methodology on the costs of occupational injuries in Québec that provides new insights into the consequences of occupational accidents and diseases.

Scientific Adviser

Dany Dumont, Professor in physical oceanography, Institut des sciences de la mer de Rimouski (ISMER), head of the monitoring, security, and safety program at the Réseau Québec Maritime, **scientific adviser.** Mr. Dumont specializes in the study of physical processes affecting the ocean surface, particularly in the presence of sea ice in polar and subpolar environments, in an effort to improve the performance of environmental prediction models. He has worked on and led interdisciplinary and intersectoral research projects for several years and is particularly interested in the perception and understanding of the elements of risk definition and assessment.

Consultants

Robert Fecteau, Manager, Transport Canada Marine Safety and Security, Rimouski, **consultant**. A graduate of the Maritime Institute of Québec in 1986, Robert Fecteau has dedicated himself, since the beginning of his career at the department, to the safety of professional fish harvesters. He is currently Manager of Marine Safety and Security at Transport Canada where he is the special adviser for the Québec region's Office of Primary Interest for fishing vessel safety. He is also vice-chair of the Comité permanent sur la sécurité des bateaux de pêche du Québec (CPSBPQ). For nearly thirty years, he has contributed to the development of a fisheries safety culture and is interested in the anthropological approach that can increase the empowerment of fishermen and enable measures on active safety conditions.

Valérie Dufresne Dubé, Ph.D. candidate in marine resources management at UQAR and intern in the research assistant program, Transport Canada Marine Safety and Security, Rimouski, **consultant**. Ms. Dufresne Dubé holds a master's degree in Marine Resource Management—Fisheries Resources profile from UQAR and a bachelor's degree in Business Administration from HEC Montréal—International Management and Marketing profile. She holds two years' experience in the Québec commercial fishing industry as an at-sea fisheries observer for the Department of Fisheries and Oceans Canada. She contributes to knowledge development through strategic and socio-economic analysis and assists in project coordination activities aimed at improving the safety culture in the fisheries sector.

Research Team

Lysiane Drewitt, coordinator, Comité permanent sur la sécurité des bateaux de pêche du Québec, **liaison officer**. With a bachelor's degree in International Studies and Project Management and a Master's in Marine Resource Management, Ms. Drewitt has spent more than three years coordinating the activities of the Comité permanent sur la sécurité des bateaux de pêche du Québec, a non-profit organization dedicated to developing a safety culture in the Québec Commercial Fishing Industry. She is also working on a national strategy to implement regional governance structures for improved safety in this industry.

Lise-Andrée Francoeur, project coordinator, Transport Canada Marine Safety and Security, Rimouski, **liaison officer**. She holds a master's degree in Business Administration—Business Management profile, a master's degree in Biological and Forensic Anthropology, as well as a master's degree in Translation and Terminology. Ms. Francoeur is also a certified reviser and a self-taught professional who stands out for her organizational skills and strong sense of autonomy. She has been with Transport Canada for over a year and assists in the management and coordination of projects designed to improve the safety of fishing vessels.

Research Officers

Marie-Pier Chevrette, Anthony Côté, Adélène Lessard et Shannel St-Laurent, interns, Transport Canada Marine Safety and Security, Rimouski, research officers. Within the framework of their collegial studies in naval architecture at the Maritime Institute of Québec (IMQ), they assisted in this research project by administering questionnaires to masters and fishermen's helpers and conducting observations on board vessels. As a result, data was collected in the Gaspésie and Lower St. Lawrence, North Shore and Magdalen Islands regions.

Partners

Fisheries and Oceans Canada (DFO). In accordance with the Memorandum of Understanding between Fisheries and Oceans Canada (DFO) and Transport Canada (TC) regarding safety at sea of commercial fish harvesters, this partner department provided, through its databases, the updated information necessary to identify commercial fishing vessels and captain-owners in the Québec Region holding active fishing licences.

Canadian Coast Guard (CCG). The SAR division will share its databases detailing the context in which deployments were made to conduct search and rescue operations involving fishing vessels in the Québec region.

Commission des normes, de l'équité et de la santé et sécurité au travail (CNESST). In accordance with the Memorandum of Understanding concerning commercial fishing activities in Québec, this partner organization provided access to its databases for the purpose of analyzing the costs related to compensation claims resulting from an occupational accident on board a fishing vessel.

MP2B Insurance. In accordance with agreements, this company has provided us with data on claims made as a result of incidents and accidents on board fishing vessels.

Appendix B
Fields Maintained in the Merged Database for Statistical Analysis

NAMES OF VARIABLES	WORDINGS AND FORMS OF VARIABLES
NUMBER	Canadian Coast Guard event number
DATE_UTC	Date of the event—YYYY-MM-DD—Universal time
TIME_UTC	Event time—HH: MM: SS—Universal time
POSITION	Geographical location of the accident
LENGTH	Vessel length in metres
LENGTH_CATEGORY	Vessel length based on categories (12 m and less, more than 12 m)
GROSS_TONNAGE	Gross tonnage of vessel
INSPECTION	15 and less = no mandatory inspection
AGE_VESSEL	Vessel age (Year of accident - Year built)
VESSEL_AGE_CATEGORY	Vessel age category (0 to 10 years = group 1; 11 to 20 years = group 2; 21 years and over = group 3)
WIND_SPEED_KNOTS	Wind speed in knots. 1 knot = 1 nautical mile per hour
WIND_SPEED_BEAUFORT	Wind speed according to the Beaufort scale 0 = <1 knot 1 = 1 to 3 knots 2 = 4 to 6 knots 3 = 7 to 10 knots 4 = 11 to 16 knots 5 = 17 to 21 knots 6 = 22 to 27 knots 7 = 28 to 33 knots 8 = 34 to 40 knots 9 = 41 to 47 knots 10 = 48 to 55 knots 11 = 56 to 63 knots 12 = 64 to 71 knots
HEIGHT_SEA WAVE	Wave height in metres
HEIGHT_SEA WAVE_DOUGLAS	Wave height according to the Douglas scale 0 = 0 m 1 = <0.1 m 2 = 0.11 to 0.5 m 3 = 0.51 to 1.25 m 4 = 1.26 to 2.50 m 5 = 2.51 to 4 m 6 = 4.01 to 6 m 7 = 6.01 to 9 m 8 = 9.01 to 14 m 9 = > 14 m
POSITION_LATITUDE_GEO	Latitude at time of accident
POSITION_LONGITUDE_GEO	Longitude at the time of accident
YEAR	Fishing year
RES_COMM_VESSEL_OWNER	Name of residential community of vessel owner Lower St. Lawrence [Cacouna to Rimouski, including Saint-Anaclet]. North of Gaspésie [Sainte-Flavie to Forillon] South of Gaspésie [Barachois to Listuguj] Upper North Shore [Saint-Siméon to Portneuf sur mer] Mid North Shore [Betsiamites to Natashquan] Lower North Shore [Kegaska to Blanc-Sablon, including Port-Menier] Magdalen Islands Outside Québec
VESSEL_OWNER_INDIGENOUS	Yes/No, the owner of the vessel is indigenous
RES_COMM_VESSEL_USER	Name of residential community of vessel user Lower St. Lawrence [Cacouna to Rimouski, including Saint-Anaclet]. North of Gaspésie [Sainte-Flavie to Forillon] South of Gaspésie [Barachois to Listuguj] Upper North Shore [Saint-Siméon to Portneuf sur mer] Mid North Shore [Betsiamites to Natashquan] Lower North Shore [Kegaska to Blanc-Sablon, including Port-Menier] Magdalen Islands Outside Québec

NAMES OF VARIABLES	WORDINGS AND FORMS OF VARIABLES
INDIGENOUS_BOAT_USER	Yes/No, the owner of the vessel is indigenous
TYPE_USE	Type of use (owner/tenant)
TARGETED_SPECIES	Species targeted during fishing
FISHING_TYPE	Type of fishing (regular, experimental, sentinel)
MONITORING_TYPE	Type of fishery monitoring for the target species of the voyage (overall = competitive fishery; participation = quota fishery)
FIRST_DEPAR_SEASON	Date of first departure of the fishermen of the fleet for the year
LAST_DEPAR_SEASON	Date of last departure of the fishermen of the fleet for the year
PERCENTAGE_SEASON	Percentage of the season, based on first and last landing data for the fleet for the season, for the year
TIME_SEASON	Time of the season, based on a percentage of the season (≤33% = start; ≤66% = middle; ≤100% = end; Transit if the vessel was not fishing at time of accident).
FLEET_AFFILIATION	Fishing vessel fleet Crabber—Lower North Shore (Areas 13, 14 and 15) Crabber—Area 12 Crabber—Area 16 Crabber—Area 17 Shrimper (all areas) Lobster boat—Anticosti (area 17) Lobster boat—Mid North Shore (area 18) Lobster boat — Baie-des-Chaleurs (area 20-B) Rental Multifisheries—Daily Multifisheries—Mid-shore scallops and other molluscs (all areas) Groundfish (all areas) Lobster boat—Lower North Shore (areas 15 and 16) Lobster boat—North of Gaspésie (area 19) Lobster boat—South of Gaspésie (area 20-A) Lobster boat—Magdalen Islands (area 22)
OBSERVATION:	Observations added when merging data
INITIAL_ EVENT	Initial event A Capsizing B Disabled C Grounding D Explosion E Man overboard F Fire G Medical H Shipwreck I Leak J Collision K Allision L Bottom Contact M Other
SEVERITY_ACCIDENT (2 FIELDS: INCIDENT [TO CHECK]; ACCIDENT [SERIOUS])	Severity of the accident (accident/incident) If it is an accident: M3 = Minor (disabled without adverse consequences, minor injury, fire, or waterway quickly under control, etc.). M2 = Serious (disabled that required major intervention; without intervention, the situation would have worsened) M1 = Disaster (shipwreck, crew evacuation, capsizing, death or missing person)

NAMES OF VARIABLES	WORDINGS AND FORMS OF VARIABLES	
ACCIDENT_ CAUSES **(2 FIELDS: CAUSE_1; CAUSE_2)**	Causes of the accident 1 Collision 2 Damage to hull or appendages 3 Injury 4 Propeller shaft failure 5 Rudder failure 6 Hydraulic failure 7 Mechanical failure (engine, transmission, 7) 8 Cable or net caught in the propeller 9 Unknown cause 10 Grounding 11 Downflooding 12 Human error 13 Explosion 14 Heating system fire 15 Cooking fire	16 Exhaust fire 17 Electric fire 18 Hydraulic fire 19 Engine room fire 20 Fire of unknown source 21 Allision 22 Fire 23 Disease 24 Weather 25 Out of fuel 26 Unknown failure cause 27 Electric problem 28 Pumping system problem 29 Other
ACCIDENT_ EFFECTS **(2 FIELDS: EFFET_1; EFFET_2)**	Effects of the accident a Need assistance b Grounding c Autonomous evacuation of the vessel d Explosion e Autonomous extinction f Fire	g Shipwreck h Assistance by crew i Autonomous repair j Leak k Other l None
ACTIONS_TAKEN **(4 FIELDS: ACTION_1; ACTION_2; ACTION_3; ACTION_4)**	Actions taken i CCG Escort ii Escort by fishing vessel iii Evacuation of individual by helicopter iv Assisted extinction v First aid vi Research vii Recovery by fishing vessel viii Recovery by CCG ix Towing by fishing vessel x Towing by CCG	xi Salvage xii Assisted repair xiii None xiv Other xv Recovery by another vessel xvi Evacuation of individual by another vessel xvii Evacuation of individual by CCG xviii Evacuation of individual by fishing vessel xix Towing by another vessel
NB_ACTIONS	Number of actions taken by stakeholders	

NAMES OF VARIABLES	WORDINGS AND FORMS OF VARIABLES			
TYPE_ACCIDENT_IN_THE_END	Type of accident in the end			
	A Capsizing	E Man overboard	I Leak	M Other
	B Disabled	F Fire	J Collision	
	C Grounding	G Medical	K Allision	
	D Explosion	H Shipwreck	L Bottom Contact	
FATALITIES	Number of fatalities			
INJURIES	Number of injuries			
MATERIAL_LOSSES	Categorization of material losses I Vessel total loss (sunk or burnt) II Vessel major material loss (survivor with major damage) III Vessel minor material loss (survivor with minor damage) IV None			

Appendix C
Causes by Fleets

Table 53: Number of Accidental Events by Cause for Crabbers

Causes	Lower North Shore	Area 12	Area 16	Area 17	Total
Mechanical failure (engine, transmission, ...)	2	25	20	6	53
Cable or net caught in the propeller	0	3	6	1	10
Unknown failure cause	0	1	5	1	7
Rudder failure	0	3	4	1	8
Unknown cause	0	3	0	1	4
Out of fuel	0	0	1	0	1
Human error	0	1	3	1	5
Electric problem	0	1	1	0	2
Injury	0	0	4	0	4
Disease	0	1	0	0	1
Propeller shaft failure	0	1	0	0	1
Other	1	1	0	0	2
Damage to hull or appendages	0	1	0	0	1
Fire unknown source	0	0	0	1	1
Engine room fire	0	0	1	0	1
Exhaust fire	0	0	1	1	2
Total	**3**	**41**	**46**	**13**	**103**

Table 54: Number of Accidental Events by Cause for Lobster Boats

Causes	Anticosti	Baie-des-Chaleurs	North of Gaspésie	South of Gaspésie	Magdalen Islands	Total
Mechanical failure (engine, transmission, ...)	6	2	1	1	124	134
Cable or net caught in the propeller	0	0	1	1	9	11
Unknown failure cause	0	0	0	0	26	26
Rudder failure	1	0	0	0	27	28
Unknown cause	1	1	0	0	8	10
Out of fuel	0	0	0	0	7	7
Human error	1	0	0	0	1	2
Electric problem	0	0	0	0	2	2
Injury	1	0	0	0	5	6
Disease	0	0	0	0	1	1
Propeller shaft failure	1	0	0	0	4	5
Other	0	0	0	0	3	3
Damage to hull or appendages	2	1	0	0	1	4
Hydraulic failure	0	0	0	0	1	1
Fire unknown source	1	0	0	0	1	2
Weather	2	0	0	0	0	2
Total	**16**	**4**	**2**	**2**	**220**	**244**

Table 55: Number of Accidental Events by Cause for the Other Fleet

Causes	Shrimpers	Multifisheries	Scallop vessels and other molluscs	Groundfish	Total
Mechanical failure (engine, transmission, ...)	50	81	12	22	165
Cable or net caught in the propeller	23	21	1	2	47
Unknown failure cause	6	16	6	4	32
Rudder failure	7	12	0	2	21
Unknown cause	3	9	4	7	23
Out of fuel	8	6	1	3	18
Human error	1	10	2	3	16
Electric problem	3	5	4	2	14
Injury	6	2	0	0	8
Disease	7	4	3	1	15
Propeller shaft failure	1	4	2	1	8
Other	2	5	0	0	7
Damage to hull or appendages	2	1	0	1	4
Hydraulic failure	1	4	1	0	6
Fire unknown source	0	1	1	0	2
Engine room fire	2	2	0	0	4
Weather	0	1	1	0	2
Pumping system problem	1	1	0	0	2
Electric fire	1	1	0	0	2
Flooding from above	1	0	0	0	1
Collision	1	0	0	0	1
Total	**126**	**186**	**38**	**48**	**398**

Appendix D
Charts and Fleet

Chart 3: Crabbers—Lower North Shore

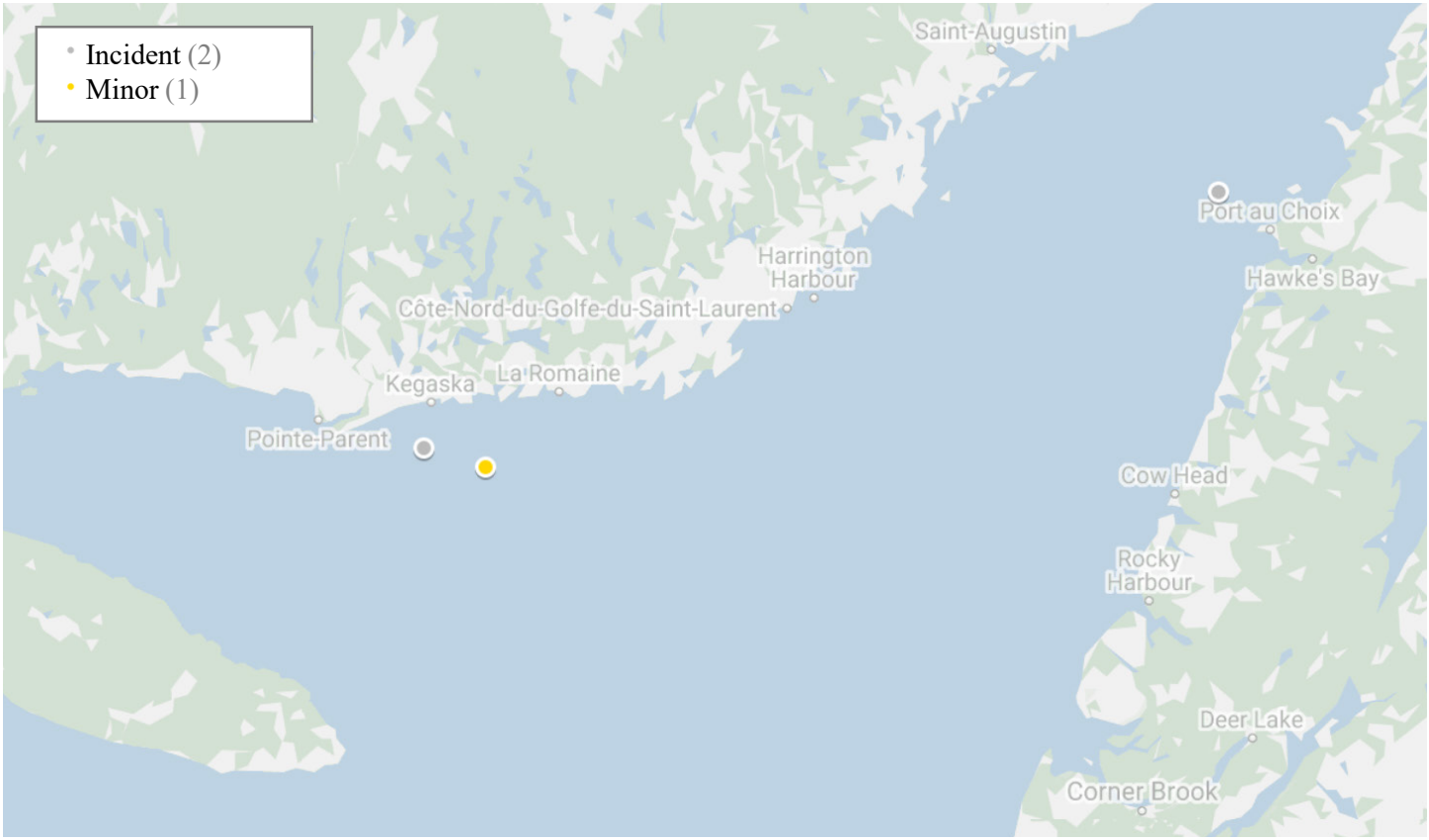


Chart 4: Crabbers—Area 12

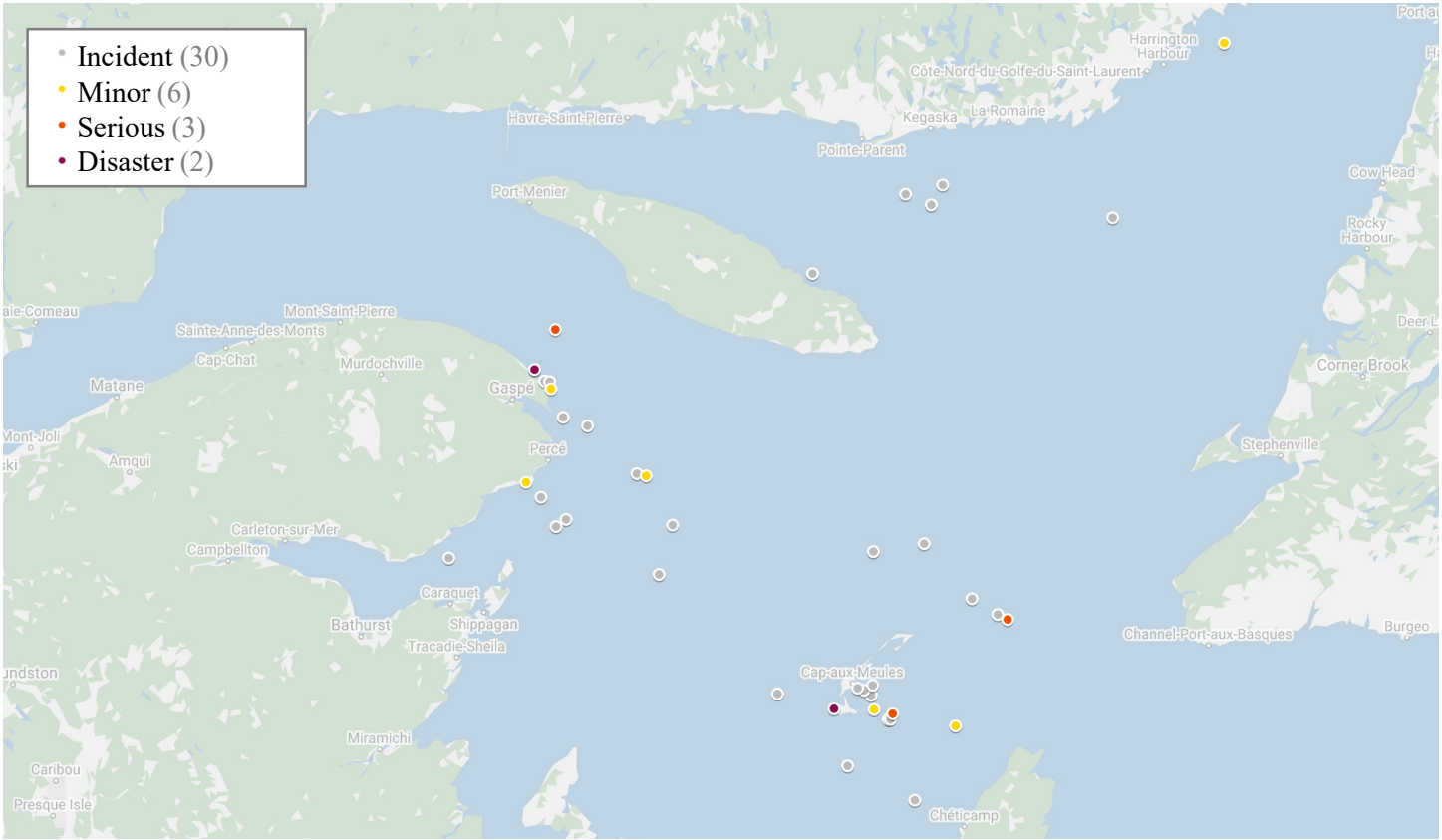


Chart 5: Crabbers—Area 16

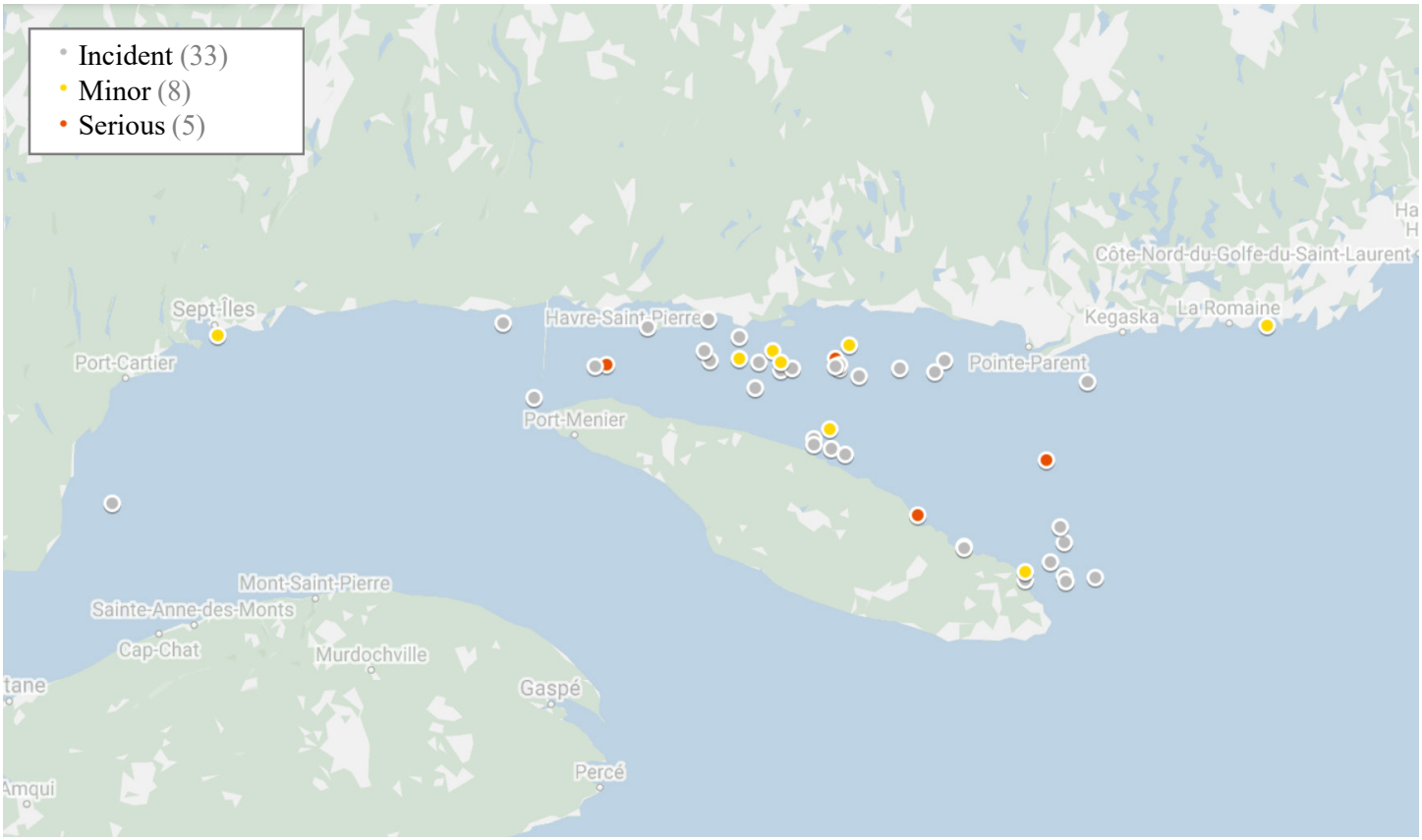


Chart 6: Crabbers—Area 17

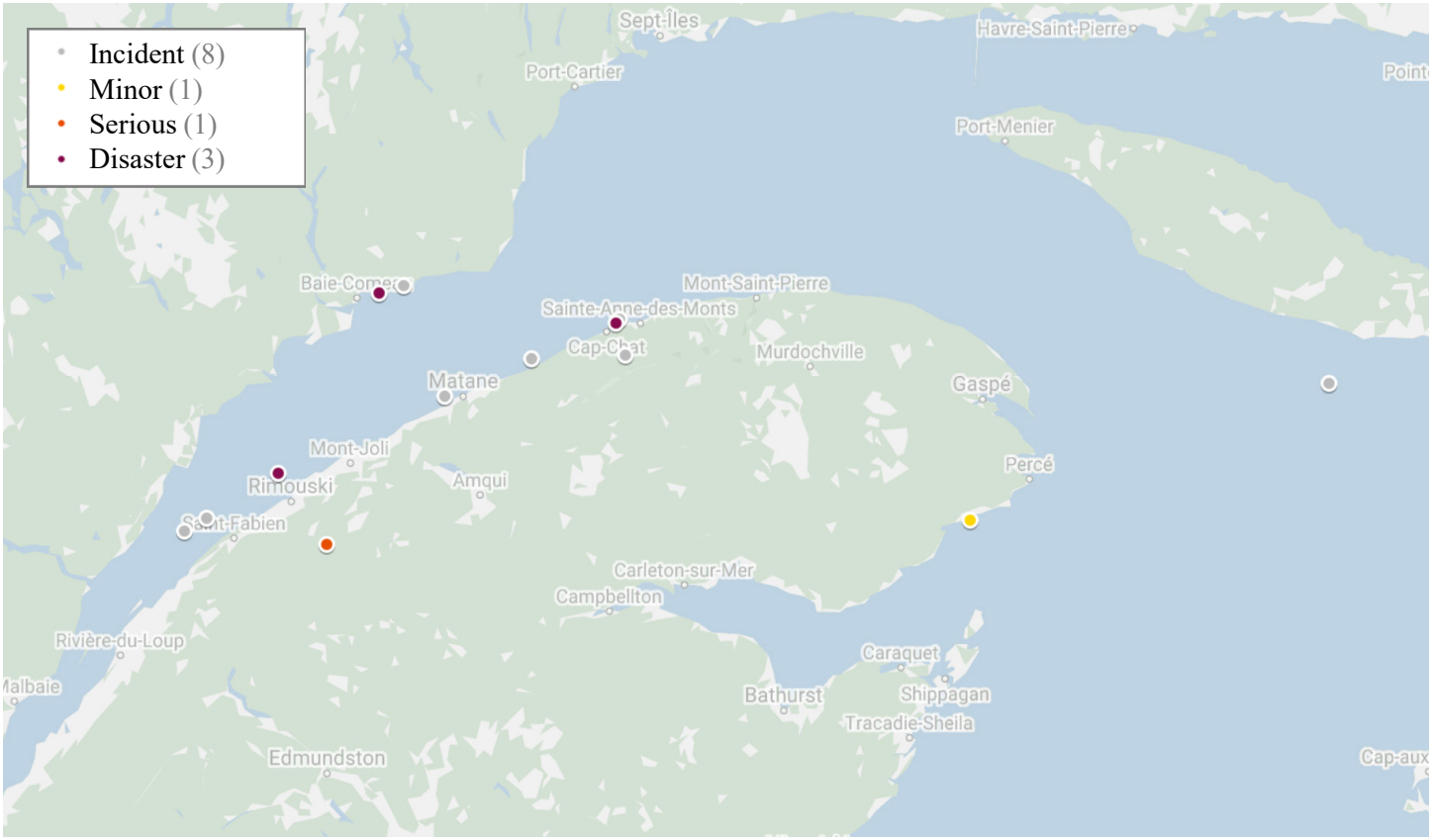


Chart 7: Shrimpers

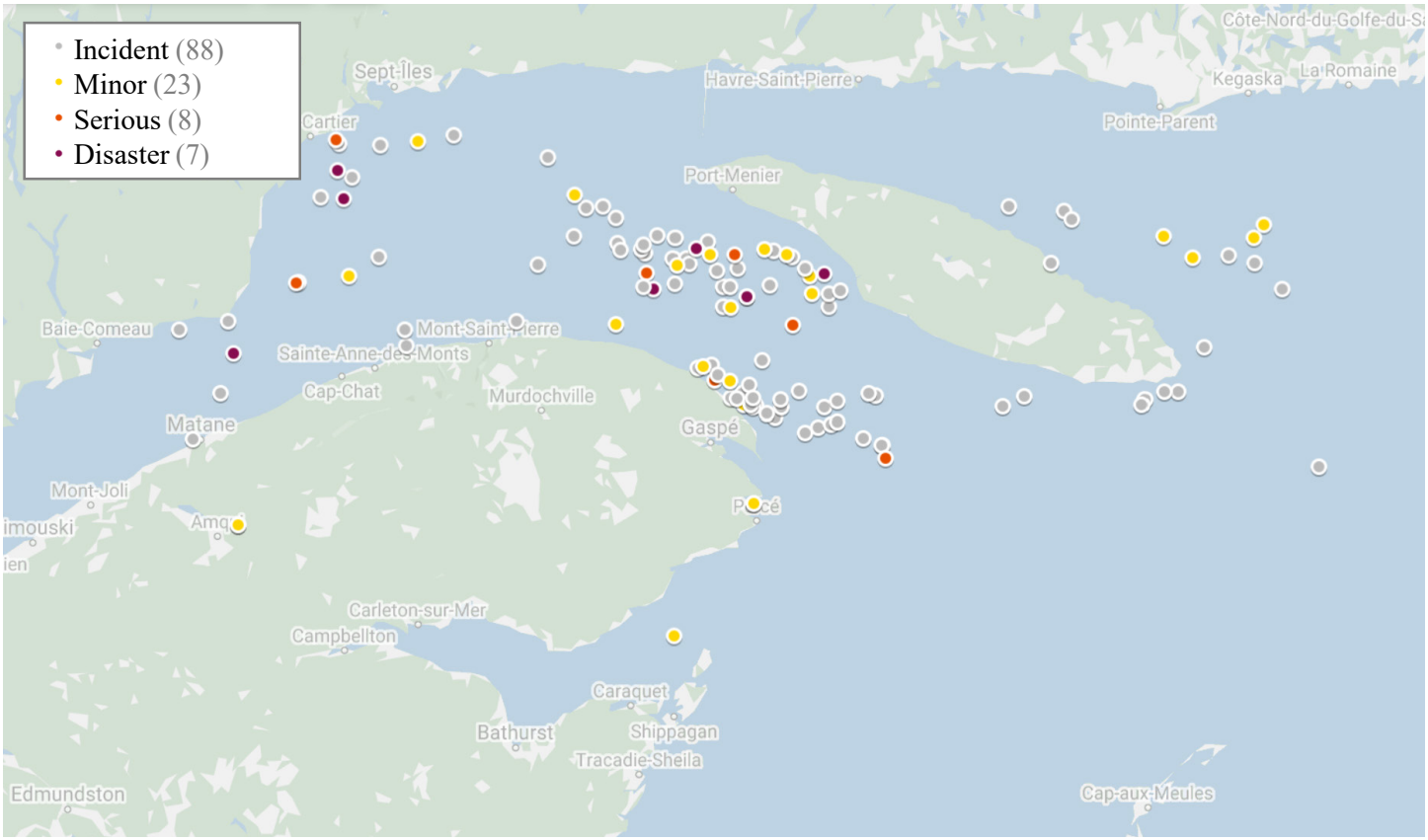


Chart 8: Lobster Boats—Anticosti

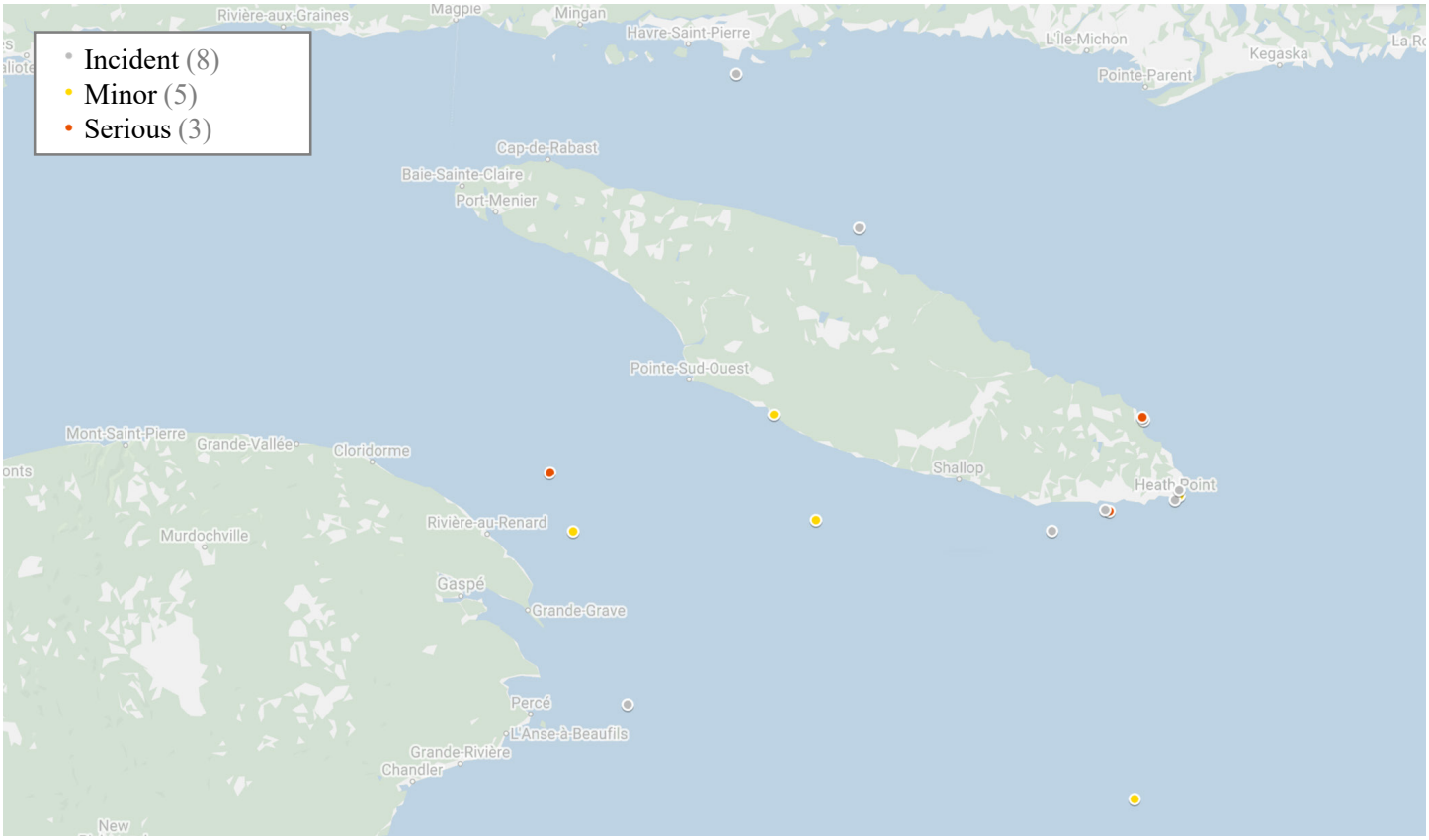


Chart 9: Lobster Boats—Baie-des-Chaleurs

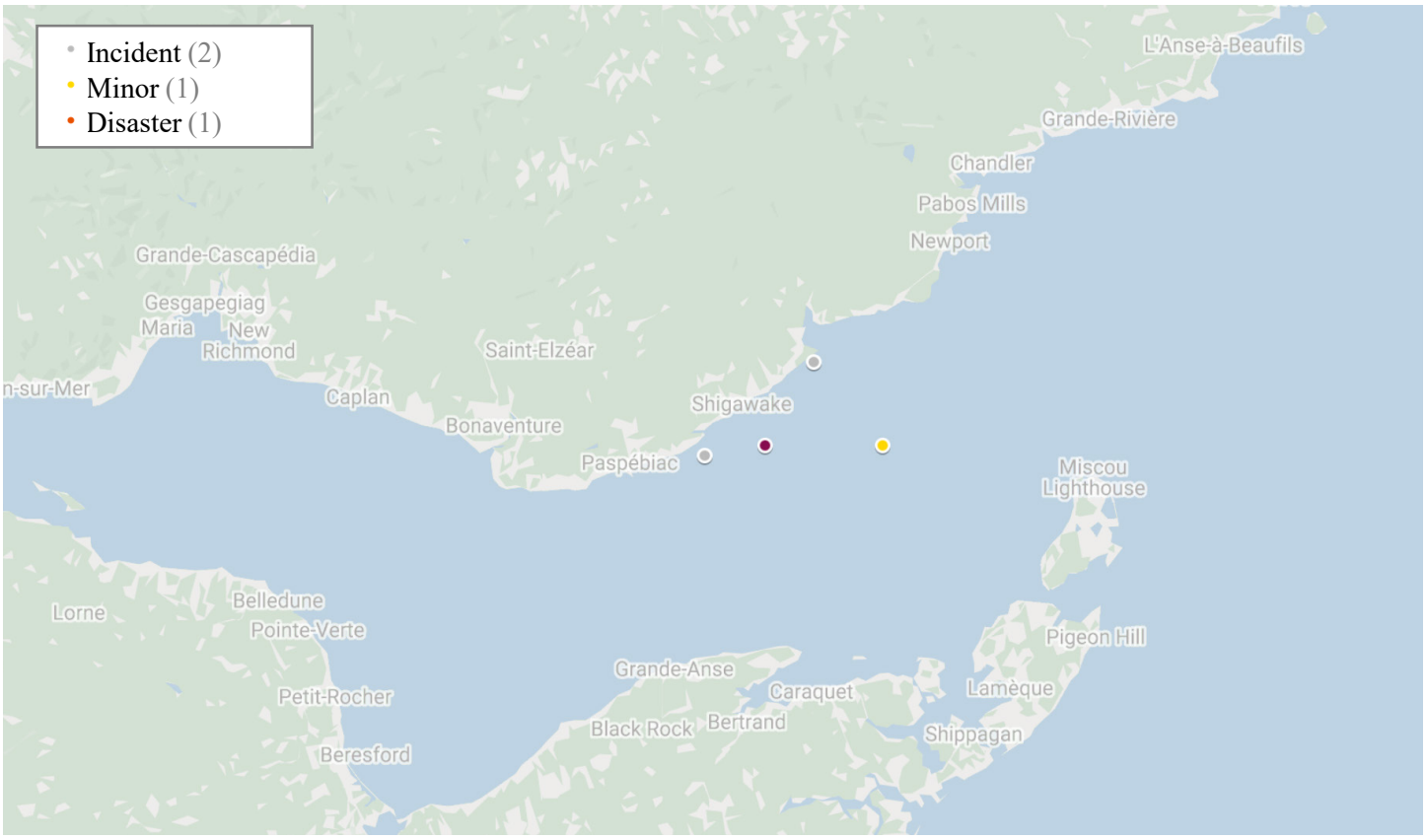


Chart 10: Lobster Boats—North of Gaspésie

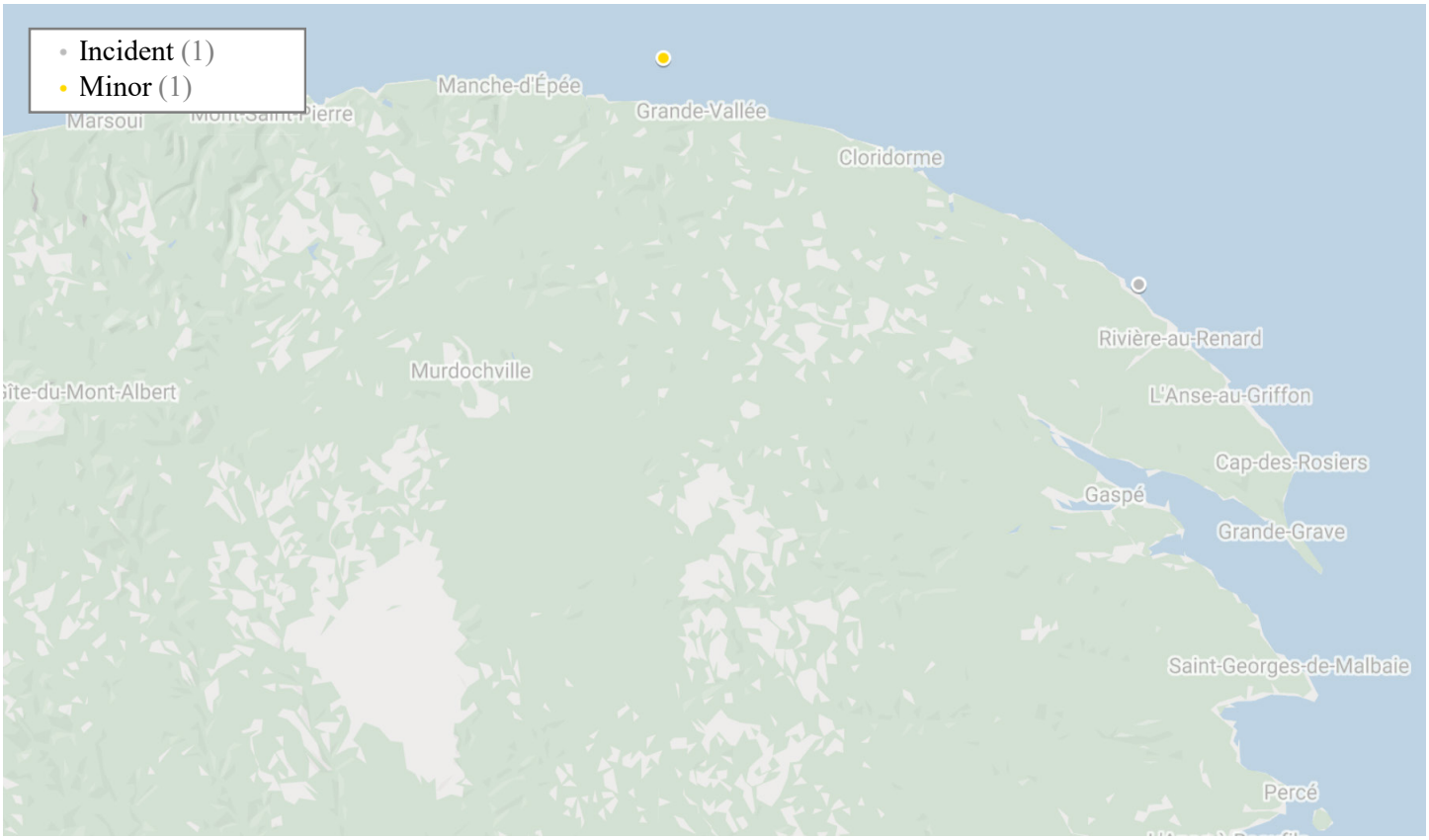


Chart 11: Lobster Boats—South of Gaspésie

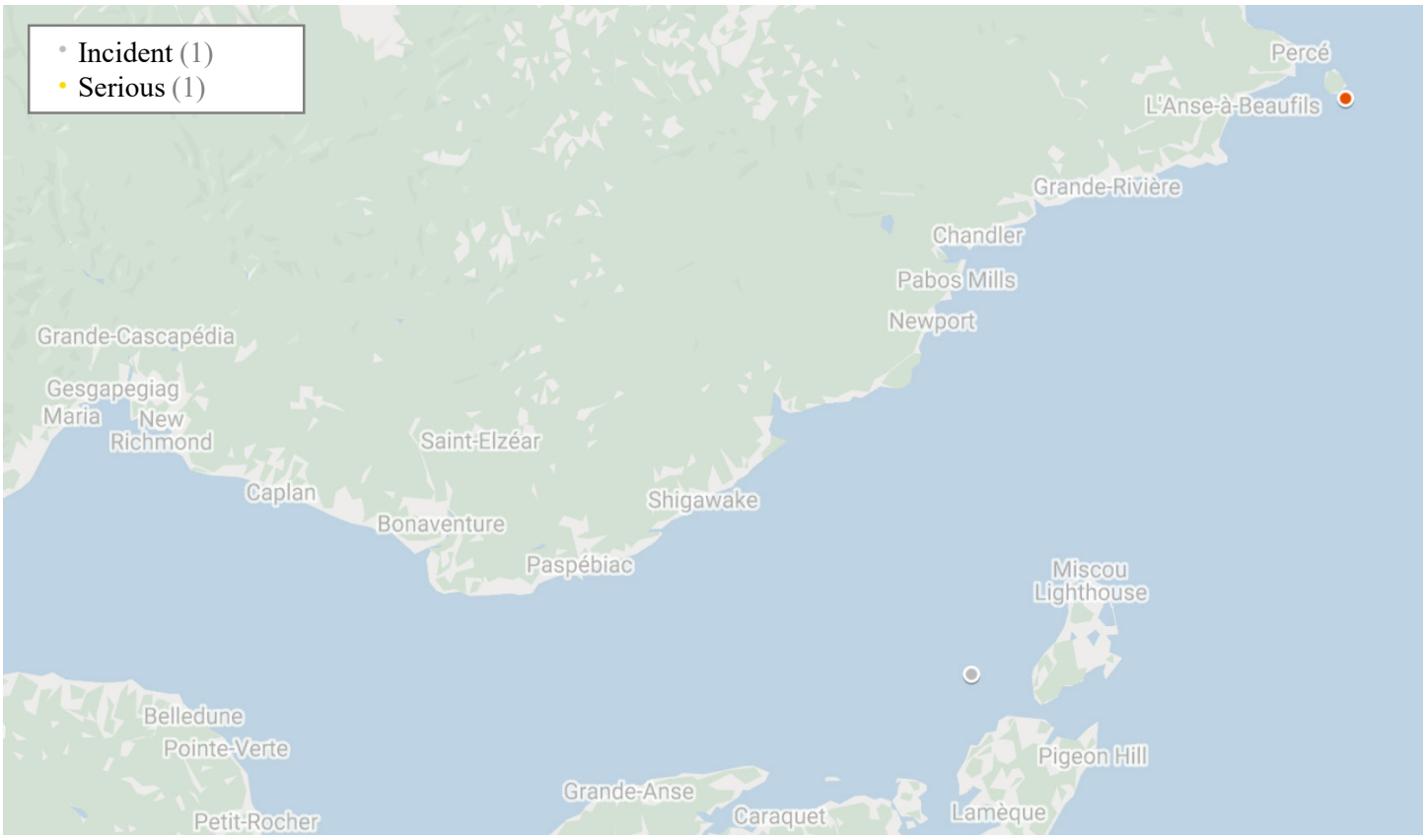


Chart 12: Lobster Boats—Magdalen Islands

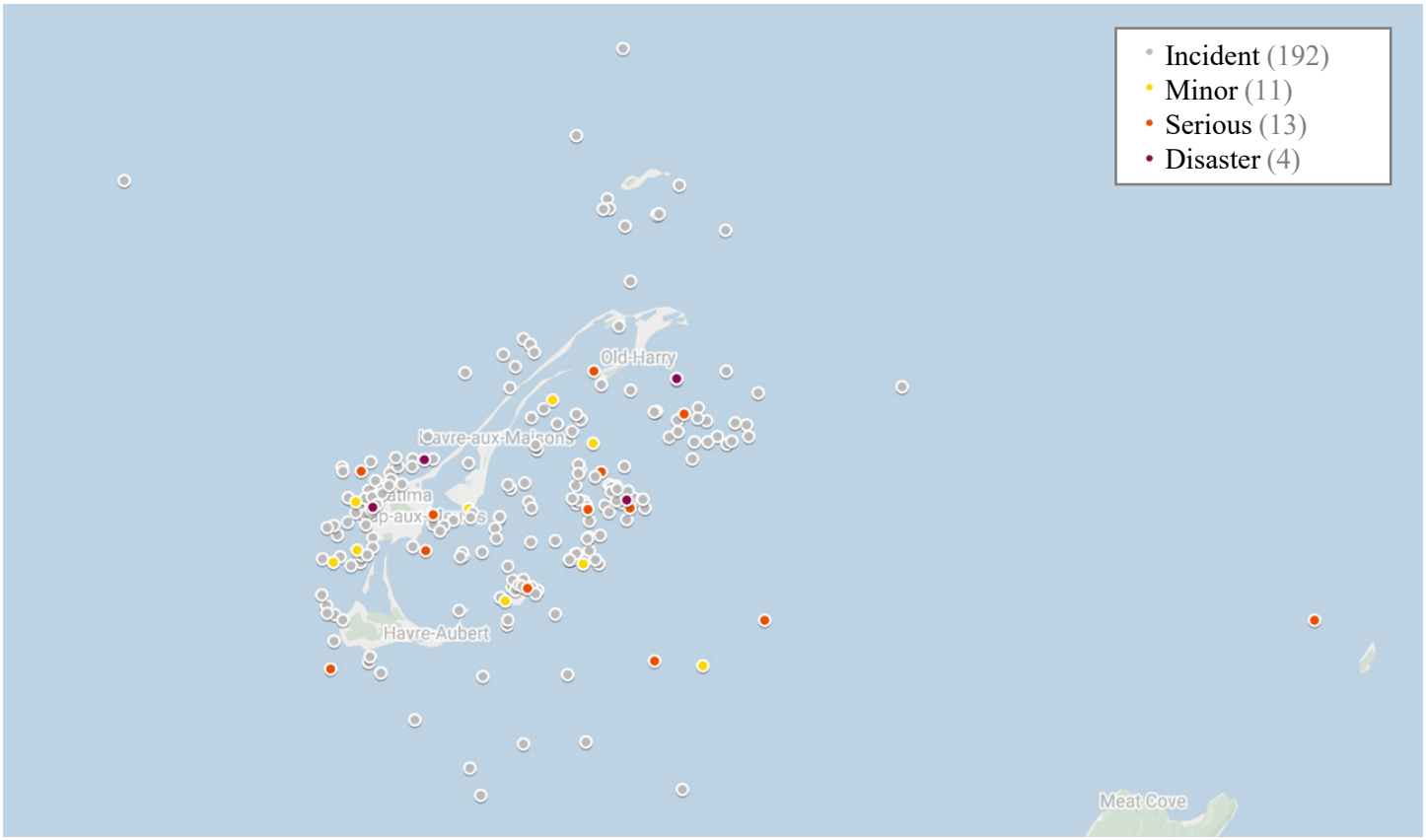


Chart 13: Multifisheries

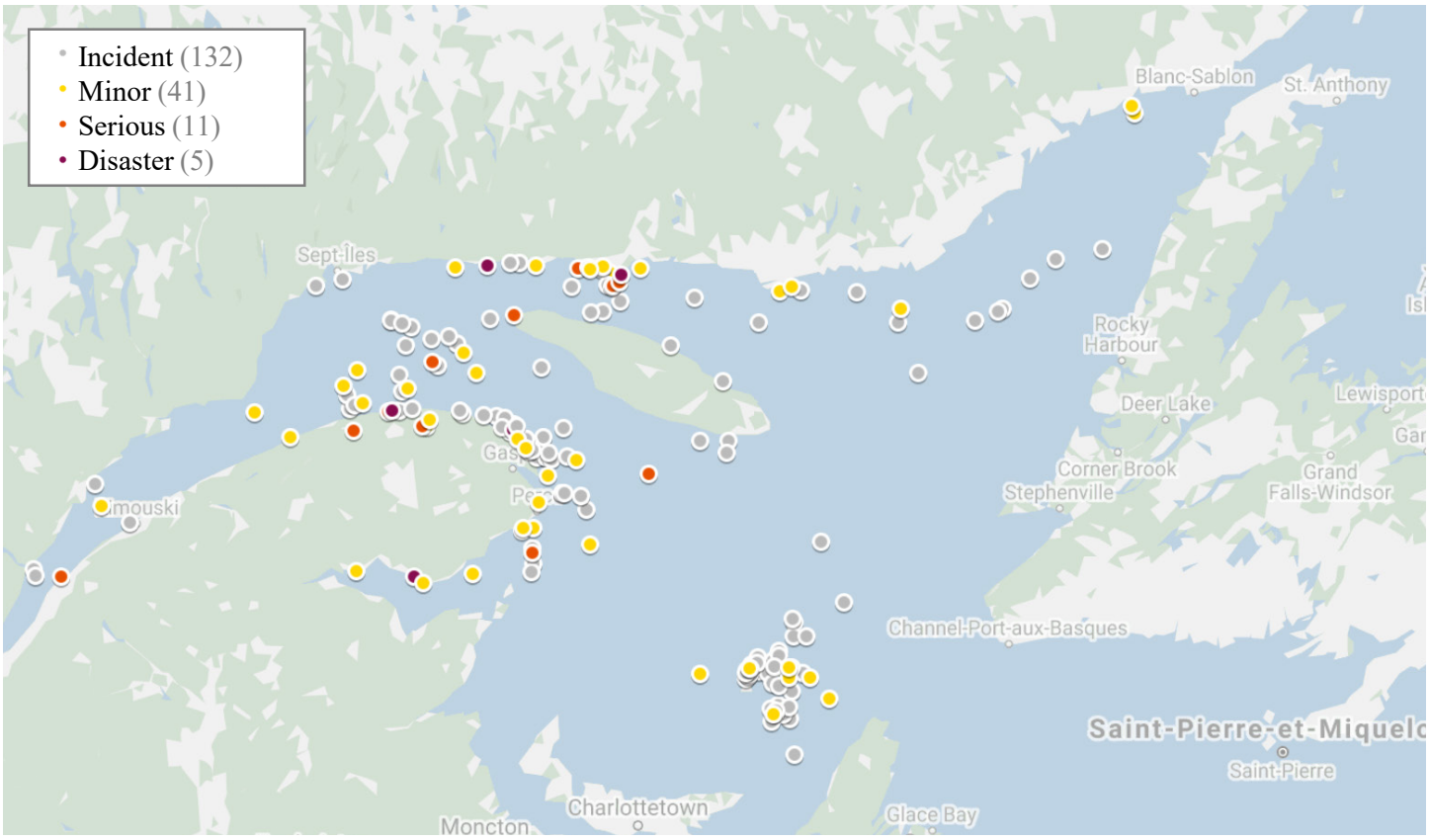


Chart 14: Scallops and Other Molluscs

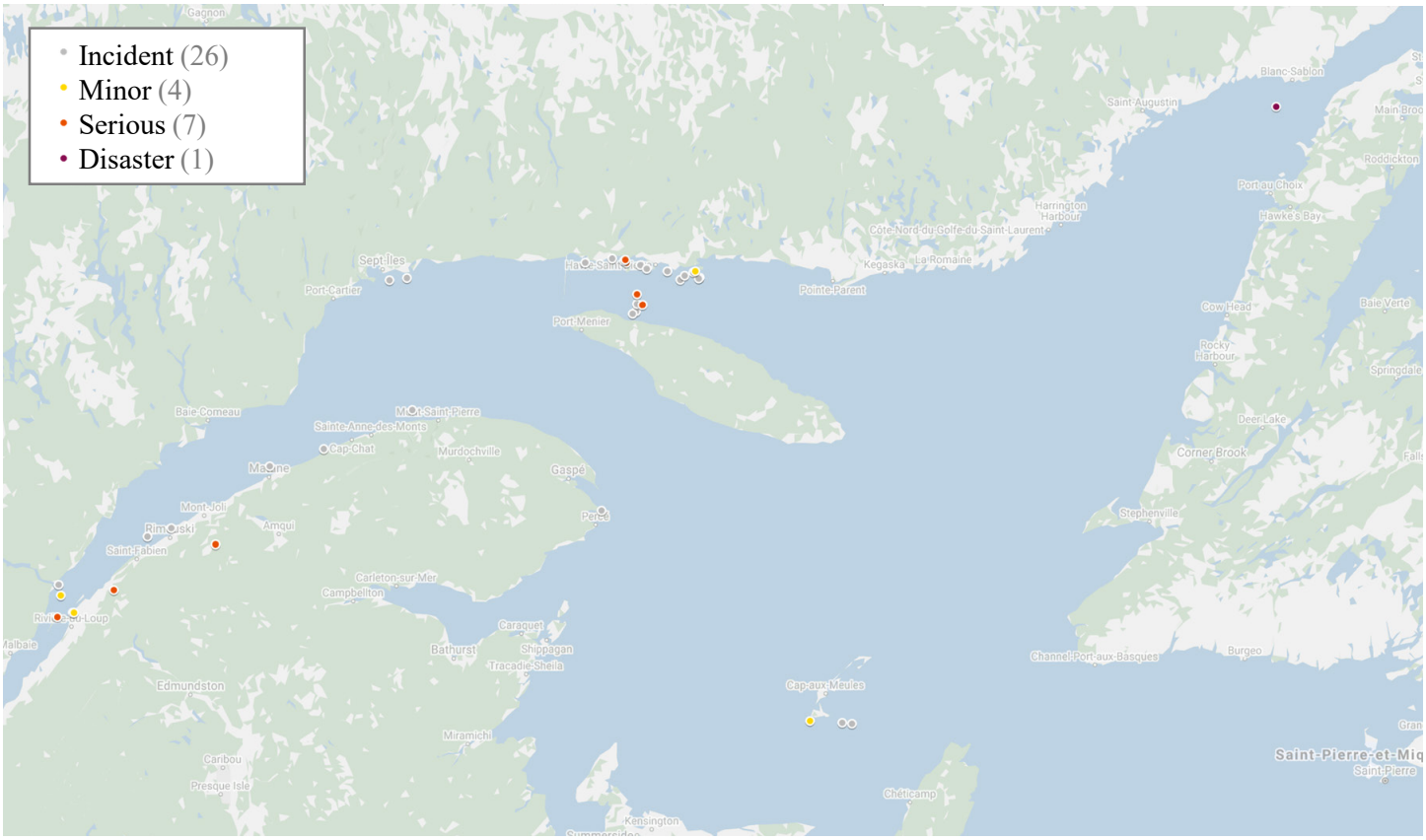


Chart 15: Groundfish

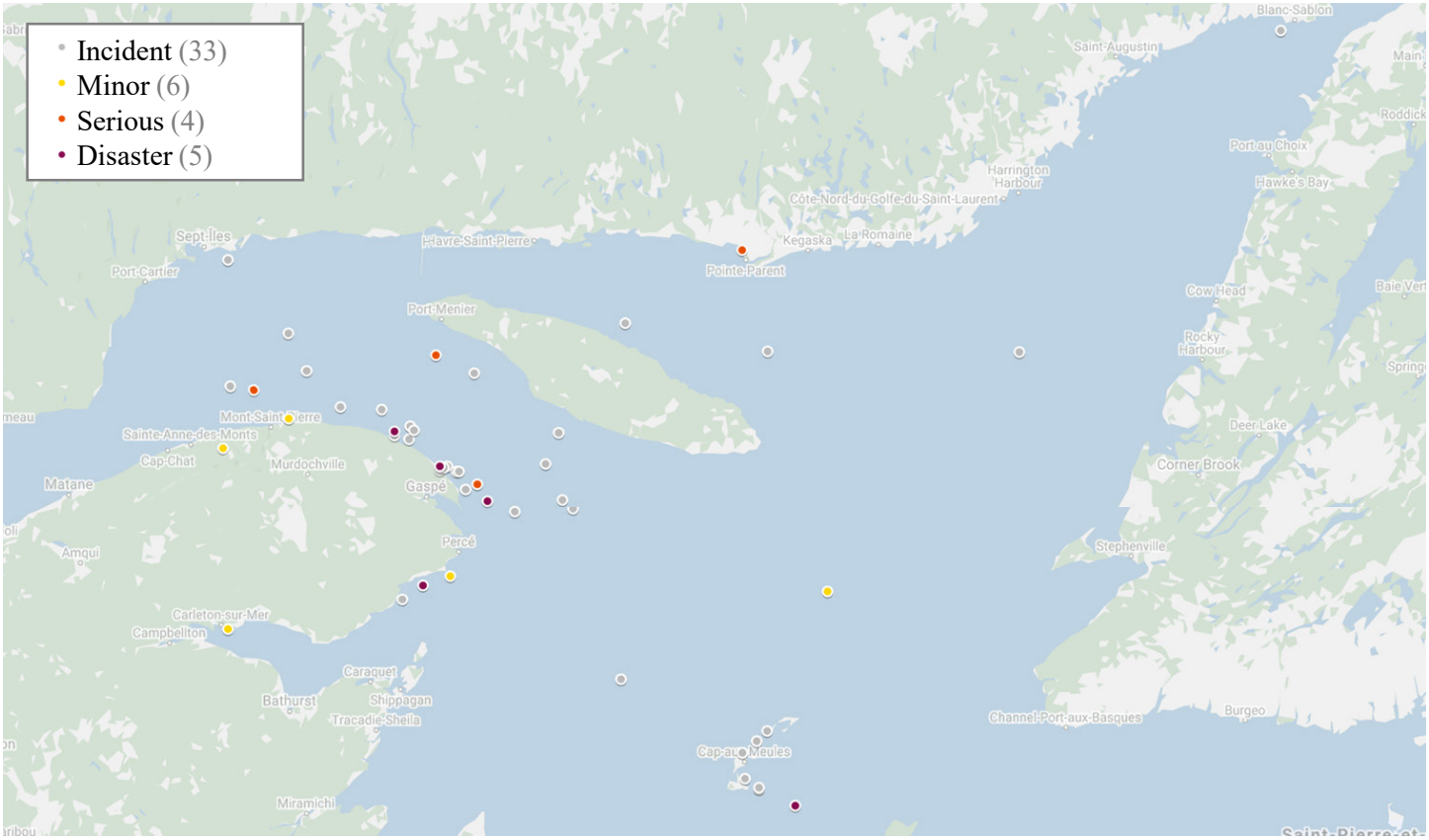
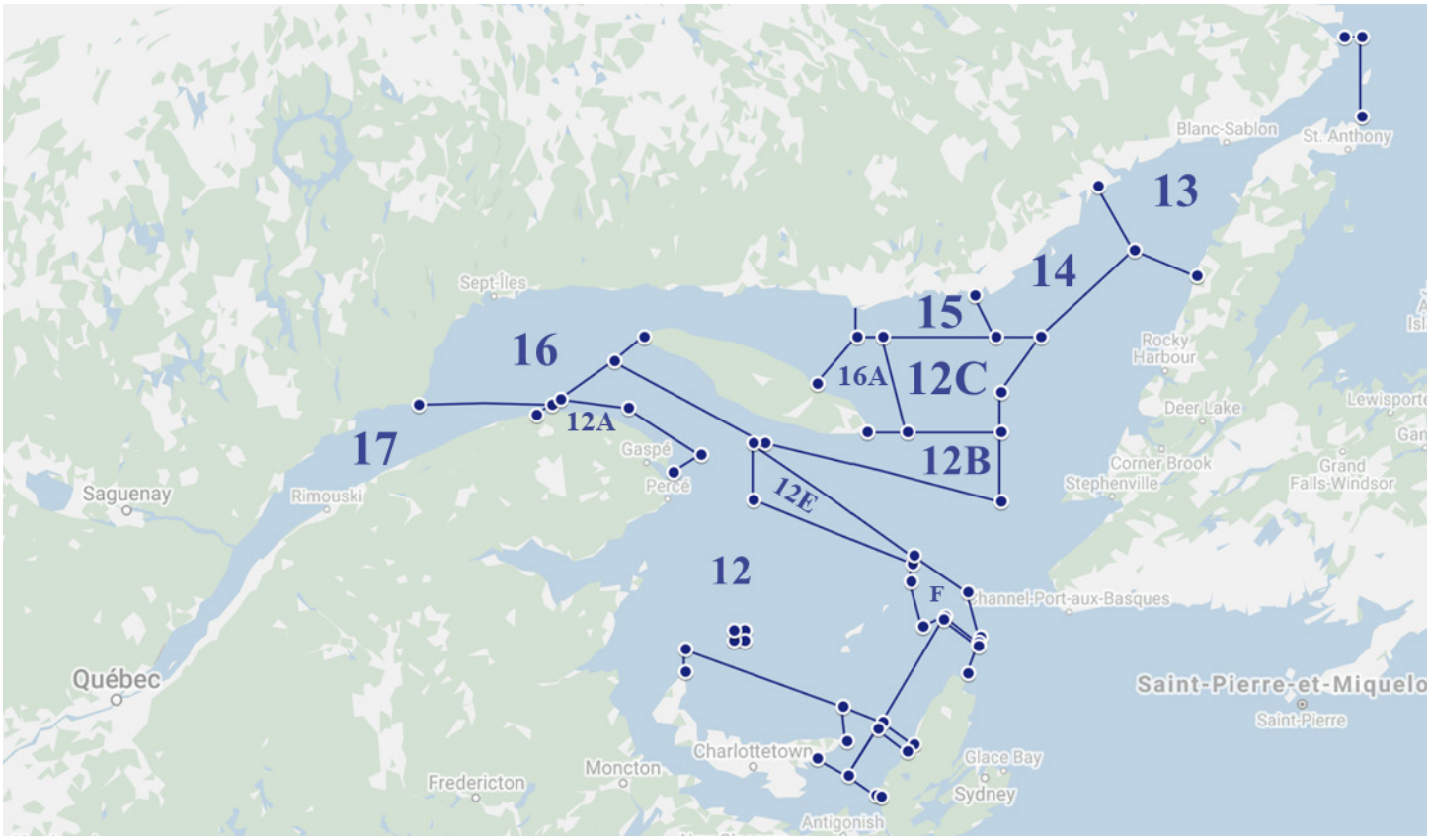


Chart 16: Snow Crab Fishing Areas—Québec Region[17]



[17] Source: Fisheries and Oceans Canada, 2007.

Chart 17: Lobster Fishing Areas—Québec Region[18]

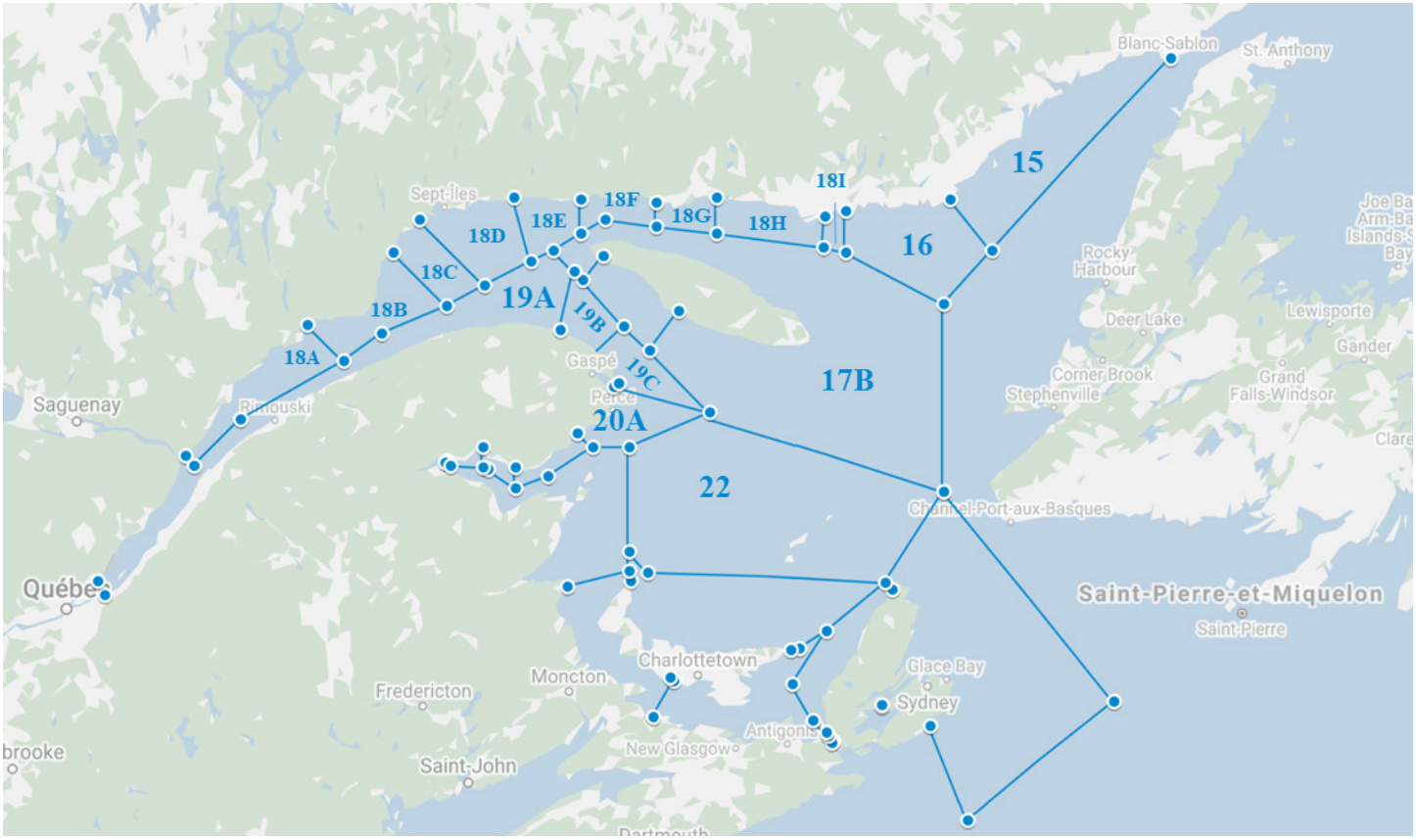
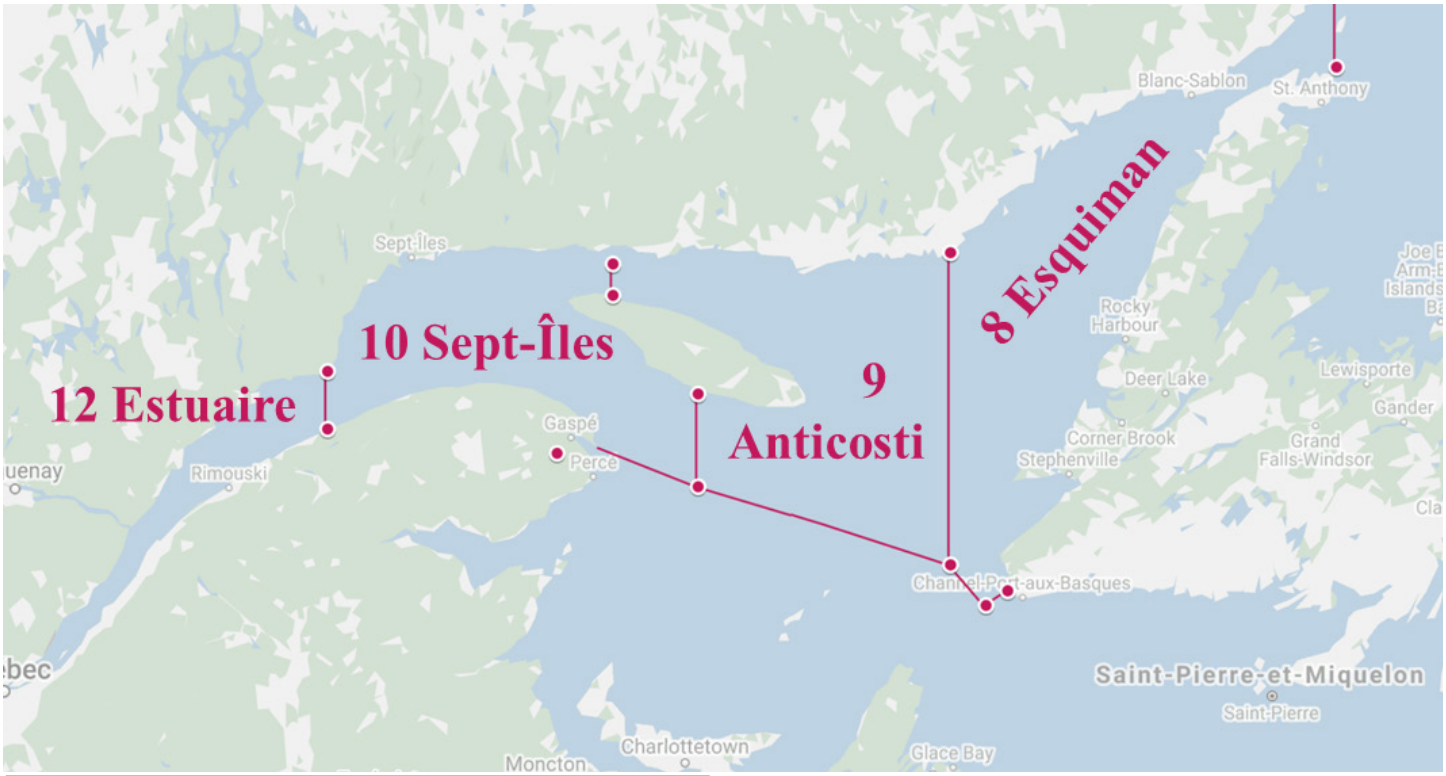


Chart 18: Shrimp Fishing Areas—Québec Region[19]



[18] Source: Fisheries and Oceans Canada, 2011.

[19] Source: Fisheries and Oceans Canada, 2017.

Appendix E
Glossary of Accidents and Incidents

Glossary of Accidents and Incidents

Term	Description
Allision	Collision of the ship with another object (other than a ship and different from grounding).
Assistance by crew	Care by the crew of a sick or injured person.
Assisted extinction	Fire controlled by resources external to the vessel.
Assisted repair	Act of repairing (a damage, etc.) that depends on the help given or received.
Autonomous evacuation of the vessel	Abandonment of the vessel by the crew using the vessel's emergency equipment.
Autonomous extinction	Fire controlled by the crew.
Autonomous repair	Repair carried out by the crew without external assistance.
Bottom Contact	Touching the bottom of the sea.
Cable or net caught in the propeller	Fishing rigging that wraps around the ship's propeller.
Capsizing	Turn upside down.
CCG Escort	Guided by the Canadian Coast Guard (CCG).
Collision	Collision between vessels.
Cooking fire	Fire that involves cooking appliances.
Damage to hull or appendages	Damage to vessel's hull or to one of its components (stabilizer, bulbous bow, etc.).
Disabled	Vessel that is out of service by depriving it of what is necessary for its navigation.
Disease	Impairment, disorder of the organism.
Downflooding	Downflooding is defined as unwanted water infiltration into the vessel. Downflooding ranges from catastrophic water ingress to slow leaks through various openings above the waterline, with potentially serious cumulative impacts.
Drift	Drifting of a vessel without control of its maneuver under the effect of winds or currents.
Electric fire	Fire relating to the electrical circuit.
Electric problem	Specific to electricity or electricity related.
Engine room fire	Fire located in the compartment where the main engine and auxiliary machinery are located.
Escort by another vessel	Guided by a vessel other than the CCG vessel and which is not a fishing vessel.
Escort by fishing vessel	Guided by a fishing vessel.
Evacuation of individual by another vessel	An organized, rapid, and immediate removal of people from a hazard that depends on the intervention of a vessel other than a fishing vessel or the CCG.
Evacuation of individual by CCG	An organized, rapid, and immediate removal of people from a hazard that depends on the intervention of a CCG vessel.
Evacuation of individual by fishing vessel	An organized, rapid, and immediate removal of people from a danger that depends on the intervention of another fishing boat.
Evacuation of individual by helicopter	An organized, rapid, and immediate removal of people from a danger that depends on a helicopter intervention.
Exhaust fire	Fire from exhaust pipe or surrounding structures.
Explosion	Rapid volume increase and energy release, usually with high temperature and gas generation.

Glossary of Accidents and Incidents

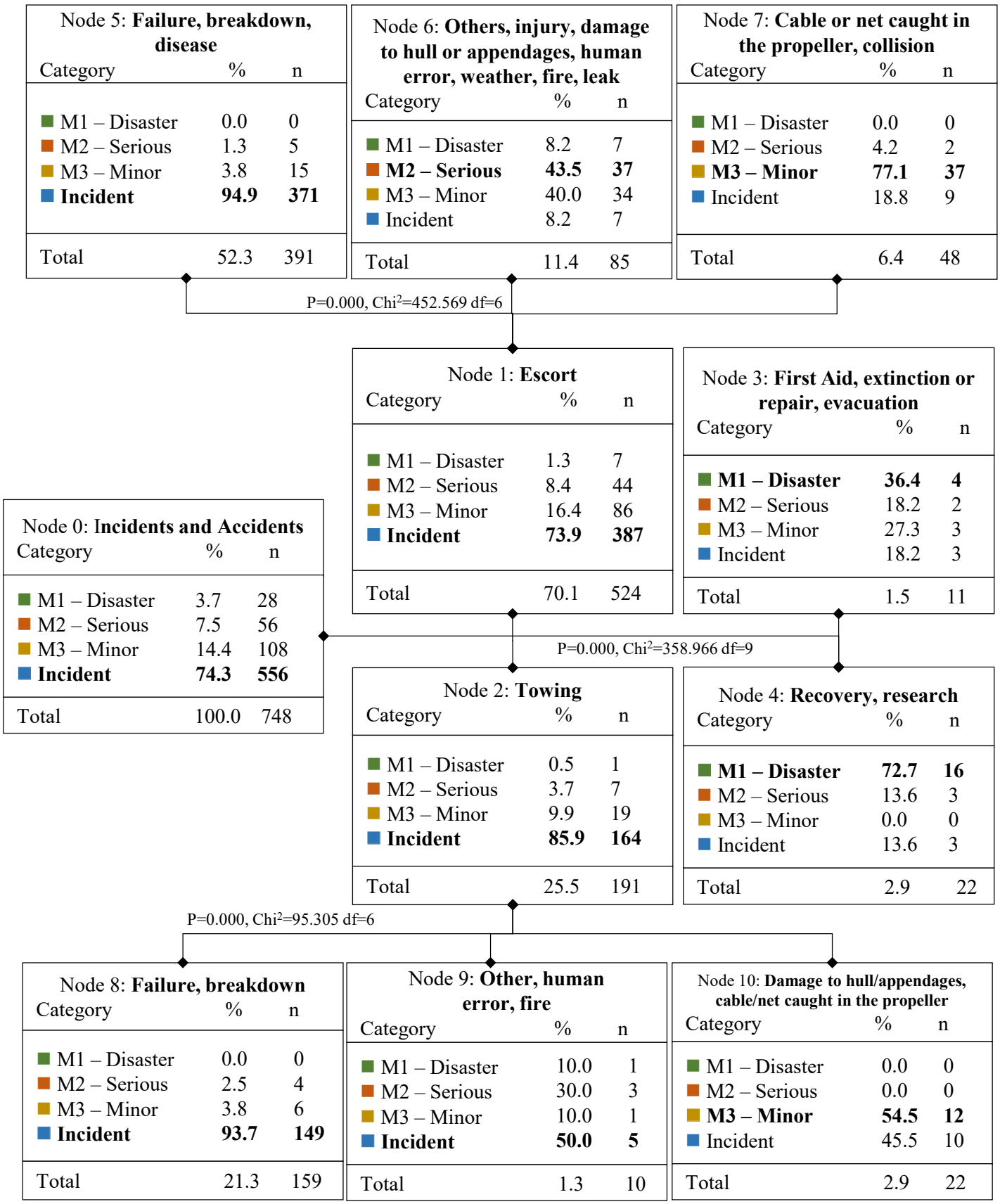
Term	Description
Fall overboard	Falling out of the vessel.
Fire	A fire which causes damage as it spreads.
First aid	Represent the set of technical assistance provided to people who are victims of an accident, a disaster, a health problem, or a social problem that compromises their health in the short term.
Grounding	Accidental immobilization of a vessel on a shoal.
Heating system fire	Fire caused by the heating system and heat distribution in the compartments.
Human error	The action or lack of action by an individual that resulted in effects in the causal chain of an accident.
Hydraulic failure	Relating to hydraulic oil circuits (winch, *crab-block*, fishing rigging in general).
Hydraulic fire	Fire caused by hydraulic oil projected on a hot surface.
Injury	Injury caused, unintentionally or to harm living tissue by pressure, shock, blow, weapon, or heat.
Leak	Unexpected water entering a vessel as a result of an opening in the hull below the waterline.
Man overboard	Man fallen overboard.
Mechanical failure (engine, transmission, 7)	Failure of the main engine or one of its components essential to the propulsion of the vessel.
Medical	Is considered medical what concerns the treatment and prevention of diseases and injuries.
Need assistance	Help requested, given, or received.
None	Indicates complete absence; none.
Out of fuel	Fuel starvation.
Propeller shaft failure	Failure of the shaft line connecting the engine to the propeller or failure of one of its components.
Pumping system problem	Flooding caused by a defect in the dewatering system or a seawater pumping system.
Recovery by another vessel	Act of recovering or being recovered by a vessel other than a fishing vessel or CCG vessel.
Recovery by CCG	Act of recovering or being recovered by a CCG vessel.
Recovery by fishing vessel	Act of recovering or being recovered by a fishing vessel.
Recovery by helihoisting	Act of retrieving or being retrieved by helihoisting, which consists of moving a load hooked to a helicopter with a hoist.
Research	Effort to find someone and/or something.
Rudder failure	The failure may be due to one of the components of the system used to steer the vessel, either the rudder or its control system.
Salvage	Act of refloating a vessel that is stranded on a reef or has completely sunk.
Shipwreck	Ship that sinks after an accident.
Towing by another vessel	Act of towing; being towed, by a vessel other than a fishing vessel or CCG vessel.
Towing by CCG	Act of towing; being towed, by a CCG vessel.
Towing by fishing vessel	Act of towing; being towed, by a fishing vessel.
Unknown cause	The nature of which is unknown.

Glossary of Accidents and Incidents

Term	Description
Vessel—major material loss	Rescued vessel with major damage.
Vessel—minor material loss	Rescued vessel with minor damage.
Vessel—no material loss	Vessel without any resulting damage.
Vessel—total loss	Vessel that sank or burned.
Weather	Atmospheric phenomena such as clouds, precipitation, sea conditions or wind.

Appendix F
CHAID Analyses

Figure 9: Actions Taken by Stakeholders Based on the Causes of Accidental Events[20]



[20] The CHAID algorithm correctly classifies 85.9% of events.

Figure 10: Causes According to Severity and Inspections

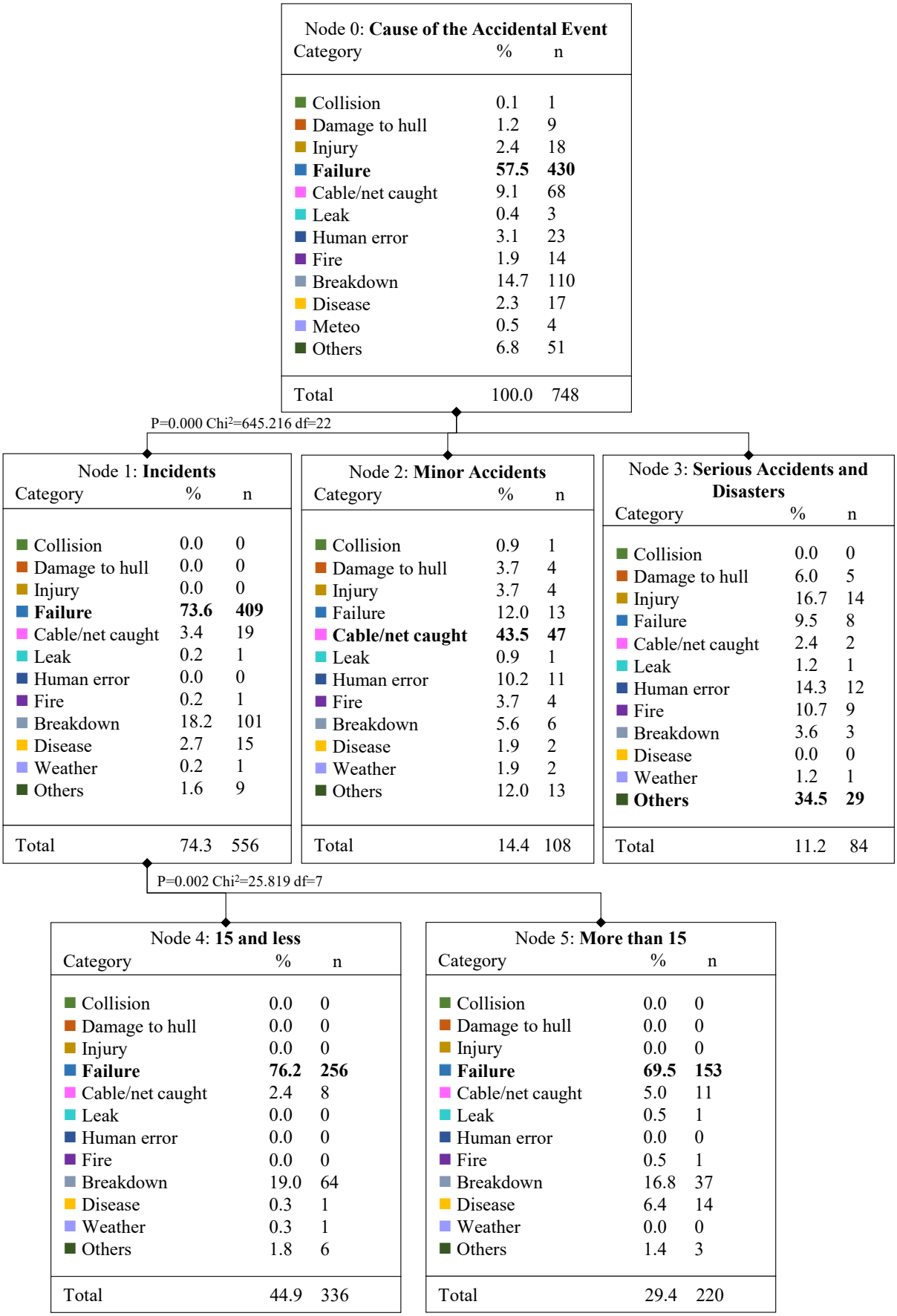


Figure 11: The Extent of Losses According to Accidents and Causes

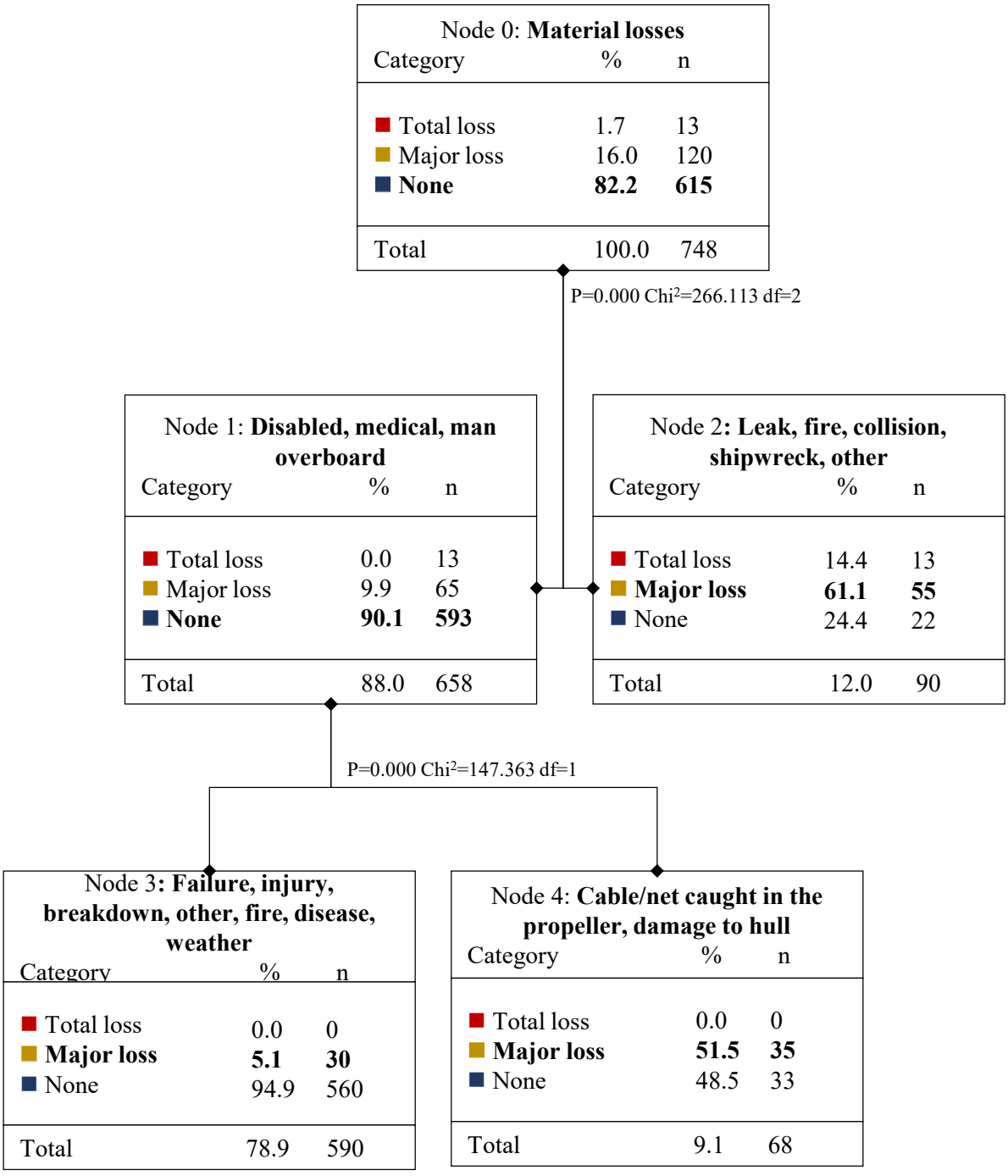


Figure 12: Losses According to Fleets and causes of Accidents

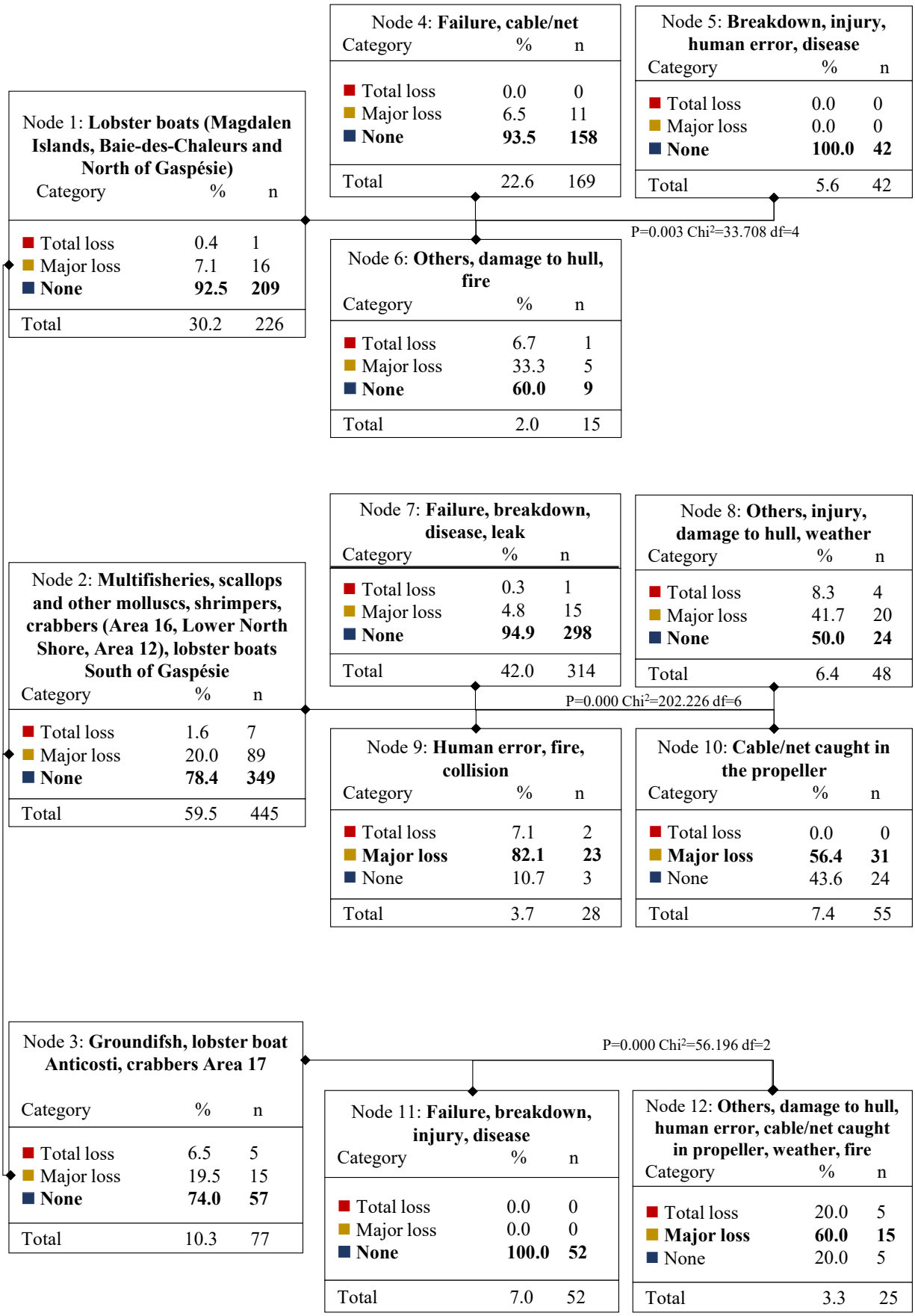


Figure 13: Causes and Fleets—Crabbers

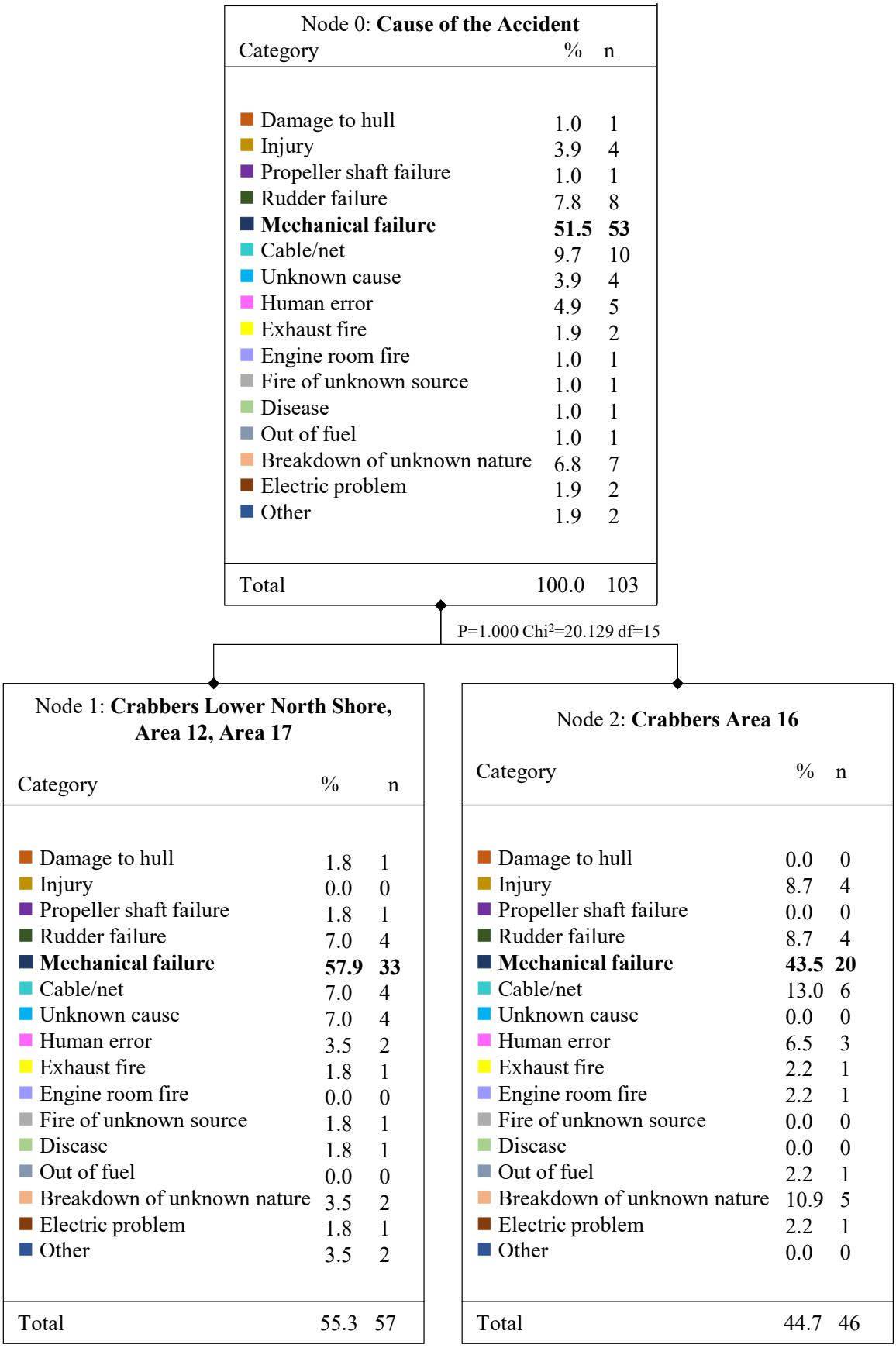


Figure 14: Causes and Fleets—Lobster boats

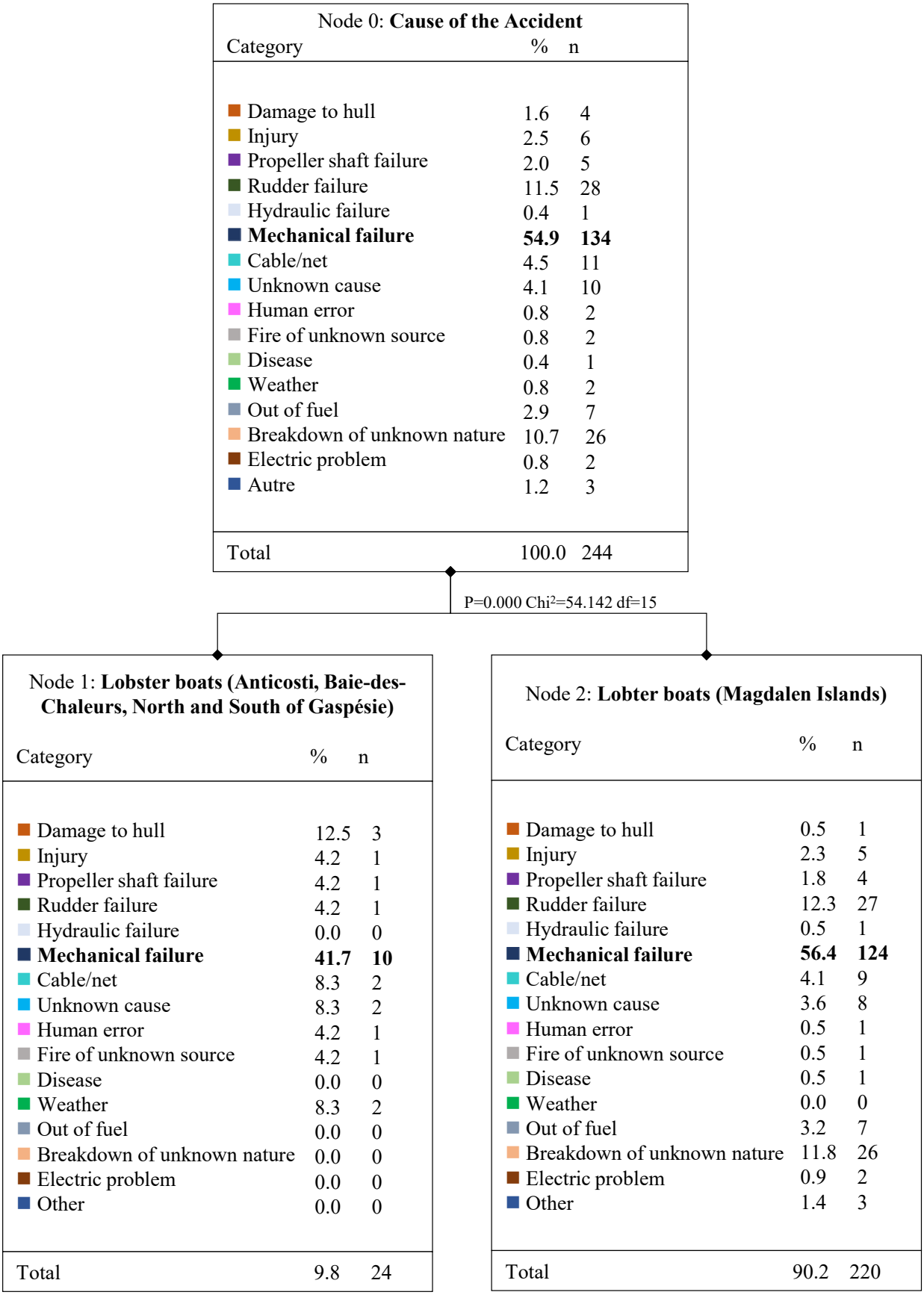
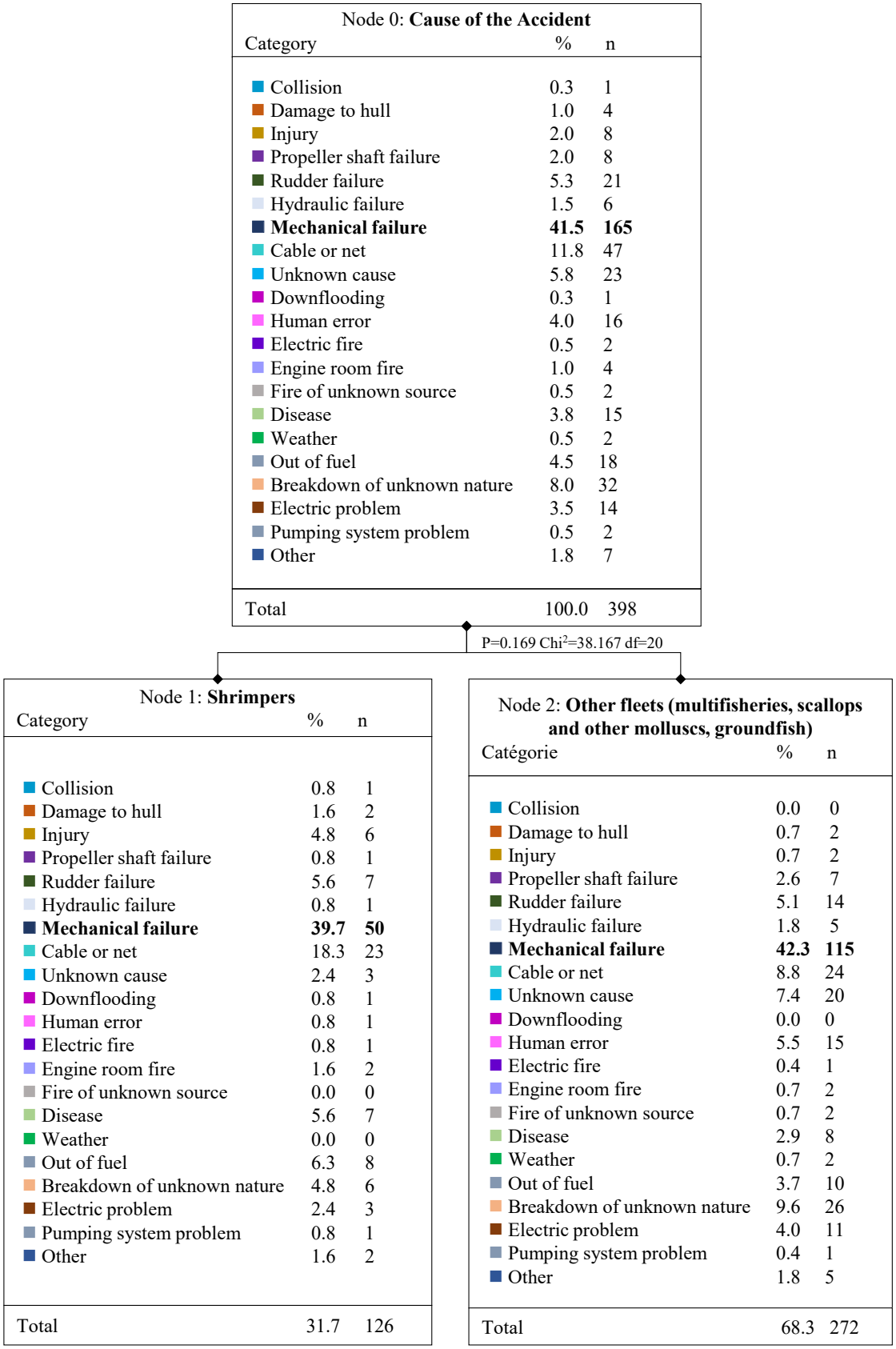


Figure 15: Causes and Fleets—Shrimpers, Multifisheries, Scallops and Other Molluscs and Groundfish[21]



[21] These fleets were grouped together due to the high occurrence of types of accidental events (mechanical failure) that affect them.

Figure 16: Causes and Fleets—Shrimpers Only

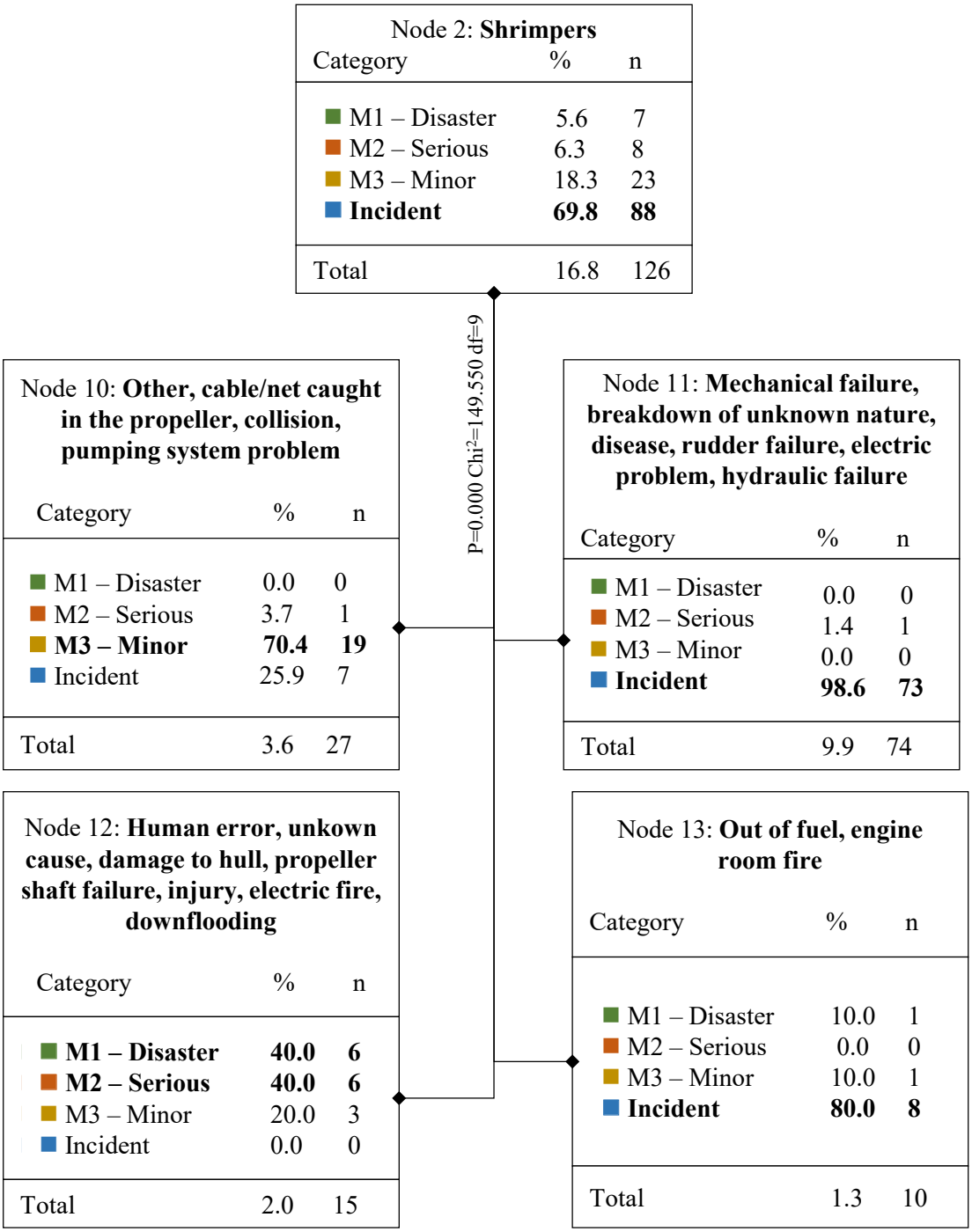


Figure 17: Material Losses as a Function of Causes and Users

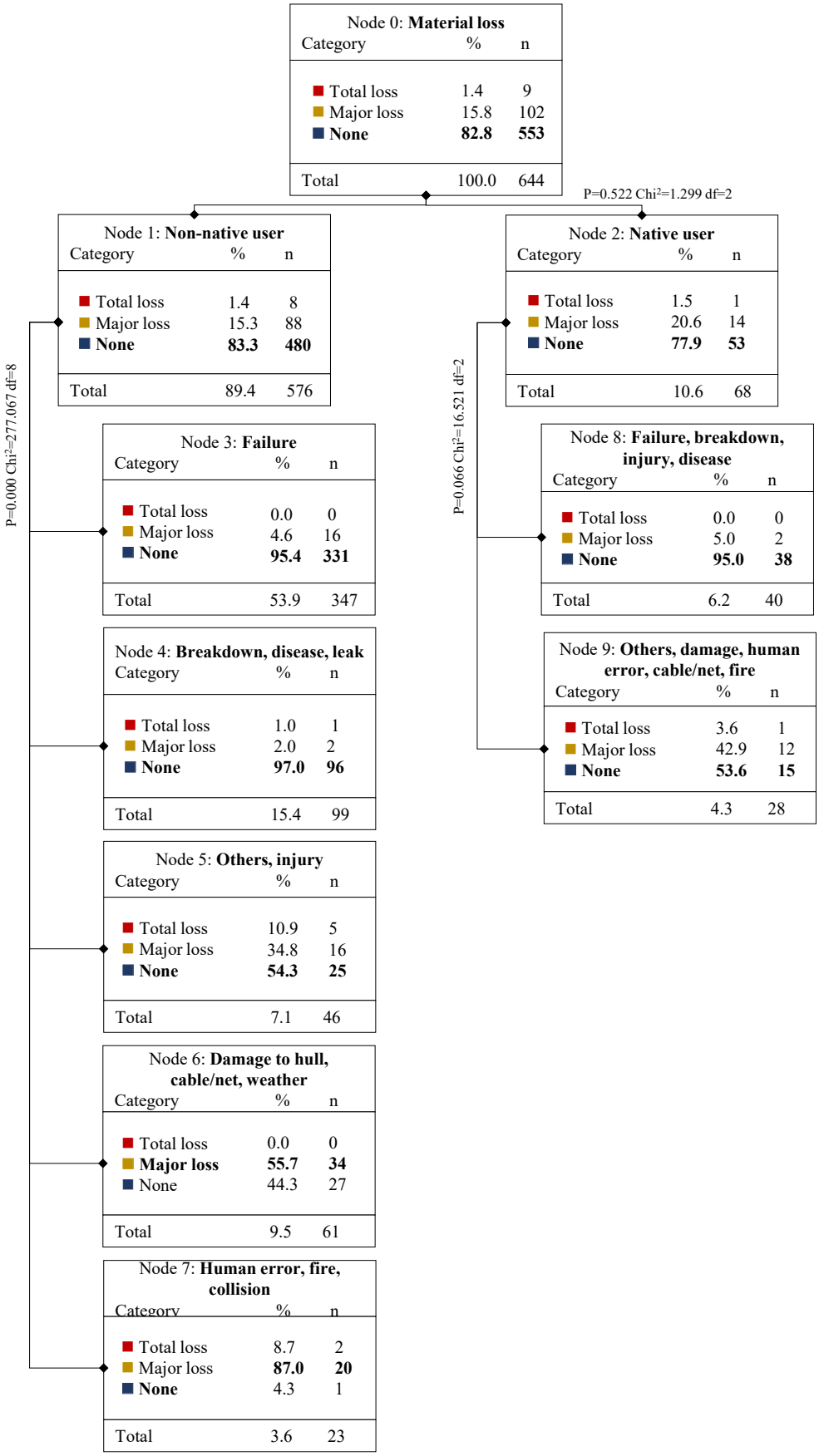


Figure 18: Shrimpers as a Function of Other Variables

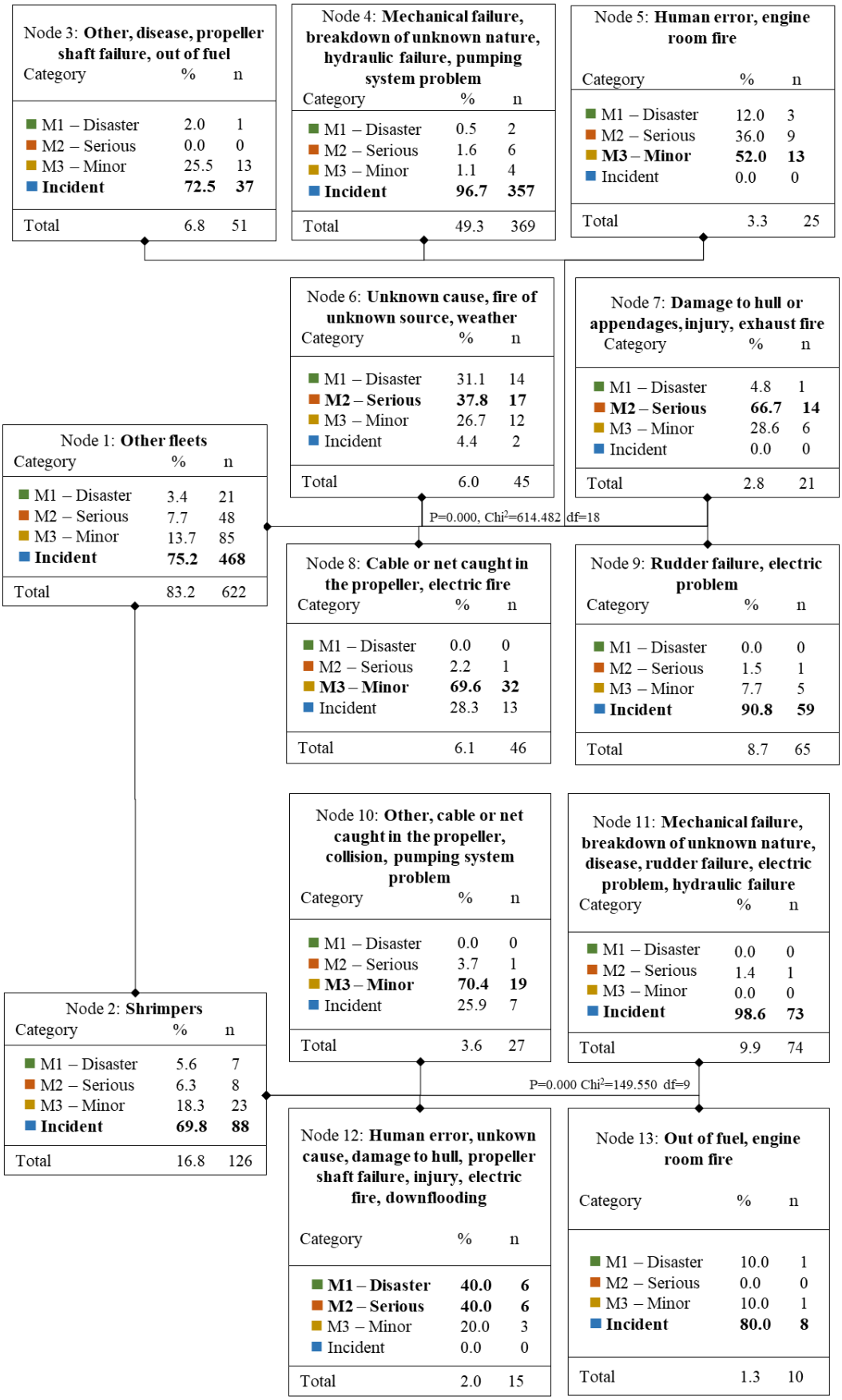
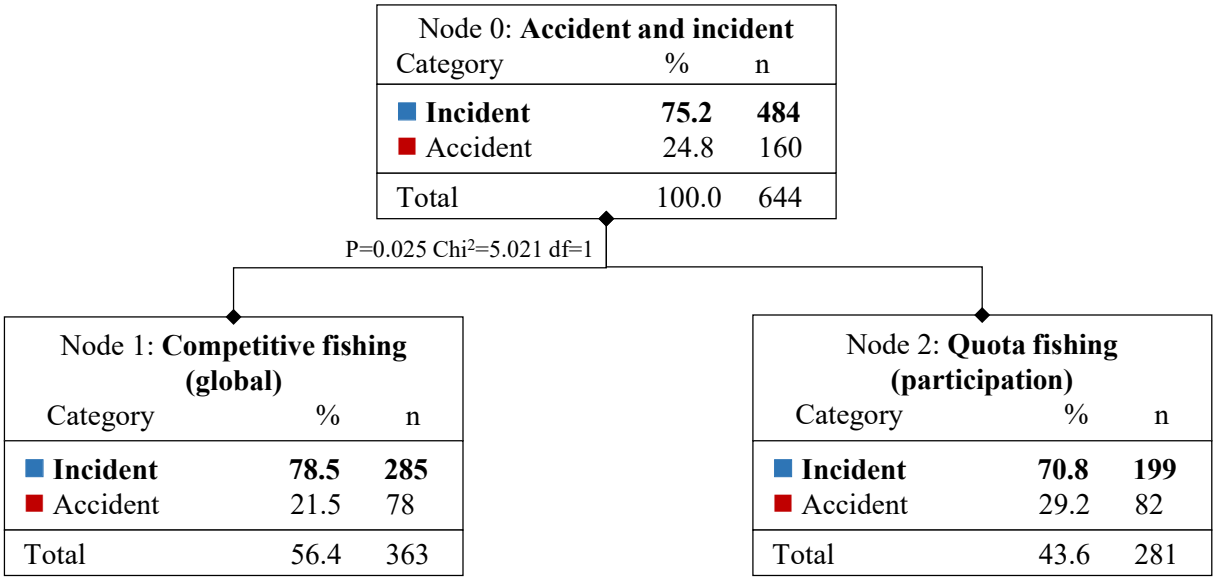


Figure 19: Competitive or Quota Fishing (Global or Participation)



Appendix G
Questionnaire for the Master

Questionnaire for the master
The research project "Making prevention a priority"

Instructions

Hello and thank you for agreeing to participate to our project. As agreed, I will ask you questions and record your answers. The information you give us will remain strictly confidential and you will in no way be identifiable. At any time, if you wish to end the interview, just let me know and we will stop instantly. Besides, if you wish to withdraw from the project afterwards, you just have to let us know by indicating the date and time of the interview, and we will withdraw your data from the project.

Ready to start?

Section 1: Sociodemographic data

1. Number of the vessel observation form: O2019 – _____
2. Port/town: _____
3. Type of fishery: _____
4. Date of the interview: _____
5. Time of the interview: _____
6. Function: Master
7. Age:

☐ 19 years and under
☐ 20 to 29 years
☐ 30 to 39 years
☐ 40 to 49 years
☐ 50 to 59 years
☐ 60 to 69 years
☐ 70 years and older
☐ Prefer not to answer

8. Ethnic origin:

☐ White
☐ Black or African American
☐ Indigenous
☐ Other (specify) _____

9. Gender

☐ Man
☐ Woman
☐ Other (specify) _____

10. Place of the permanent residence: _____

-.-

Section 2: Safety on the vessel

11. Are fishing, handling and processing equipment properly installed and do they allow you to do your work safely?

☐ Totally [6]
☐ Some improvements should be made [4]
☐ Many improvements should be made [2]
☐ The working plan should be reviewed in its entirety [0]

Comments:

_____

_____

12. According to you, which aspect is the most important to verify for the hiring of a crew member?
- ☐ Experience [2]
- ☐ Reference [2]
- ☐ Obtained certificates [4]
- ☐ DVS in professional fishing [6]
- ☐ None of these answers [?]

Comments:

_____

_____

13. You notice that the first-aid certification of one of your crew members is expired. What is your reaction?
- ☐ You don't take it into account as only one crew member must have it. [0]
- ☐ You ask him to renew it as soon as possible. [4]
- ☐ You enroll him in the next training offered. [6]
- ☐ You tell him that he will need it to be hired for the next season. [2]

Comments:

_____

_____

14. In which regulations do we find the life saving equipment required on a fishing vessel?
- ☐ Navigation Safety Regulations [0]
- ☐ Life Saving Equipment Regulations [0]
- ☐ Fishing Vessel Safety Regulations [5]
- ☐ None of the above [0]
- ☐ No idea! [0]

Comments:

_____

_____

15. In which regulations do we find the requirements regarding the navigation lights?
- ☐ Navigation Safety Regulations [0]
- ☐ Collision Regulations [5]
- ☐ Fishing Vessel Safety Regulations [0]
- ☐ None of these answers [0]
- ☐ No idea! [0]

Comments:

_____

_____

16. If you navigate with missing life saving equipment, which enforcement action may be imposed on you?
- ☐ Written notice [2]
- ☐ Administrative monetary penalty [2]
- ☐ Penal action [2]
- ☐ All of these answers [6]
- ☐ No idea! [0]

Comments:

_____

_____

17. Do you consider that the stability of your vessel is adequate?

- ☐ Yes [2]
- ☐ No [-2]
- ☐ You don't know [0]

Comments:

_____

_____

18. If so, why do you consider the stability of your vessel as adequate?

- ☐ A stability assessment has been conducted on my vessel [4]
- ☐ My offshore experience shows me that it is stiff [1]
- ☐ The vessel is well designed and the weights are well distributed [2]
- ☐ I never had any accident [0]

Comments:

_____

_____

19. Of the following, which one can have the greatest impact on the stability of your vessel?

- ☐ Modification to the type of fishery—the addition of a portal [3]
- ☐ Addition of stabilizing fins [1]
- ☐ Installation of a fish pond or a seawater hold [2]
- ☐ It's impossible to know without calculations [6]
- ☐ No idea! [0]

Comments:

_____

_____

20. For which task do you give instructions to your employees?

- ☐ Fishing gear operation [1]
- ☐ Cargo handling [1]
- ☐ Stabilizer and other equipment operation [1]
- ☐ Berthing, anchoring, etc. [1]
- ☐ All of these answers [6]
- ☐ None [0]

Comments:

_____

_____

21. How do you give these work instructions?

- ☐ Orally [1]
- ☐ In writing [4]
- ☐ By having them doing it [2]
- ☐ You don't give work instructions [0]

Comments:

_____

_____

22. Do you give familiarization to the work techniques to all new crew members?

- ☐ Always [4]
- ☐ On occasion [0]
- ☐ When you deem it necessary [0]
- ☐ Never [0]

Comments:

_____

_____

23. Does your crew respect your instructions and techniques for a safe work?

- ☐ Always [4]
- ☐ Sometimes no [3]
- ☐ Rarely [1]
- ☐ Never [0]

Comments:

_____

_____

24. Do you call your crew to order when it doesn't correctly apply safe work instructions and techniques?

- ☐ Always [4]
- ☐ Sometimes no [3]
- ☐ Rarely [1]
- ☐ Never [0]

Comments:

_____

_____

25. Which individual protective equipment (IPE), amongst the following, do you force your crew members to wear (check all the applicable answers)?

- ☐ PFD [3]
- ☐ Harness [2]
- ☐ Glasses [1]
- ☐ Hearing protector [1]
- ☐ Hat [1]
- ☐ Boots [1]
- ☐ Gloves [1]
- ☐ All of these answers [10]
- ☐ None [0]

Comments:

_____

_____

26. When do you wear a PFD on the deck (check all the applicable answers)?

- ☐ At all times [4]
- ☐ When the weather is bad [2]
- ☐ When you work [1]
- ☐ Never [-2]

Comments:

_____

_____

27. When do your crew members wear a PFD on the deck (check all the applicable answers)?

- ☐ At all times [4]
- ☐ When the weather is bad [2]
- ☐ When they work [1]
- ☐ Never [0]

Comments:

_____

_____

28. When do you wear a safety harness?

- ☐ When you work at heights [4]
- ☐ When there is a risk of falling overboard [4]
- ☐ The two previous answers [8]
- ☐ Never [0]

Comments:

_____

29. Which equipment, amongst the following, do you wear when required (check all the applicable answers)?

- ☐ Hat [1]
- ☐ Boots [1]
- ☐ Glasses [1]
- ☐ Hearing protector [1]
- ☐ Gloves [1]
- ☐ All of these answers [6]
- ☐ None [0]

Comments:

_____

_____

30. To what extent do you agree with the following statement: I make sure that all my crew members apply the same safe methods.

- ☐ Totally agree [2]
- ☐ Agree [1]
- ☐ Neither agree nor disagree [0]
- ☐ Disagree [-1]
- ☐ Strongly disagree [-2]

Comments:

_____

_____

31. At what time do you talk, as a group, about the ways to improve your work techniques?

- ☐ When an accident or a near-miss happens [2]
- ☐ At the beginning of the season [1]
- ☐ In your ongoing discussions [4]
- ☐ Never [0]

Comments:

_____

_____

32. At what time do you perform safety inspection of the vessel and equipment?

- ☐ Before each trip [16]
- ☐ A few times during the season [8]
- ☐ Once a month [4]
- ☐ At the beginning of the season [2]
- ☐ Never [0]

Comments:

_____

_____

33. Did you carry a risk analysis of your day-to-day activities (loading, fishing, unloading, etc.)?

- ☐ Yes [4]
- ☐ No [0]
- ☐ You don't know/N/A [0]

Comments:

_____

_____

34. Who provides the IPE?

- ☐ The master-owner [4]
- ☐ Each crew member [1]
- ☐ Some are provided by the master-owner and some others are provided by each crew member [2]
- ☐ No IPE is provided [0]

Comments:

_____

_____

35. Complete the following statement: I give training on the good way to use the IPE...

- ☐ To the new crew members [2]
- ☐ At the beginning of the season [2]
- ☐ The two previous answers [4]
- ☐ Never [0]

Comments:

_____

_____

36. How often are the IPE inspected and verified?

- ☐ Never [0]
- ☐ Rarely [1]
- ☐ Occasionally [2]
- ☐ Frequently [4]

Comments:

_____

_____

37. At what time do you perform maintenance and servicing of the vessel and its equipment?

- ☐ From time to time, when we have the time [2]
- ☐ After each trip [4]
- ☐ A few times during the season [1]
- ☐ According to an established schedule [3]
- ☐ On an ongoing basis [5]

Comments:

_____

_____

38. When do you report the accidents/incidents to the competent authorities?

- ☐ Each time [4]
- ☐ Most of the time [2]
- ☐ Sometimes [1]
- ☐ Rarely [0]
- ☐ Not applicable/you never had any accident CATEGORY I

Comments:

_____

_____

39. How often do you investigate following an accident/incident?

- ☐ Each time [4]
- ☐ Most of the time [2]
- ☐ Sometimes [1]
- ☐ Rarely [0]
- ☐ Not applicable/you never had any accident CATEGORY I

Comments:

_____

_____

40. After an accident/incident, when do you discuss, as a team, to make sure this doesn't happen again?

- ☐ Each time [4]
- ☐ Most of the time [2]
- ☐ Sometimes [1]
- ☐ Rarely [0]
- ☐ Not applicable/you never had any accident

CATEGORY I

CATEGORY I

Comments:

_____

_____

41. At what time do you stage emergency training and drills?

- ☐ Before each trip [10]
- ☐ A few times during the season [4]
- ☐ Once a month [6]
- ☐ At the beginning of the season [2]
- ☐ Never [0]

Comments:

_____

_____

42. To what extent do you agree with the following statement: I am well prepared to face emergencies (falling overboard, capsizing, etc.).

- ☐ Totally agree [5]
- ☐ Agree [10]
- ☐ Neither agree nor disagree [0]
- ☐ Disagree [-5]
- ☐ Strongly disagree [-10]

Comments:

_____

_____

43. Have you already had any work accident related to the fishery?

- ☐ Yes
- ☐ No

If so, can you tell briefly what happened?

_____

_____

_____

44. Do you know someone who has already had a work accident related to the fishery?

- ☐ Yes
- ☐ No

If so, can you tell briefly what happened?

_____

_____

45. Do you know someone who died in the aftermath of a work accident related to the fishery?

- ☐ Yes
- ☐ No

If so, can you tell briefly what happened?

_____

_____

_____

-.-

Section 3: We want your opinion

For the next section, please indicate to what extent you agree with each statement.

46. The safety in the fishing industry improved strongly in the last years.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

47. It is important for me to have a profitable season.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

48. My crew and I are a close-knit team.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

49. In our crew, respect is a core value.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

50. There is a lot of mutual aid in our team.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

51. For me, safety always comes before production.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

52. For me, the health, safety and well-being of my crew members is a constant concern.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

53. We sometimes take risks to have a more abundant fishery.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

54. We sometimes work even when we are tired when circumstances require it.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

55. The safety measures that we apply are sufficient to prevent accidents.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

56. Laws and regulations applicable to our operations make work safer.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

57. Laws and regulations applicable to our operation make work more complex or difficult.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

58. Alcohol and drugs are widely used in our industry.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

59. I am always worried when we are setting sail.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

60. Accidents are part of the fisherman's profession.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

61. Our destiny depends on Mother Nature.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

62. Human life is more precious than anything else.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

63. It is possible to have fishing seasons without any accidents.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

64. Caution can help us prevent most of the types of accidents.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

65. Do you attend the meetings of the *Comité permanent sur la sécurité des bateaux de pêche du Québec*?

☐ Never ☐ Sometimes ☐ Each time

Comments:

_____

_____

-.-

Thank you again for your participation

Appendix H
Questionnaire for the Crew Members

Questionnaire for the crew members
The research project "Making prevention a priority"

Instructions

Hello and thank you for agreeing to participate to our project. As agreed, I will ask you questions and record your answers. The information you give us will remain strictly confidential and you will in no way be identifiable. At any time, if you wish to end the interview, just let me know and we will stop instantly. Besides, if you wish to withdraw from the project afterwards, you just have to let us know by indicating the date and time of the interview, and we will withdraw your data from the project.

Ready to start?

Section 1: Sociodemographic data

1. Number of the vessel observation form: O2019 – _____
2. Port/town: _____
3. Type of fishery: _____
4. Date of the interview: _____
5. Time of the interview: _____
6. Function:
   - ☐ Crew member 1
   - ☐ Crew member 2
   - ☐ Crew member 3
   - ☐ Crew member 4

7. Age:
   - ☐ 19 years and under
   - ☐ 20 to 29 years
   - ☐ 30 to 39 years
   - ☐ 40 to 49 years
   - ☐ 50 to 59 years
   - ☐ 60 to 69 years
   - ☐ 70 years and older
   - ☐ Prefer not to answer

8. Ethnic origin:
   - ☐ White
   - ☐ Black or African American
   - ☐ Indigenous
   - ☐ Other (specify) _____

9. Gender
   - ☐ Man
   - ☐ Woman
   - ☐ Other (specify) _____

10. Place of the permanent residence: _____

-.-

Section 2: Safety on the vessel

11. Are fishing, handling and processing equipment properly installed and do they allow you to do your work safely?
    - ☐ Totally [6]
    - ☐ Some improvements should be made [4]
    - ☐ Many improvements should be made [2]
    - ☐ The working plan should be reviewed in its entirety [0]

Comments:

_____

_____

12. In which regulations do we find the life saving equipment required on a fishing vessel?

- ☐ Navigation Safety Regulations [0]
- ☐ Life Saving Equipment Regulations [0]
- ☐ Fishing Vessel Safety Regulations [5]
- ☐ None of these answers [0]
- ☐ No idea! [0]

Comments:

_____

_____

13. In which regulations do we find the requirements regarding the navigation lights?

- ☐ Navigation Safety Regulations [0]
- ☐ Fishing Vessel Safety Regulations [0]
- ☐ Collision Regulations [5]
- ☐ None of these answers [0]
- ☐ No idea! [0]

Comments:

_____

_____

14. If you navigate with missing life saving equipment, which enforcement action may be imposed on you?

- ☐ Written notice [2]
- ☐ Administrative monetary penalty [2]
- ☐ Penal action [2]
- ☐ All of these answers [6]
- ☐ No idea! [0]

Comments:

_____

_____

15. Do you consider that the stability of your vessel is adequate?

- ☐ Yes [2]
- ☐ No [-2]
- ☐ You don't know [0]

Comments:

_____

_____

16. Of the following, which one can have the greatest impact on the stability of your vessel?

- ☐ Modification to the type of fishery—the addition of a portal [3]
- ☐ Addition of stabilizing fins [1]
- ☐ Installation of a fish pond or a seawater hold [2]
- ☐ It's impossible to know without calculations [6]
- ☐ No idea! [0]

Comments:

_____

17. For which task does your master give you work instructions?

- ☐ Fishing gear operation [1]
- ☐ Cargo handling [1]
- ☐ Stabilizer and other equipment operation [1]
- ☐ Berthing, anchoring, etc. [1]
- ☐ All of these answers [6]
- ☐ None [0]

Comments:

_____

_____

18. How does your master give you these instructions?

- ☐ Orally [1]
- ☐ In writing [4]
- ☐ By having us doing it [2]
- ☐ He doesn't give you work instructions [0]

Comments:

_____

_____

19. Do you receive familiarization to the work techniques?

- ☐ Always [4]
- ☐ On occasion [1]
- ☐ When the captain deems it necessary [1]
- ☐ Never [0]

Comments:

_____

_____

20. Do you respect the instructions and techniques for a safe work given by your master?

- ☐ Always [4]
- ☐ Sometimes no [3]
- ☐ Rarely [1]
- ☐ Never [0]

Comments:

_____

_____

21. Does your master call you to order when you don't correctly apply safe work instructions and techniques?

- ☐ Always [4]
- ☐ Sometimes no [3]
- ☐ Rarely [1]
- ☐ Never [0]

Comments:

_____

_____

22. Which individual protective equipment (IPE), amongst the following, does your master force you to wear (check all the applicable answers)?

- ☐ PFD [3]
- ☐ Harness [2]
- ☐ Glasses [1]
- ☐ Hearing protector [1]
- ☐ Hat [1]
- ☐ Boots [1]
- ☐ Gloves [1]
- ☐ All of these answers [10]
- ☐ None [0]

Comments:

_____

23. When do you wear a PFD on the deck (check all the applicable answers)?

- ☐ At all times [4]
- ☐ When the weather is bad [2]
- ☐ When you work [1]
- ☐ Never [0]

Comments:

_____

_____

24. When does your captain wear a PFD on the deck (check all the applicable answers)?

- ☐ At all times [4]
- ☐ When the weather is bad [2]
- ☐ When you work [1]
- ☐ Never [0]

Comments:

_____

_____

25. When do you wear a safety harness?

- ☐ When you work at heights [4]
- ☐ When there is a risk of falling overboard [4]
- ☐ The two previous answers [8]
- ☐ Never [0]

Comments:

_____

_____

26. Which equipment, amongst the following, do you wear when required (check all the applicable answers)?

- ☐ Hat [1]
- ☐ Boots [1]
- ☐ Glasses [1]
- ☐ Hearing protector [1]
- ☐ Gloves [1]
- ☐ All of these answers [6]
- ☐ None [0]

Comments:

_____

_____

27. To what extent do you agree with the following statement: The master make sure that all the crew members apply the same safe methods.

- ☐ Totally agree [2]
- ☐ Agree [1]
- ☐ Neither agree nor disagree [0]
- ☐ Disagree [-1]
- ☐ Strongly disagree [-2]

Comments:

_____

_____

28. At what time do you talk, as a group, of the ways to improve your work techniques?

- ☐ When an accident or a near-miss happens [2]
- ☐ At the beginning of the season [1]
- ☐ In your ongoing discussions [4]
- ☐ Never [0]

Comments:

_____

_____

29. At what time do you perform safety inspection of the vessel and of the equipment?

- ☐ Before each trip [16]
- ☐ A few times during the season [8]
- ☐ Once a month [4]
- ☐ At the beginning of the season [2]
- ☐ Never [0]

Comments:

_____

_____

30. Who provides the IPE?

- ☐ The master-owner [4]
- ☐ Each crew member [1]
- ☐ Some are provided by the master-owner and some others are provided by each crew member [2]
- ☐ No IPE is provided [0]

Comments:

_____

_____

31. Complete the following statement: I received training on the good way to use the IPE...

- ☐ When I was a new crew member [2]
- ☐ At the beginning of the season [2]
- ☐ The two previous answers [4]
- ☐ Never [0]

Comments:

_____

_____

32. How often are the IPE inspected and verified?

- ☐ Never [0]
- ☐ Rarely [1]
- ☐ Occasionally [2]
- ☐ Frequently [4]

Comments:

_____

_____

33. How often do you perform maintenance and servicing of the vessel and its equipment?

- ☐ From time to time, when we have the time [2]
- ☐ After each trip [4]
- ☐ A few times during the season [1]
- ☐ According to an established schedule [3]
- ☐ On an ongoing basis [5]

Comments:

_____

_____

34. When do you report the accidents/incidents to the competent authorities?

- ☐ Each time [4]
- ☐ Most of the time [2]
- ☐ Sometimes [1]
- ☐ Rarely [0]
- ☐ Not applicable/you never had any accident [CATEGORY 1]

Comments:

_____

_____

35. How often do you investigate following an accident/incident?

- ☐ Each time [4]
- ☐ Most of the time [2]
- ☐ Sometimes [1]
- ☐ Rarely [0]
- ☐ Not applicable/you never had any accident [CATEGORY 1]

Comments:

_____

_____

36. After an accident/incident, when do you discuss, as a team, to make sure this doesn't happen again?

- ☐ Each time [4]
- ☐ Most of the time [2]
- ☐ Sometimes [1]
- ☐ Rarely [0]
- ☐ Not applicable/you never had any accident [CATEGORY 1]

Comments:

_____

_____

37. At what time do you stage emergency training and drills?

- ☐ Before each trip [10]
- ☐ A few times during the season [4]
- ☐ Once a month [6]
- ☐ At the beginning of the season [2]
- ☐ Never [0]

Comments:

_____

_____

38. To what extent do you agree with the following statement: I am well prepared to face emergencies (falling overboard, capsizing, etc.).

- ☐ Totally agree [5]
- ☐ Agree [10]
- ☐ Neither agree nor disagree [0]
- ☐ Disagree [-5]
- ☐ Strongly disagree [-10]

Comments:

_____

_____

39. Have you already had any work accident related to the fishery?

- ☐ Yes
- ☐ No

If so, can you tell briefly what happened?

_____

40. Do you know someone who has already had a work accident related to the fishery?

☐ Yes ☐ No

If so, can you tell briefly what happened?

_____

_____

_____

41. Do you know someone who died in the aftermath of a work accident related to the fishery?

☐ Yes ☐ No

If so, can you tell briefly what happened?

_____

_____

_____

-.-

Section 3: We want your opinion

For the next section, please indicate to what extent you agree with each statement.

42. The safety in the fishing industry improved strongly in the last years.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

43. It is important for my master to have a profitable season.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

44. My colleague and I are a close-knit team.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

45. In our crew, respect is a core value.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

46. There is a lot of mutual aid in our team.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

47. For my master, safety always comes before production.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

48. For my master, the health, safety and well-being of the crew members is a constant concern.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

49. We sometimes take risks to have a more abundant fishery.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

50. We sometimes work even when we are tired when circumstances require it.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

51. The safety measures that we apply are sufficient to prevent accidents.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

52. Laws and regulations applicable to our operations make work safer.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

53. Laws and regulations applicable to our operation make work more complex or difficult.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

54. Alcohol and drugs are widely used in our industry.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

55. I am always worried when we are setting sail.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

56. Accidents are part of the fisherman's profession.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

57. Our destiny depends on Mother Nature.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

58. Human life is more precious than anything else.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

59. It is possible to have fishing seasons without any accidents.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

60. Caution can help us prevent most of the types of accidents.

☐ Totally agree [5] ☐ Neither agree nor disagree [3] ☐ Strongly disagree [1]
☐ Agree [4] ☐ Disagree [2]

Comments:

_____

_____

61. Do you attend the meetings of the *Comité permanent sur la sécurité des bateaux de pêche du Québec*?

☐ Never ☐ Sometimes ☐ Each time

Comments:

_____

_____

-.-

Thank you again for your participation!

Appendix I
Vessel Observation Form

Vessel Observation Form
The research project "Making prevention a priority"

GENERAL INFORMATION

of the master questionnaire: C2019 –
of the crew member 1 questionnaire: E2019 –
of the crew member 2 questionnaire: E2019 –
of the crew member 3 questionnaire: E2019 –

SECTION A—INFORMATION ON THE VESSEL

Type of vessel…….. ☐ 1.1 Dragger ☐ 1.2 Lobster boat ☐ 1.3 Gillnetter ☐ 1.4 Crabber
☐ 1.5 Scallop vessel ☐ 1.6 Longliner ☐ 1.7 Other (specify): _____

* Check the main fishery of the vessel.

Gross tonnage…….. ☐ 2.1 ≥ 15 ☐ 2.2 > 15 ≥ 60 ☐ 2.3 > 60 ≥ 100 ☐ 2.4 > 100

Overall length…….. ☐ 3.1 ≥ 12 m (39' 4'') ☐ 3.2 > 12 m ≥ 15 m (39' 4'' - 49' 2'') ☐ 3.3 > 15 m ≥ 18 m (49' 2'' - 59') ☐ 3.4 > 18 m (59')

☐ 4.1 Decked ☐ 4.2 Undecked Home port: _____

5.1 Vessel operation staff (number of people normally on board): _ 5.2 Vessel capacity (max number of transported people): _____

SECTION B—DOCUMENTARY CHECK

1) Certificates

1.1 Master……..	☐ *1.1.1* Third class	☐ *1.1.2* Fourth class	☐ *1.1.3* SVOP	☐ *1.1.4* Pleasure Craft Card
☐ *1.1.5* DVS	☐ *1.1.6* Proof of 7 seasons	☐ *1.1.7* ROC-MC	☐ *1.1.8* None	☐ *1.1.9* Others: _____
☐ *1.1.10* BAPAP		Are the certificates valid?	☐ Yes	☐ No
1.2 Crew member 1……	☐ *1.2.1* Third class	☐ *1.2.2* Fourth class	☐ *1.2.3* SVOP	☐ *1.2.4* Pleasure Craft Card
☐ *1.2.5* DVS	☐ *1.2.6* Proof of 7 seasons	☐ *1.2.7* ROC-MC	☐ *1.2.8* None	☐ *1.2.9* Others: _____
☐ *1.2.10* BAPAP		Are the certificates valid?	☐ Yes	☐ No
1.3 Crew member 2……	☐ *1.3.1* Third class	☐ *1.3.2* Fourth class	☐ *1.3.3* SVOP	☐ *1.3.4* Pleasure Craft Card
☐ *1.3.5* DVS	☐ *1.3.6* Proof of 7 seasons	☐ *1.3.7* ROC-MC	☐ *1.3.8* None	☐ *1.3.9* Others: _____
☐ *1.3.10* BAPAP		Are the certificates valid?	☐ Yes	☐ No
1.4 Crew member 3……	☐ *1.4.1* Third class	☐ *1.4.2* Fourth class	☐ *1.4.3* SVOP	☐ *1.4.4* Pleasure Craft Card
☐ *1.4.5* DVS	☐ *1.4.6* Proof of 7 seasons	☐ *1.4.7* ROC-MC	☐ *1.4.8* None	☐ *1.4.9* Others: _____
☐ *1.4.10* BAPAP		Are the certificates valid?	☐ Yes	☐ No
1.5 Crew member 4……	☐ *1.5.1* Third class	☐ *1.5.2* Fourth class	☐ *1.5.3* SVOP	☐ *1.5.4* Pleasure Craft Card
☐ *1.5.5* DVS	☐ *1.5.6* Proof of 7 seasons	☐ *1.5.7* ROC-MC	☐ *1.5.8* None	☐ *1.5.9* Others: _____
☐ *1.5.10* BAPAP		Are the certificates valid?	☐ Yes	☐ No
1.6 Crew member 5……	☐ *1.6.1* Third class	☐ *1.6.2* Fourth class	☐ *1.6.3* SVOP	☐ *1.6.4* Pleasure Craft Card
☐ *1.6.5* DVS	☐ *1.6.6* Proof of 7 seasons	☐ *1.6.7* ROC-MC	☐ *1.6.8* None	☐ *1.6.9* Others: _____
☐ *1.6.10* BAPAP		Are the certificates valid?	☐ Yes	☐ No

2) Training

2.1 Master……..	☐ MED	☐ First Aid	☐ Valid	☐ Non-valid
2.2 Crew member 1……	☐ MED	☐ First Aid	☐ Valid	☐ Non-valid
2.3 Crew member 2……..	☐ MED	☐ First Aid	☐ Valid	☐ Non-valid
2.4 Crew member 3……	☐ MED	☐ First Aid	☐ Valid	☐ Non-valid
2.5 Crew member 4……	☐ MED	☐ First Aid	☐ Valid	☐ Non-valid
2.6 Crew member 5……	☐ MED	☐ First Aid	☐ Valid	☐ Non-valid

2.7 Is there crew members in training (training already started or starting after the fishing season)? ☐ Yes [2*NB] ☐ No [0] ☐ Number: _____

2.8 Overall observations about the documents……..
- ☐ *2.8.1* All the documents are on board [5]
- ☐ *2.8.2* Some documents are missing [2]
- ☐ *2.8.3* Many documents are missing [1]
- ☐ *2.8.4* The master has a good knowledge of the skills of his crew [6]
- ☐ *2.8.5* The master doesn't't know the skills of his crew [0]
- ☐ *2.8.6* The minimum crew level is properly certified

3) Stability

3.1 Is there stability booklet for the vessel?.....	☐ Yes [CATEGORY 1]	☐ No [CATEGORY 2]
3.2 If so, is this information on board?……..	☐ Yes [5]	☐ No [0]
3.3 Question for the master: What is the worst stability condition of your vessel?..	☐ Success [5]	☐ Failure [0]
3.4 Are there been modifications to the vessel since the last assessment?.....	☐ Yes [-5]	☐ No [0]

4) Procedures and registers

Procedures

4.1 Is there emergency and operation procedures on board?.....	☐ Yes [20]	☐ No [0]
4.2 Do they seem complete?.....	☐ Yes [10]	☐ No [0]
4.3 Do they seem used?.....	☐ Yes [10]	☐ No [0]

Drills registers

4.4 Is there a register on board? ☐ Yes [10] ☐ No [0]

4.5 Is the register up to date? ☐ Yes [10] ☐ No [0]

4.5.1 How many drills have there been during the last year? _____ 0/5/10/15

Familiarization and training register

4.6 Is there a register on board? ☐ Yes ☐ No

4.7 Is the register up to date? ☐ Yes ☐ No

Date of the last entry: _____

Date of the last visit of an observer: _____

Maintenance history

4.8 Is there a register on board? ☐ Yes ☐ No

4.9 Is the register up to date? ☐ Yes ☐ No

Date of the last entry:

Date of the last engine oil change: _____

Risk register

4.10 Is there a register on board? ☐ Yes [5] ☐ No [0]

4.11 Is the register up to date? ☐ Yes [5] ☐ No [0]

IPE register

4.12 Is there a register on board? ☐ Yes [5] ☐ No [0]

4.13 Is the register up to date? ☐ Yes [2] ☐ No [0]

Verification form

4.14 Is there a checklist for the vessel equipment? ☐ Yes [5] ☐ No [0]

Date of the last inspection: _____

SECTION C—INSPECTION OF THE SAFETY EQUIPMENT

Distress signals

1.1 Valid? ☐ Yes [2] ☐ No [0]

1.2 Storage ☐ Good [2] ☐ Average [1] ☐ Bad [0]

Life jackets

2.1 Condition ☐ Good [2] ☐ Average [1] ☐ Bad [0]

2.2 Storage ☐ Good [2] ☐ Average [1] ☐ Bad [0]

2.3 In sufficient number for the crew? ☐ Yes [2] ☐ No [0]

Immersion suits

3.1 In sufficient number for the crew? ☐ Yes [2] ☐ No ☐ N/A

3.2 Condition ☐ Good [2] ☐ Average [1] ☐ Bad [0]

3.3 Storage ☐ Good [2] ☐ Average [1] ☐ Bad [0]

Inflatable or rigid liferaft

4.1 Was the last servicing performed during the last year? ☐ Yes [2] ☐ No ☐ N/A

4.2 Condition ☐ Good [2] ☐ Average [1] ☐ Bad [0]

4.3 Is it well secured? ☐ Yes [2] ☐ No [0]

4.4 Is it easily accessible? ☐ Yes [2] ☐ No [0]

4.5 Is there an hydrostatic trigger? ☐ Yes [2] ☐ No [0]

Expiration date: _____

Emergency position-indicating radio beacon (EPIRB)

Battery Date: _____

Class ☐ A ☐ B

Life buoy and/or heaving line

5.1 Condition ☐ Good [2] ☐ Average [1] ☐ Bad [0]

Man overboard recovery system

6.1 Is it easily accessible? ☐ Yes [2] ☐ No [0]

6.2 Does it seem functional? ☐ Yes [2] ☐ No [0]

7 ***First Aid Kit*** ☐ Yes [2] ☐ No [0]

8 ***Epinephrine autoinjector (EpiPen)*** ☐ Yes [2] ☐ No [0]

9 ***Defibrillator*** ☐ Yes [2] ☐ No [0]

SECTION D—IPE INSPECTION

Hats	Present?	☐ Yes [4]	☐ No [0]	Number: _____
Glasses	Present?	☐ Yes [2]	☐ No [0]	Number: _____
Hearing protectors	Present?	☐ Yes [2]	☐ No [0]	Number: _____
Harness	Present?	☐ Yes [4]	☐ No [0]	Number: _____
PFD	Present?	☐ Yes [4/8]	☐ No [0]	Number: _____

Others: _____

SECTION E—OVERALL ASSESSMENT OF THE VESSEL

1 Working deck well clear……		☐ Yes [5]	☐ No [0]
2 Non-slip deck surface……	☐ Yes [5]	☐ No [0]	☐ N/A
3 Control stations well-located……	☐ Yes [5]	☐ No [0]	☐ N/A
4 Ergonomic workstation……	☐ Yes [5]	☐ No [0]	☐ N/A
5 Adequate protection of the moving parts……..	☐ Yes [5]	☐ No [0]	☐ N/A
6 Railing present and compliant (min. 760 mm)…….	☐ Yes [5]	☐ No [0]	☐ N/A
7 Handling equipment in good condition……	☐ Yes [5]	☐ No [0]	☐ N/A

8 Number of non-compliance at the time of the last inspection: _____ [25/20/15/10/5]

9 Overall cleanliness

☐ Terrible (this vessel should not set sail) [0]
☐ Substandard (this vessel is lacking love) [4]
☐ Good (clean and tidy) [8]
☐ Frightening (I would not navigate on board) [2]
☐ Fair (some deficiencies, but good overall) [6]
☐ Extraordinary (above average, I could eat on the floor) [10]

Please use this space for comments, observations and/or clarifications.

Appendix J
List of Questions for Research Stations

Research Station Questions for Communities

1. Who are you?
   a. Master
   b. Fisherman's helper
   c. Spouse
   d. Other

Part 1: Downflooding

1. After the presentations about the "Nadine", do you think that the causes of the shipwreck are clear?
   a. Yes
   b. No

2. On your vessel, do you close water tightly all the openings after use?
   a. Yes, always
   b. Yes, when the weather is bad
   c. Yes, when loading is finished
   d. No, never

3. Do you have written procedures to prevent downflooding?
   a. Yes
   b. No
   c. No idea!

4. On board your vessel, is there water-level detectors?
   a. Yes
   b. No
   c. I don't know
   d. Not anymore

5. Are the water-level detectors on your vessel regularly tested?
   a. Yes
   b. No
   c. I don't have any
   d. N/A

6. Do you think that the risks linked to downflooding are better understood now than 30 years ago? (scale, not at all to completely)

Part 2: Training

1. Do you think that ALL crew members should have their MED?
   a. Yes
   b. No

2. How do you estimate the chance of survival in the event of a shipwreck…
   a. of someone with a MED? (scale, low to high)
   b. of someone WITHOUT a MED? (scale, low to high)

3. Do you believe that Transport Canada should require the MED for all crew members?
   a. Yes
   b. No

Part 3: Drills and Familiarization

1. Do you think that a single emergency exercise at the beginning of the season is enough?
   a. Yes
   b. No

2. On your vessel, how many exercises do you do each season?
   a. None
   b. 1
   c. 2
   d. 3 and more

3. For which reason do you believe that fishermen do not do exercises more often?
   a. Lack of time
   b. Embarrassment
   c. Do not know how
   d. Useless
   e. Other

4. Why do you think that the majority of fishermen do not give familiarization?
   a. Not useful
   b. Embarrassment
   c. Lack of time
   d. Do not know how
   e. Other

Part 4: Safety Equipment

1. Do you believe that safety equipment on your vessel is easily accessible and ready for immediate use? (scale, hardly accessible to easily accessible)
   a. Life raft/Ovatek
   b. Immersion suits
   c. Life jackets

2. Do you believe that inspectors should be more demanding regarding safety equipment?
   a. Yes
   b. No
   c. Certainly not!

3. According to you, why did a single crew member of the “Nadine” succeeded in properly closing its immersion suit?
   a. Lack of practice
   b. Lack of maintenance
   c. Lack of time
   d. Wrong size
   e. All of the above

4. Is maintenance of the following equipment done annually, by yourself or someone else?
   a. Immersion suits (yes/no)
   b. PFD (yes/no)

Part 5: Safety Culture

1. In the past 30 years, have we changed our habits and solved the safety issues which have led to the tragedy of the "Nadine"?
   a. Yes
   b. No
   c. I don't know

2. According to you, where do the safety culture in the fishing industry in Quebec stands? (scale, low to high)

Research Station Questions for Other Participants (Officials and Industry Representatives)

1. In which field are you?
   a. Insurances
   b. Finances
   c. Education
   d. Sales
   e. Public administration
   f. Construction
   g. Consulting
   h. NPO
   i. Other

Part 1: Downflooding

1. After the presentations about the "Nadine", do you think that the causes of the shipwreck are clear?
   a. Yes
   b. No

2. Do you believe that fishermen close water tightly all the openings after use?
   a. Yes, always
   b. Yes, when the weather is bad
   c. Yes, when loading is finished
   d. No, never

3. To what extent can written procedures help prevent downflooding? (scale, totally useless to highly effective)

4. According to you, what percentage of the fleet has water-level detectors? (scale, percentage)

5. Why do some fishermen not equip their vessel with water-level detectors?
   a. Too expensive
   b. Not mandatory
   c. Often faulty
   d. Disturbing alarms
   e. Unnecessary

6. Do you think that the risks linked to downflooding are better understood now than 30 years ago? (scale, not at all to completely)

Part 2: Training

1. Do you think that ALL crew members should have their MED?
   a. Yes
   b. No

2. How do you estimate the chance of survival in the event of a shipwreck…
   a. of someone with a MED? (scale, low to high)
   b. of someone WITHOUT a MED? (scale, low to high)

3. Do you believe that Transport Canada should require the MED for all crew members?
   a. Yes
   b. No

Part 3: Drills and Familiarization

1. Do you think that a single emergency exercise at the beginning of the season is enough?
   a. Yes
   b. No

2. For which reason do you believe that fishermen do not do exercises more often?
   a. Lack of time
   b. Embarrassment
   c. Do not know how
   d. Useless
   e. Other

3. Why do you think that the majority of fishermen do not give familiarization?
   a. Not useful
   b. Embarrassment
   c. Lack of time
   d. Do not know how
   e. Other

Part 4: Safety Equipment

1. Do you believe that safety equipment on fishing vessels is easily accessible and ready for immediate use? (scale, hardly accessible to easily accessible)
   a. Life raft/Ovatek
   b. Immersion suits
   c. Life jackets

2. Do you believe that inspectors should be more demanding regarding safety equipment?
   a. Yes
   b. No
   c. Certainly not!

3. According to you, why did a single crew member of the "Nadine" succeeded in properly closing its immersion suit?
   a. Lack of practice
   b. Lack of maintenance
   c. Lack of time
   d. Wrong size
   e. All of the above

4. Do you consider that fishermen do an appropriate maintenance of their vessel and equipment?
   a. Vessel (scale, inappropriate to appropriate)
   b. Equipment (scale, inappropriate to appropriate)

Part 5: Safety Culture

1. In the past 30 years, have we changed our habits and solved the safety issues which have led to the tragedy of the "Nadine"?
   a. Yes
   b. No
   c. I don't know

2. According to you, where do the safety culture in the fishing industry in Quebec stands? (scale, low to high)

3. What changes do we still need to make to improve the safety culture in the industry? (word cloud)

Appendix K
Measuring Safety Culture:
Method of Calculating Scores by Triangulation

For the master and crew member questionnaire and the vessel observation form, all the choices of possible answers have a score assigned to them. This score varies between -10 and 25. Negative scores, or scores less than zero, are assigned when responses indicate that an item is at odds with the overall concept of a safety culture. For instance, for a master who says that they totally disagree with the statement "I make sure that all my crew members apply the same safe work practices", then the score is negative because it is an anti-safety behaviour.

The number of points given to the answers varies to reflect the relative importance of each aspect in relation to the totality of all the elements studied. The highest scores are given to the most "outstanding" safety elements. For instance, conducting pre-voyage safety inspections (16 points), conducting pre-voyage emergency drills (10 points), and making the wearing of all PPE mandatory for all crew members (10 points) are elements of responses that reflect a strong culture—or a higher-than-average maturity level. These are indicators that are easily distinguishable from the norm or more customary behaviours and can have a direct and significant impact on safety, unlike other less critical but still important elements.

The score given to each of the response choices for the master and crew questionnaire and the observation form is found in the explanation at the end of each response choice (see Appendix' G, H, and I). Obviously, the questionnaires used for administering the survey did not show the scores; these are the versions that were used for data entry.

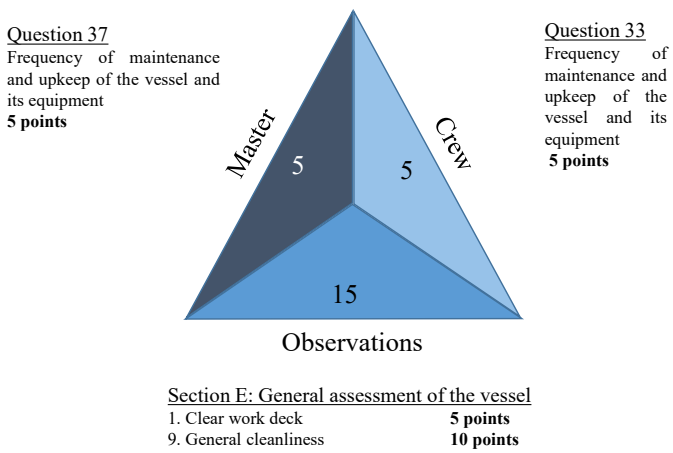
The scale used to assess the relative importance of each aspect was the subject of consultations with experts since technical knowledge, a solid understanding of the Act, regulations and their application in the commercial marine fishing industry and expertise on the current state of the Québec fleets are required to be able to establish milestones for all elements. The final version of the point scale presented in this report has been tested, modified, retested and finally validated. Based on the data collected from three controls "fishing enterprises", the scale could be tested, and, after some adjustments, the results were confirmed to be reflective of reality.

Details of the Calculation of Scores for Each Dimension

Technical Artefact: Vessel—Determinant: Maintenance

Based on the master's response to Question 37, the crew member's response to Question 33 and the observations in Section E (1 and 9) regarding the deck and general cleanliness of the vessel, the points from the four responses are added up. The maximum score is 25 points.

Figure 20: Score Calculation—Technical Artefact—Vessel



Technical Artefact: Safety Equipment—Determinant: Presence on Board

For this artefact, since we are referring to the safety equipment, the calculation of the score is based solely on the answers obtained during the observations. We have distinguished four categories to reflect variances in the requirements for immersion suits and rafts. Requirements differ according to the length of the vessel and the type of voyage undertaken by the crew. For each category, points are awarded based on the requirements that apply to each case. We have summarized the elements taken into consideration for each of the categories.

Table 56: Score Assigned by Safety Equipment Needs According to Requirement Category

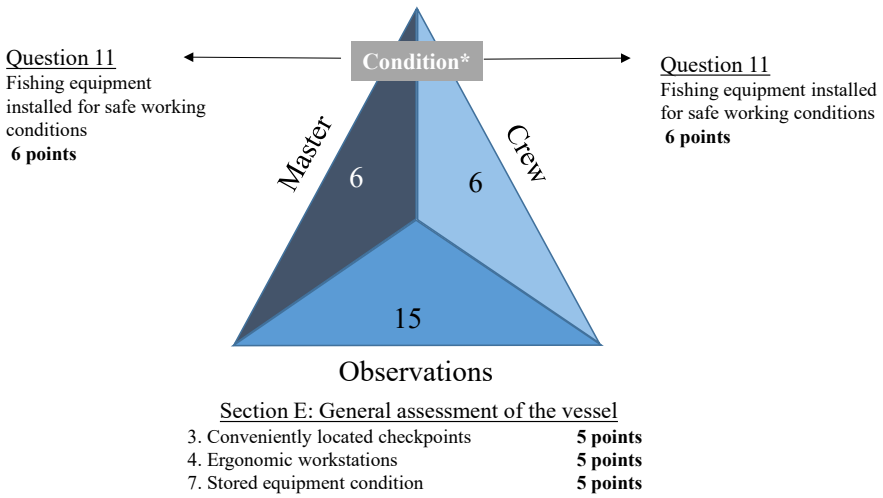
Safety equipment	Category A: Raft and suits	Category B: Suits without raft	Category C: Raft without suits	Category D: Without raft or suits
1.1 Valid distress flares	2 points if yes	2 points if yes	2 points if yes	2 points if yes
1.2 Well stored flares	2 points if yes	2 points if yes	2 points if yes	2 points if yes
2.1 Condition of life jackets	2 points if yes	2 points if yes	2 points if yes	2 points if yes
2.2 Well-stored lifejackets	2 points if yes	2 points if yes	2 points if yes	2 points if yes
2.3 Sufficient number of vests	2 points if yes	2 points if yes	2 points if yes	2 points if yes
3.1 Sufficient number of suits	2 points if yes	2 points if yes		
3.2 Condition of immersion suits	2 points if yes	2 points if yes		
3.3 Well stored suits	2 points if yes	2 points if yes		
4.1 Last raft maintenance	2 points if yes		2 points if yes	
4.2 Condition of the raft	2 points if yes		2 points if yes	
4.3 Well secured raft	2 points if yes		2 points if yes	
4.4 Accessible raft	2 points if yes		2 points if yes	
4.5 Hydrostatic trigger	2 points if yes		2 points if yes	
5.1 Condition of the buoy or line	2 points if yes	2 points if yes	2 points if yes	2 points if yes
6.1 Accessible system	2 points if yes	2 points if yes	2 points if yes	2 points if yes
6.2 Functional system	2 points if yes	2 points if yes	2 points if yes	2 points if yes
7.0 First aid kit	2 points if yes	2 points if yes	2 points if yes	2 points if yes
8.0 EpiPen	2 points if yes	2 points if yes	2 points if yes	2 points if yes
9.0 Defibrillator	2 points if yes	2 points if yes	2 points if yes	2 points if yes
Maximum score	**38 points**	**28 points**	**32 points**	**22 points**

The maximum score varies for each category: A—maximum of 38 points, B—maximum of 28 points, C—maximum of 32 points and D—maximum of 22 points.

Technical Artefact: Fishing and Handling Equipment—Determinant: Proper Installation

For observations relating to section E (3, 4 and 7), the points are simply added up. We have added a condition for the master's and crew member's responses to question 11. If the master's and crew member's answers are not the same, then the score for both answers will be 0 points. For instance, a master who states that the fishing and handling equipment is properly installed (6 points) while the crew member states the opposite (0 points), then no points will be awarded for both responses. The maximum score is 27 points.

Figure 21: Score Calculation—Technical Artefact—Fishing Equipment



** Condition: If the master's answer is 6 and the crew's answer is 0, enter 0 for each one*

Normative Artefact: Training—Determinant: Activities and Proof of Training

For the master's answers to questions 12 and 13 and the comments relating to section B (2.7, 2.8.4 and 2.8.5), the points are added up. For the observations in section B concerning the master's certificates and training (1.1), marine emergency training (2.1), the validity of first aid courses (2.1 to 2.6) and general observations on documents (2.81, 2.8.2 and 2.8.3), the calculation of points is subject to various conditions.

For observations regarding the master's certificates and training (1.1):

- 5 points are awarded if one of the following is observed: Class III (1.1.1.); Class IV (1.1.2); SVOP (1.1.3); Pleasure craft card (1.1.4); 7 seasons' proof (1.1.5); Others (1.1.7);
- 5 points are awarded if the documents are valid (not expired);
- 5 points are awarded if the CRO-CM is valid (regardless of the number): 5 points if the answer is yes to at least one of the following observations: 1.1.8, 1.2.6, 1.3.6, 1.4.6, 1.5.6, 1.6.6, otherwise 0 points;
- 5 points are awarded if the master has their MED (Section B, 2.1).

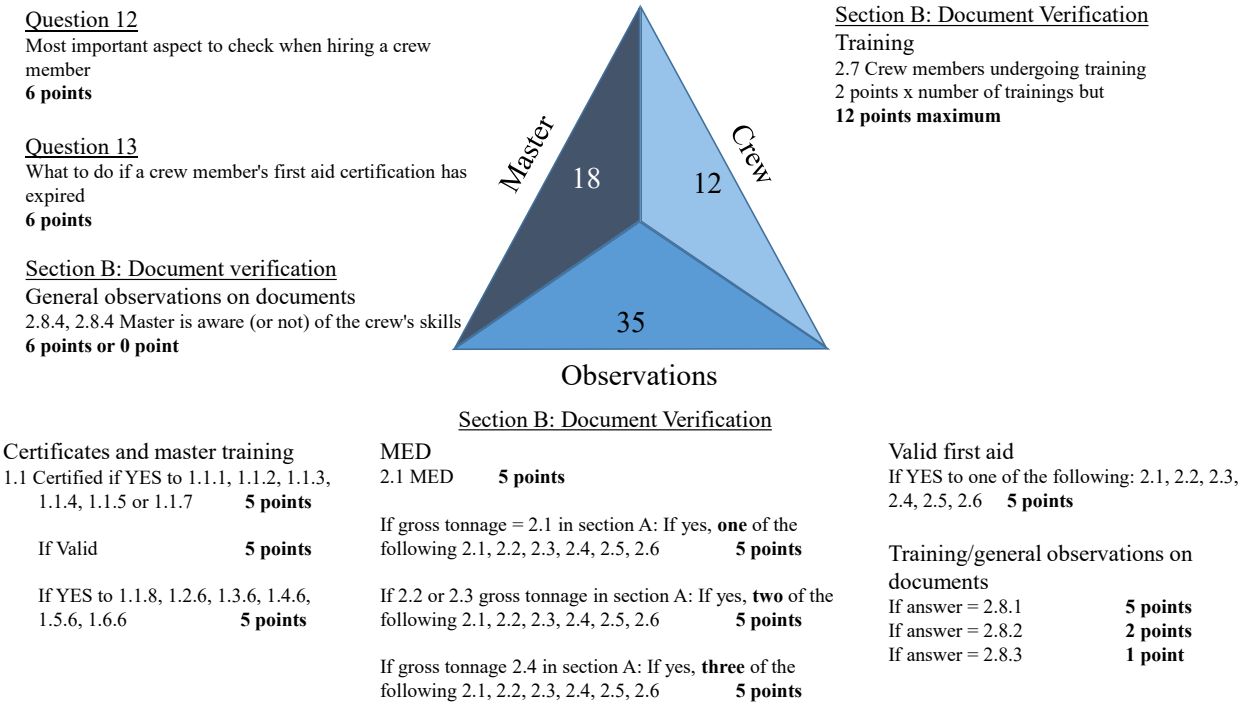
For observations related to Marine Emergency Duties (MED, 2.1 to 2.6), the requirements vary according to the gross tonnage of the vessel. To account for the different requirements depending on the gross tonnage of the vessel, points are also awarded if the entire minimum crew has their MED. We should then refer to the information in section A of the observation form in order to validate the category to be used for the calculation:

- Category 1—Gross tonnage ≤ 15 (A, 2.1): 5 points awarded if the answer is yes to at least one of the observations (2.1 to 2.6) in section B;
- Category 2—Gross tonnage> 15 ≤ 100 (A, 2.2 and 2.3): 5 points awarded if the answer is yes to at least two of the observations (2.1 to 2.6) in section B;
- Category 3—Gross tonnage> 100: 5 points awarded if the answer is yes to at least three of the observations (2.1 to 2.6) in section B.

For observations regarding the validity of first aid training, 5 points are awarded if the answer is yes to at least one of the observations (2.1 to 2.6) in Section B. For general observations relating to documents, 5 points are awarded if all are on board the vessel, 2 points are awarded if some documents are missing and only 1 point is awarded if several documents are missing. The maximum score is 65 points.

Figure 22: Score Calculation—Normative Artefact—Institutional Training

Dimension 4: Institutional training - Determinant: Activities and Proof of Training

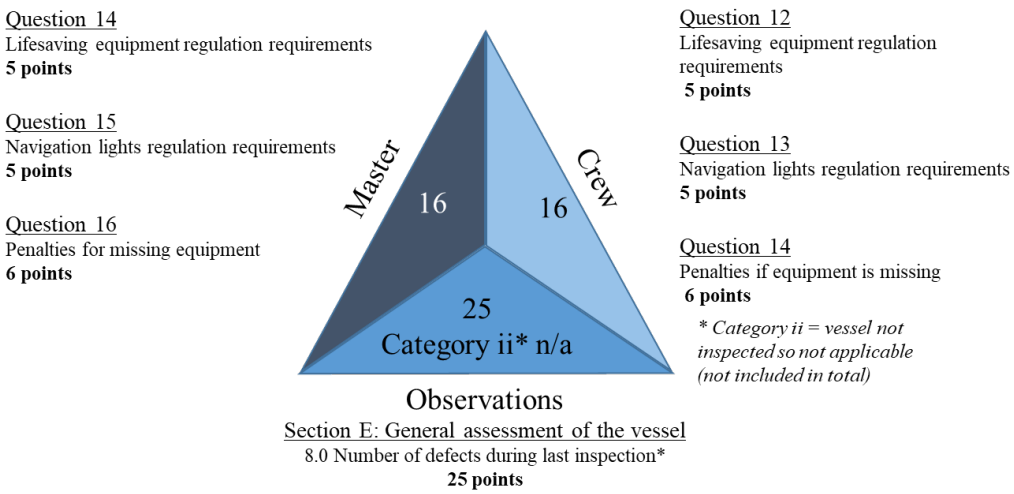


Normative Artefact: Regulation—Determinant: Compliance and Knowledge

For the master's answers to questions 14, 15 and 16, the crew member's answers to questions 12, 13 and 14, and the observations relating to section E (8), the scores are added up. Regulations require that an inspection be carried out for all vessels over 15 gross tonnage. Therefore, for all vessels of 15 gross tonnage or less, Section E was not considered in the total score. The maximum score is 47 points for vessels to be inspected and 32 points for uninspected vessels.

Figure 23: Score Calculation—Normative Artefact—Regulation

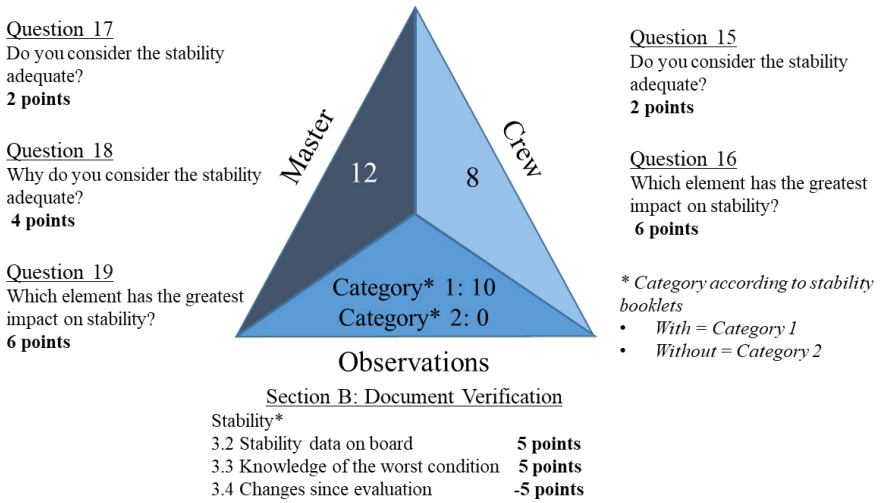
Dimension 5: Regulation - Determinant: Compliance and Knowledge



Normative Artefact: Stability—Determinant: Concern for Stability

For the answers to questions 17, 18 and 19 of the master and the answers to questions 15 and 16 of the crew members, the score is added up. For the observations in section B (3.2, 3.3 and 3.4), two categories should first be identified: with or without a stability booklet. The requirement for a stability booklet varies according to complex technical factors and the objective here is not to detail the logic behind the concepts of stability. We have simply distinguished between vessels by identifying those with a booklet as Category 1 and those without a booklet as Category 2. The score assigned to the observations considers these two categories. The maximum score for Category 1 is 30 points while the maximum score for Category 2 is 20 points.

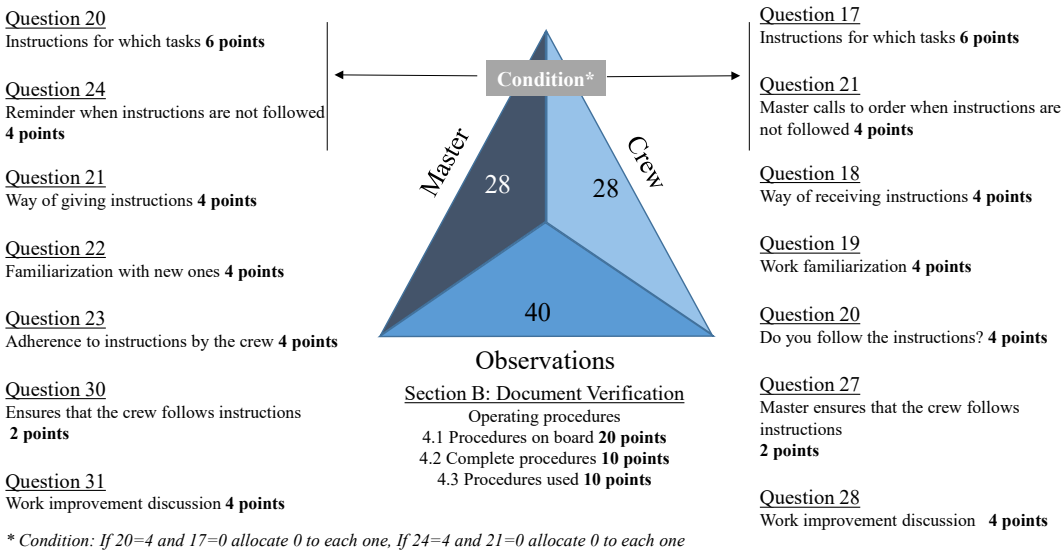
Figure 24: Score Calculation—Normative Artefact—Stability



Behavioural Artefact—Safe Work Practices: Safe Work Practices—Determinant: Initial Training, Instructions, and Familiarization

For the observations pertaining to Section B (4.1, 4.2 and 4.3), the master's answers to questions 21, 22, 23, 30 and 31 as well as the crew member's answers to questions 18, 19, 20, 27 and 28, the points are added up. A condition has been added for questions 20 and 24 to the master and questions 17 and 21 to the crew member. If the master and crew member differ in their answers, a score of 0 will be assigned to both answers. For instance, if the master states that they have established task instructions (4 points) while the crew member states the opposite (0 points), then both answers will be given a score of 0 points. The maximum score is 96 points.

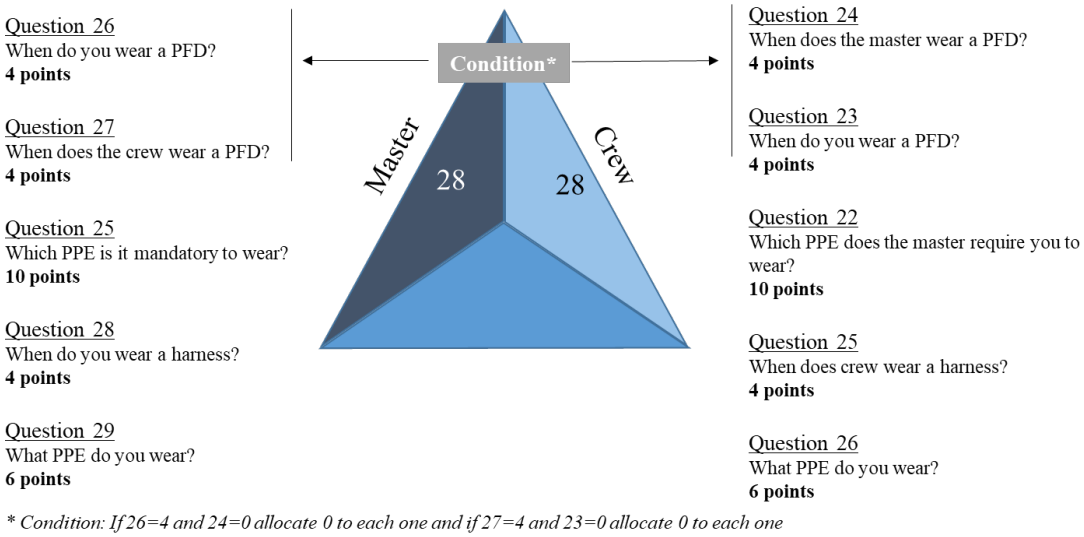
Figure 25: Score Calculation—Behavioural Artefact—Safe Work Practices



Behavioural Artefact—Safe Work Practices: Safe Work Practices—Determinant: Management of Safe Work Practices

For the master's answers to questions 25, 28 and 29 and the crew member's answers to questions 22, 25 and 26, the points are added up. A condition has been added for questions 26 and 27 to the master and questions 23 and 24 to the crew member. Since these answers should be the same, if there is a discrepancy between the answers, then a score of 0 is assigned for both answers. For instance, if the master states that they wear a PFD at all times (4 points) while the crew member states the opposite, then both answers will have a score of 0 points. The maximum score is 56 points.

Figure 26: Score Calculation—Behavioural Artefact—Practice Management

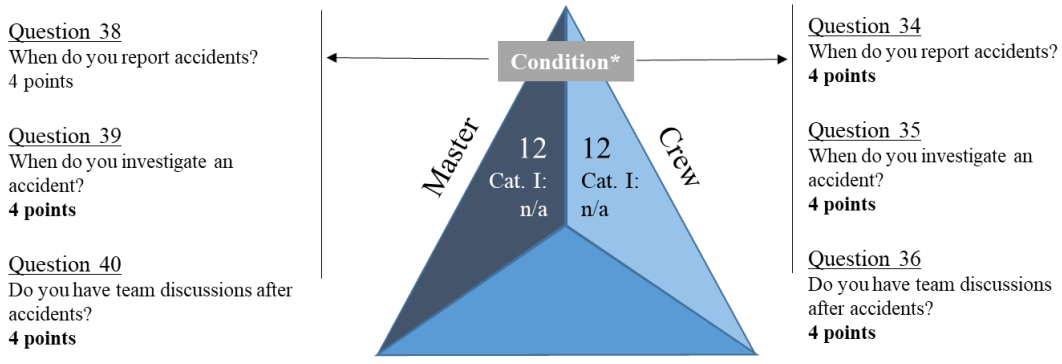


** Condition: If 26=4 and 24=0 allocate 0 to each one and if 27=4 and 23=0 allocate 0 to each one*

Behavioural Artefact—Risk Management: Risk Identification—Determinant: Inspection and Monitoring

To validate the inspection and monitoring information, the questions addressed relate to a past event, whether an accident or an incident. Since it is likely that, for a fishing enterprise, the master and their crew members were not confronted with this reality, in this case the score is not calculated. This category is simply referred to as Category I. Otherwise, the answers obtained from the captain to questions 38, 39 and 40 and the answers obtained from the crew member to questions 34, 35, 46 are all subject to a condition. Since the master's and crew member's answers should be the same, if the results are different, then no points are awarded for those answers. For instance, if the master states that they engage in team discussions (4 points) while the crew member states the opposite (0 points), then both answers will be awarded 0 points. The maximum score is 24 points.

Figure 27: Score Calculation—Behavioural Artefact—Analysis



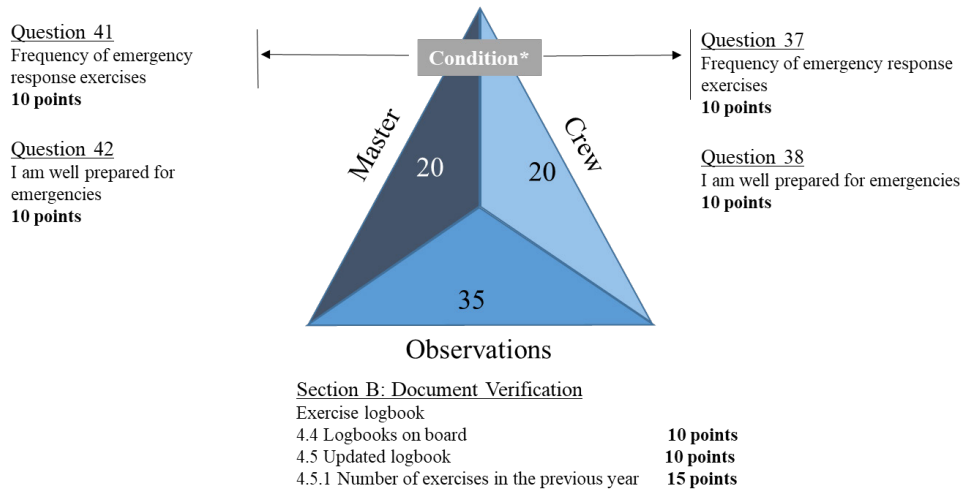
** Condition: If one gets 4 and the other gets 0, allocate 0 to each*
Category I = Not applicable / never had an accident

Behavioural Artefact—Risk Management: Risk Identification—Determinant: Emergency Procedures

Based on the comments relating to Section B (4.4, 4.5 and 4.5.1) and the responses of the master to question 42 and the crew member to question 38, the points are added up. A condition has been added for question 41 to the master and question 37 to the crew member. Since the two answers should be the same, if there is a discrepancy between the answers, then 0 points should be assigned to each of the answers since one is telling the truth and the other is lying. The maximum score is 75 points.

Figure 28: Score Calculation—Behavioural Artefact—Prevention

Dimension 10: Prevention - Determinant: Emergency Measures



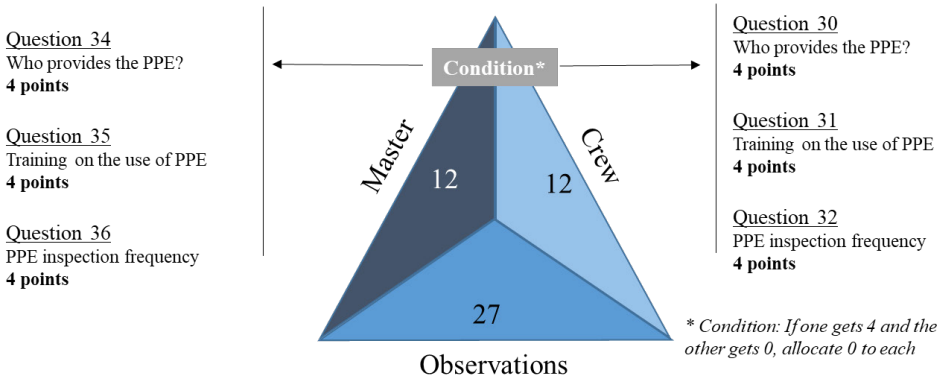
** Condition: If 41 = 10 and 37 = 0, allocate 0 to each*

Behavioural Artefact—Risk Management: Hazard Elimination and Risk Control—Determinant: Personal Protective Equipment

Based on the observations in Section B (4.12, 4.13) and Section D (PPE Inspections), the score is added up for each response. A condition has been added for the questions asked to the master (34, 35 and 36) and the crew member (30, 31 and 32). Since the same questions are being asked, we would expect the same responses from the master and the crew member. If they are not, this is an indication that one is telling the truth and the other is lying, then the score for both answers will be 0 points. The maximum score is 51 points.

Figure 29: Score Calculation—Behavioural Artefact—Risk Management

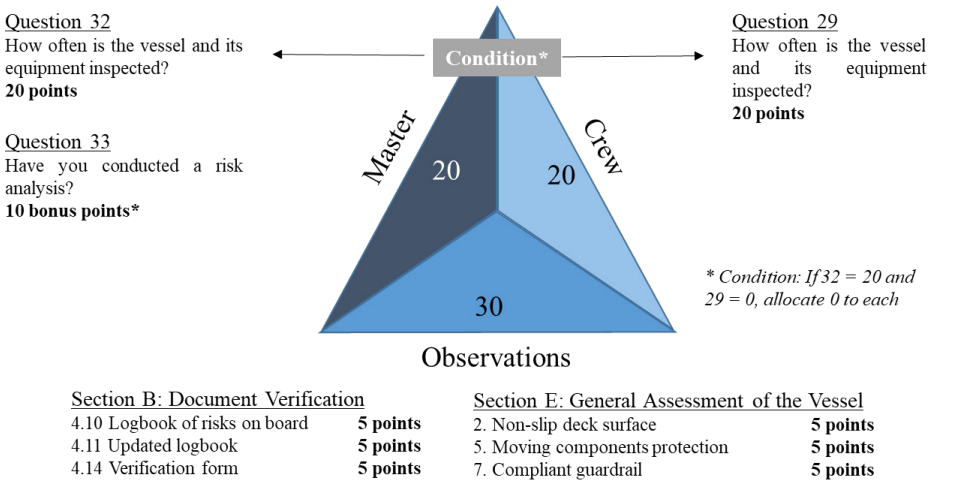
Dimension 11: Risk Control - Determinant: PPE



Behavioural Artefact—Risk Management: Hazard Elimination and Risk Control—Determinant: Preventive Maintenance

According to the observations relating to Section B (4.10, 4.11 and 4.14), Section E (2, 5 and 7) and the master's response to question 33, all items are added up. A condition has been added for the compilation of the score for question 32 to the master and question 29 to the crew member. If the master claims to conduct inspections before each sea voyage (20 points) while the crew member claims otherwise (0 points), the crew member's answer will be prioritized, and 0 points will be awarded for both answers. The maximum score is 70 points. Bonus points are awarded if the master has carried out a risk analysis, since the starting assumption is that no fishing enterprise is at this stage yet.

Figure 30: Score Calculation—Behavioural Artefact—Elimination of Dangers



All responses were compiled in an Excel file, which allowed us to calculate scores for each of the artefacts under study. Following the approach presented in this section, the added scores were then converted to percentages for comparison purposes. For each triad of data (master—crew member—vessel observation), the scores obtained were then represented as a histogram grouped by artefacts.

Finally, to obtain a picture of the fleets, triads belonging to the same group of fleets were collated by averaging all the scores obtained.

Appendix L
Consent Form for the Master

Consent Form for the Master
The research project "Making prevention a priority"

Title of the research:	**Making prevention a priority — The development of a safety culture in commercial fisheries**
Researcher*:*	**Michel Pérusse**
Co-researcher*:*	**Robert Fecteau**
	Lise-Andrée Francoeur
	Lysiane Drewitt
	Dany Dumont

A) INFORMATION TO THE PARTICIPANTS

1. Research objectives

To date, the sea fishing industry is one of the deadliest in all Canada and particularly in the Province of Quebec. In an attempt to improve the situation, the current project aims to better understand the safety culture in the industry. The accumulated knowledge gained during this project will potentially enable the implementation of more efficient preventive measures allowing to save lives and to avoid serious accidents.

2. Participation to the research

Your participation as a master-owner will be to answer a questionnaire about various aspects of the health and safety of sea fishing operations. This interview will take place at the dock and shouldn't take more than 45 minutes of your time.

3. Privacy, anonymity and distribution of information

Privacy:
The information you will provide to the research team will remain strictly confidential. For this purpose, each participant will be assigned a unique study code, and only the researcher will have access to this list of codes. The questionnaires and recording will be retained by the lead researcher in a safe place, locked and known only to himself; these items will be retained for a maximum of ten (10) years and will then be destroyed.

The coding system used will not allow an indirect identification or identification by overlapping the respondents.

Distribution:
No personal information will be distributed to people or organization outside the research project. If passages (others than personal information) were to be used for illustrative purpose in the final report (e.g., quotes taken in the interview), the source will be cited in a coded form.

MANDATORY STATEMENT

Under the Youth Protection Act, the researcher shall declare to the director of youth protection all information allowing him to believe that the safety or the development of a child is or may be considered to be in danger by sexual or physical, as a result of an excess or neglect.

I understand that if I reveal, during the interview, information indicating an imminent danger of death (including by suicide) or of serious injuries to a person or a group of people, the researcher would be obliged to tell the person under threat or the competent authorities.

4. Advantages and disadvantages

By participating to this research, you could contribute to advancing knowledge on occupational health and safety in the sea fishing industry. You could also get to know yourself better. By participating to this research, you don't run specific risks.

The main disadvantage for you is the time you'll give us for your participation. However, it is possible that sharing your experiences cause you to experience negative emotional feelings; in this case, do not hesitate to talk about it with the interviewer. Where necessary, we could promptly direct you to a resource person.

5. Right of withdrawal

Your participation is completely voluntary. You are free to withdraw at any time by verbal notice, without prejudice and without having to justify your decision. If you decide to withdraw from the research, you can contact the researcher at the phone number indicated on the last page of this document. If you withdraw from this research, your personal information and the research data concerning yourself collected before your withdrawal will be destroyed.

6. Compensation

No financial compensation would be paid for your participation to this research.

B) CONSENT

I declare that I have read the above information, that I obtained the answers to my questions about my participation to this research and that I understand the objective, the essence, the advantages, the risks and the disadvantage of this research.

After reflection and a reasonable time, I freely consent to take part in this research. I know that I can withdraw at any time without prejudice and without having to justify my decision.

Signature: _____ Date: _____

Last name: _____ First name: _____

I declare that I have explained the objectives, the essence, the advantages, the risks and the disadvantages of this research and that I answered to the best of my knowledge to questions asked.

Signature of the researcher:
(or its representative) _____ Date: _____

Last name: _____ First name: _____

For all questions concerning this research or to withdraw from the research, you can contact Michel Pérusse, lead researcher, at the following phone number: 514 443-7243 or at the following email address: michel.perusse@uqar.ca or perussem@hotmail.com.

One signed copy of the information and consent form should be given to the participant.


DAVID'S LAST

Appendix M
Consent Form for the Crew Members

Consent Form for the Crew Members
The research project "Making prevention a priority"

Title of the research:	**Making prevention a priority — The development of a safety culture in commercial fisheries**
Researcher*:*	**Michel Pérusse**
Co-researcher*:*	**Robert Fecteau** **Lise-Andrée Francoeur** **Lysiane Drewitt** **Dany Dumont**

A) INFORMATION TO THE PARTICIPANTS

1. Research objectives

To date, the sea fishing industry is one of the deadliest in all Canada and particularly in the Province of Quebec. In an attempt to improve the situation, the current project aims to better understand the safety culture in the industry. The accumulated knowledge gained during this project will potentially enable the implementation of more efficient preventive measures allowing to save lives and to avoid serious accidents.

2. Participation to the research

Your participation as a crew member will be to answer a questionnaire about various aspects of the health and safety of sea fishing operations. This interview will take place at the dock and shouldn't take more than 45 minutes of your time.

3. Privacy, anonymity and distribution of information

Privacy:
The information you will provide to the research team will remain strictly confidential. For this purpose, each participant will be assigned a unique study code, and only the researcher will have access to this list of codes. The questionnaires and recording will be retained by the lead researcher in a safe place, locked and known only to himself; these items will be retained for a maximum of ten (10) years and will then be destroyed.

The coding system used will not allow an indirect identification or identification by overlapping the respondents.

Distribution:
No personal information will be distributed to people or organization outside the research project. If passages (others than personal information) were to be used for illustrative purpose in the final report (e.g., quotes taken in the interview), the source will be cited in a coded form.

MANDATORY STATEMENT

Under the Youth Protection Act, the researcher shall declare to the director of youth protection all information allowing him to believe that the safety or the development of a child is or may be considered to be in danger by sexual or physical, as a result of an excess or neglect.

I understand that if I reveal, during the interview, information indicating an imminent danger of death (including by suicide) or of serious injuries to a person or a group of people, the researcher would be obliged to tell the person under threat or the competent authorities.

4. Advantages and disadvantages

By participating to this research, you could contribute to advancing knowledge on occupational health and safety in the sea fishing industry. You could also get to know yourself better. By participating to this research, you don't run specific risks.

The main disadvantage for you is the time you'll give us for your participation. However, it is possible that sharing your experiences cause you to experience negative emotional feelings; in this case, do not hesitate to talk about it with the interviewer. Where necessary, we could promptly direct you to a resource person.

5. Right of withdrawal

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6. Compensation

No financial compensation would be paid for your participation to this research.

B) CONSENT

I declare that I have read the above information, that I obtained the answers to my questions about my participation to this research and that I understand the objective, the essence, the advantages, the risks and the disadvantage of this research.

After reflection and a reasonable time, I freely consent to take part in this research. I know that I can withdraw at any time without prejudice and without having to justify my decision.

Signature: _____ Date: _____

Last name: _____ First name: _____

I declare that I have explained the objectives, the essence, the advantages, the risks and the disadvantages of this research and that I answered to the best of my knowledge to questions asked.

Signature of the researcher:
(or its representative) _____ Date: _____

Last name: _____ First name: _____

For all questions concerning this research or to withdraw from the research, you can contact Michel Pérusse, lead researcher, at the following phone number: 514 443-7243 or at the following email address: michel.perusse@uqar.ca or perussem@hotmail.com.

One signed copy of the information and consent form should be given to the participant.


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Appendix N
Statistics of Responses to Questions on Beliefs

Table 57: Correspondence of Questions on Beliefs and Values

Question n°	Masters	Crew Members
M46/CM42	Fisheries safety has improved significantly in recent years.	
M47/CM43	It is very important for me to have a profitable season.	It is very important for the master to have a profitable season.
M48/CM44	My crew and I are a tight-knit team.	My colleagues and I are a tight-knit team.
M49/CM45	Respect is a core value for our crew.	
M50/CM46	There is a lot of mutual help in our team.	
M51/CM47	For me, safety always comes before production.	For my fishing master, safety always comes before production.
M52/CM48	For me, the health, safety and well-being of crew members is a constant concern.	The master shows great concern for the health, safety and well-being of the crew members.
M53/CM49	We sometimes take risks to have more abundant fishing.	
M54/CM50	We sometimes work even when we are tired, when circumstances require it.	
M55/CM51	The safety measures we apply are sufficient to prevent accidents.	
M56/CM52	The laws and regulations that apply to our operations make work safer.	
M57/CM53	The laws and regulations that apply to our operations make the work more complicated or difficult.	
M58/CM54	Alcohol and drug use is widespread in our industry.	
M59/CM55	I'm always worried when we go out to sea.	
M60/CM56	Accidents form part of the fishing profession.	
M61/CM57	Our fate depends heavily on Mother Nature.	
M62/CM58	Human life is more precious than anything.	
M63/CM59	It is possible to have fishing seasons without accidents.	
M64/CM60	Caution can prevent most types of accidents.	

Table 58: Means and Differences in Means of Responses to Belief Questions

Question n°	Masters	Crew members	Differences
M46/CM42	4.48	4.46	0.02
M47/CM43	4.37	4.12	0.25
M48/CM44	4.52	4.6	-0.08
M49/CM45	4.79	4.79	0.00
M50/CM46	4.69	4.75	-0.06
M51/CM47	4.75	4.69	0.06
M52/CM48	4.77	4.71	0.06
M53/CM49	2.67	2.50	0.17
M54/CM50	3.37	3.06	0.31
M55/CM51	4.25	4.37	-0.12
M56/CM52	4.11	4.21	-0.10
M57/CM53	2.68	2.27	0.41
M58/CM54	3.16	2.67	0.49
M59/CM55	2.05	1.52	0.53
M60/CM56	3.02	3.42	-0.40
M61/CM57	2.92	4.06	-1.14
M62/CM58	4.89	4.88	0.01
M63/CM59	4.56	4.63	-0.07
M64/CM60	4.68	4.77	-0.09

Table 59: List of Elements on Which Participants Predominantly Agree

Question	Wording	Average Masters	Average Crew members
M46/CM42	Fisheries safety has improved significantly in recent years.	4.48	4.46
M47/CM43	It's very important for [me] [the master] to have a profitable season.	4.37	4.12
M48/CM44	[My crew] [My colleagues] and I are a tight-knit team.	4.52	4.6
M49/CM45	Respect is a core value for our crew.	4.79	4.79
M50/CM46	There is a lot of mutual help in our team.	4.69	4.75
M51/CM47	For [me] [my captain], safety is always more important than production.	4.75	4.69
M52/CM48	For me, the health, safety and well-being of the crew members is a constant concern/The master shows great concern for the health, safety and well-being of crew members.	4.77	4.71
M55/CM51	The safety measures we apply are sufficient to prevent accidents.	4.25	4.37
M56/CM52	The laws and regulations that apply to our operations make work safer.	4.11	4.21
M62/CM58	Human life is more precious than anything.	4.89	4.88
M63/CM59	It is possible to have fishing seasons without accidents.	4.56	4.63
M64/CM60	Caution can prevent most types of accidents.	4.68	4.77

Table 60: List of Elements on Which Participants Predominantly Disagree

Question	Wording	Average Masters	Average Crew members
M53/CM49	We sometimes take risks to have more abundant fishing.	2.67	2.5
M57/CM53	The laws and regulations that apply to our operations make the work more complicated or difficult.	2.68	2.27
M59/CM55	I'm always worried when we go out to sea.	2.05	1.52

Table 61: List of Elements on Which Participants Have Mixed Views

Question	Wording	Average Masters	Average Crew members
M54/CM50	We sometimes work even when we are tired, when circumstances require it.	3.37	3.06
M58/CM54	Alcohol and drug use is widespread in our industry.	3.16	2.67
M60/CM56	Accidents form part of the fishing profession.	3.02	3.42

Appendix O
Components of Beliefs and Values

Beliefs and Values of Masters

Factor 1: OHS as a Core Value (or OHS Beliefs).

Question	Statement	Weighting
52	For me, the health, safety and well-being of crew members is a constant concern.	0.787
49	Respect is a core value for our crew.	0.784
50	There is a lot of mutual help in our team.	0.742
62	Human life is more precious than anything,	0.634
48	My crew and I are a tight knit team.	0.612
51	For me, safety always comes before production.	0.583
64	Caution can prevent most types of accidents.	0.575
63	It is possible to have fishing seasons without accidents.	0.528

Factor 2: Attitudes Towards Laws and Regulations

Question	Statement	Weighting
56	The laws and regulations that apply to our operations make work safer.	0.685
57	The laws and regulations that apply to our operations make the work more complicated or difficult.	-0.653
46	Fisheries safety has improved significantly in recent years.	0.610

Factor 3: Fatalism/External Locus of Control

Question	Statement	Weighting
61	Our fate depends heavily on Mother Nature.	0.838
60	Accidents form part of the fishing profession.	0.791

Factor 4: Risk Is Part of the Job

Question	Statement	Weighting
53	We sometimes take risks to have more abundant fishing.	0.695
54	We sometimes work even when we are tired, when circumstances require it.	0.680
55	The safety measures we apply are sufficient to prevent accidents.	-0.469

Factor 5: Worry/stress

Question	Statement	Weighting
59	I'm always worried when we go out to sea.	0.853

Factor 6: (reactive)

Question	Statement	Weighting
47	It is very important for me to have a profitable season.	0.751
58	Alcohol and drug use is widespread in our industry.	-0.690

Beliefs and Values of Crew Members

Factor 1: OHS as a Core Value (or OHS Beliefs).

Question	Statement	Weighting
48	The master shows great concern for the health, safety and well-being of the crew members.	0.910
46	There is a lot of mutual help in our team.	0.853
44	My colleagues and I are a tight knit team.	0.813
45	Respect is a core value for our crew.	0.672
47	For my fishing master, safety always comes before production.	0.590
55	I'm always worried when we go out to sea.	-0.436

Factor 2: Attitudes Towards Laws and Regulations

Question	Statement	Weighting
42	Fisheries safety has improved significantly in recent years.	0.773
53	The laws and regulations that apply to our operations make the work more complicated or difficult.	-0.682
50	We sometimes work even when we are tired, when circumstances require it.	-0.594

Factor 3: "Where There Is a Will, There Is a Way"

Question	Statement	Weighting
59	It is possible to have fishing seasons without accidents.	0.826
51	The safety measures we apply are sufficient to prevent accidents.	0.763
60	Caution can prevent most types of accidents.	0.463

Factor 4: External Locus of Control/"As a Sailor I Have Little Control"

Question	Statement	Weighting
43	It is very important for the master to have a profitable season.	0.758
49	We sometimes take risks to have more abundant fishing.	0.654
57	Our fate depends heavily on Mother Nature.	0.561

Factor 5: Fatalism

Question	Statement	Weighting
52	The laws and regulations that apply to our operations make work safer.	-0.845
56	Accidents form part of the fishing profession.	0.802

Factor 6: Paid Season

Question	Statement	Weighting
54	There is a lot of mutual help in our team.	0.763
58	For my fishing master, safety always comes before production.	0.711

Appendix P
Correlations Between Values and Artefacts

Figure 31: Correlation Between Question 47 and the Technical Factor

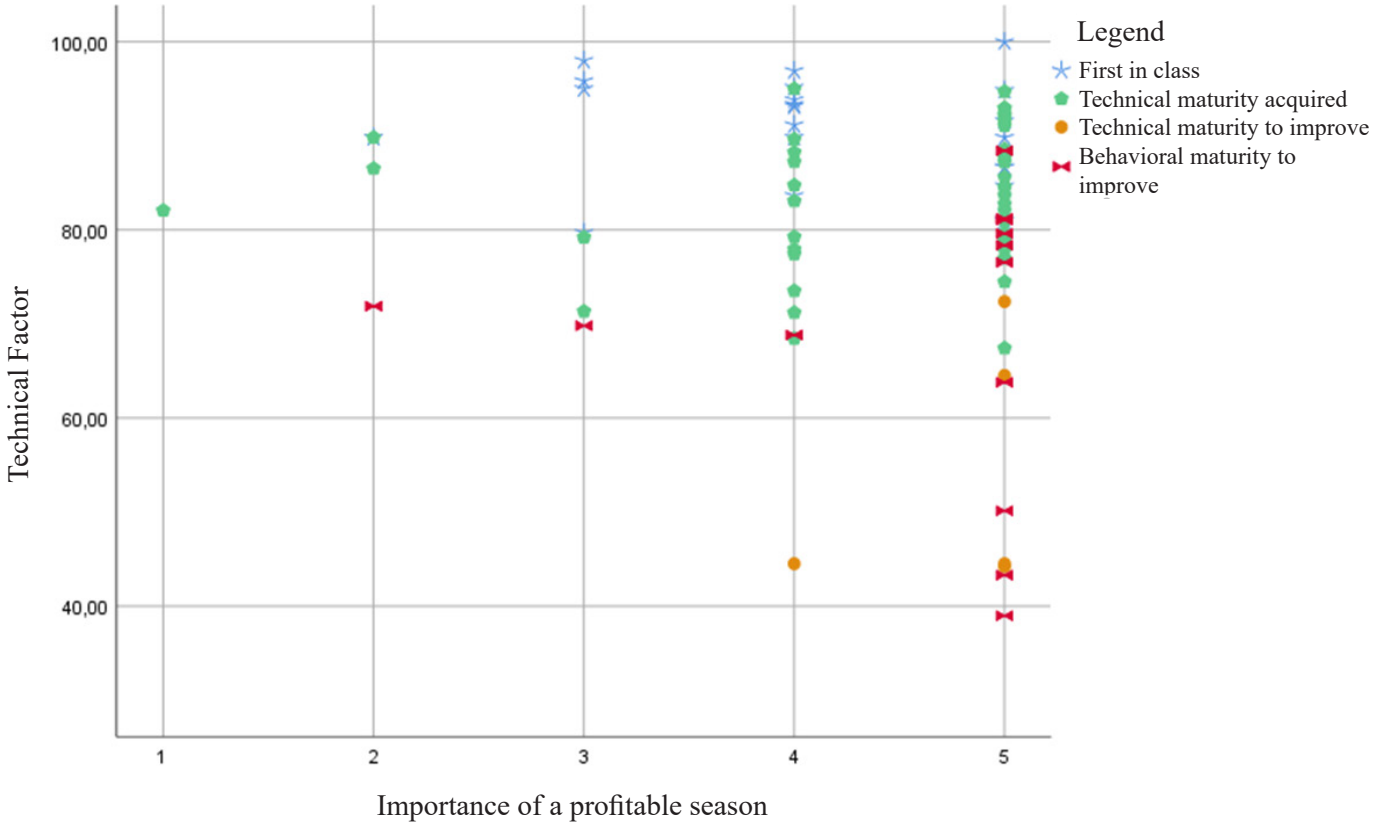


Figure 32: Correlation Between Question 47 and the Normative Factor

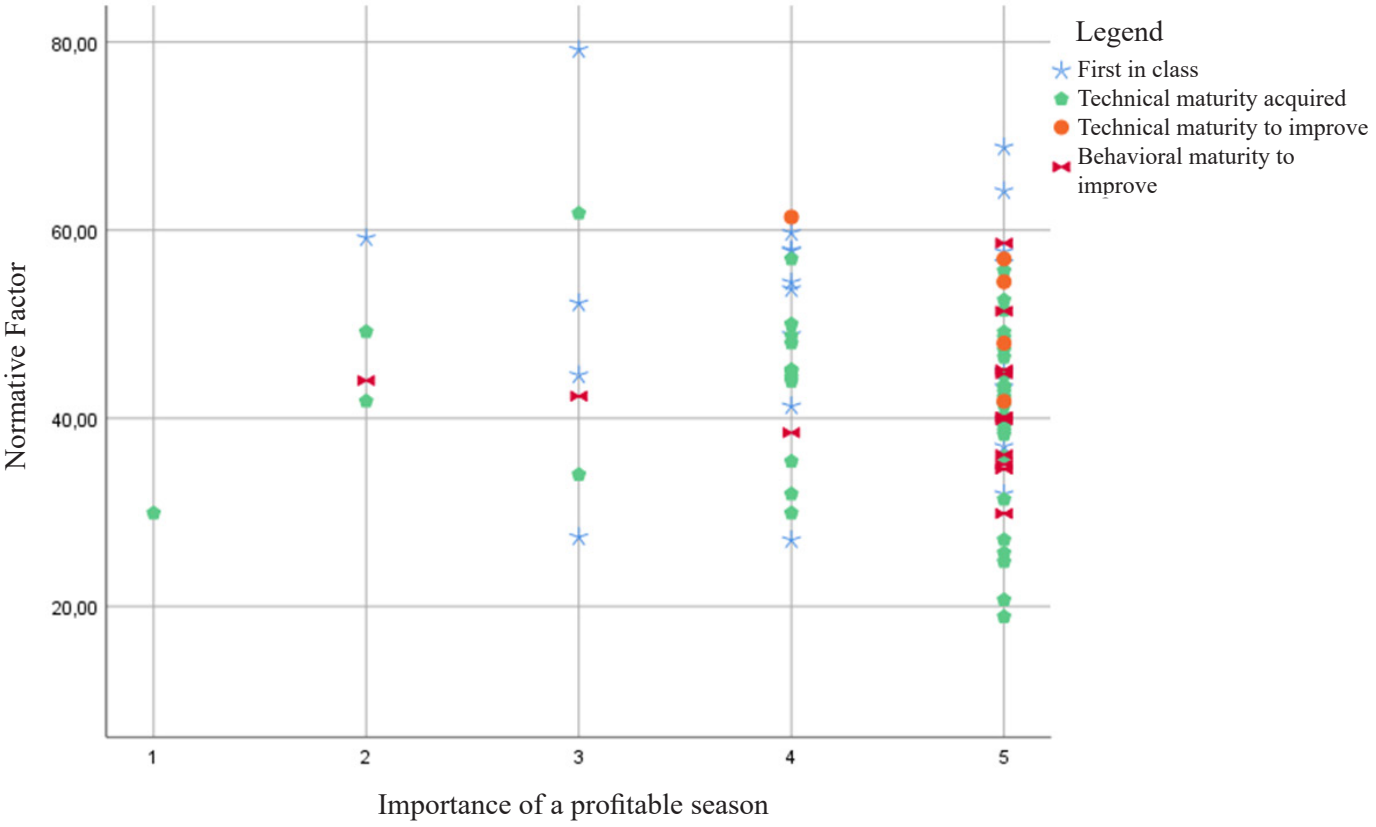


Figure 33: Correlation Between Question 47 and the Behavioural Artefact—Safe Work Practices

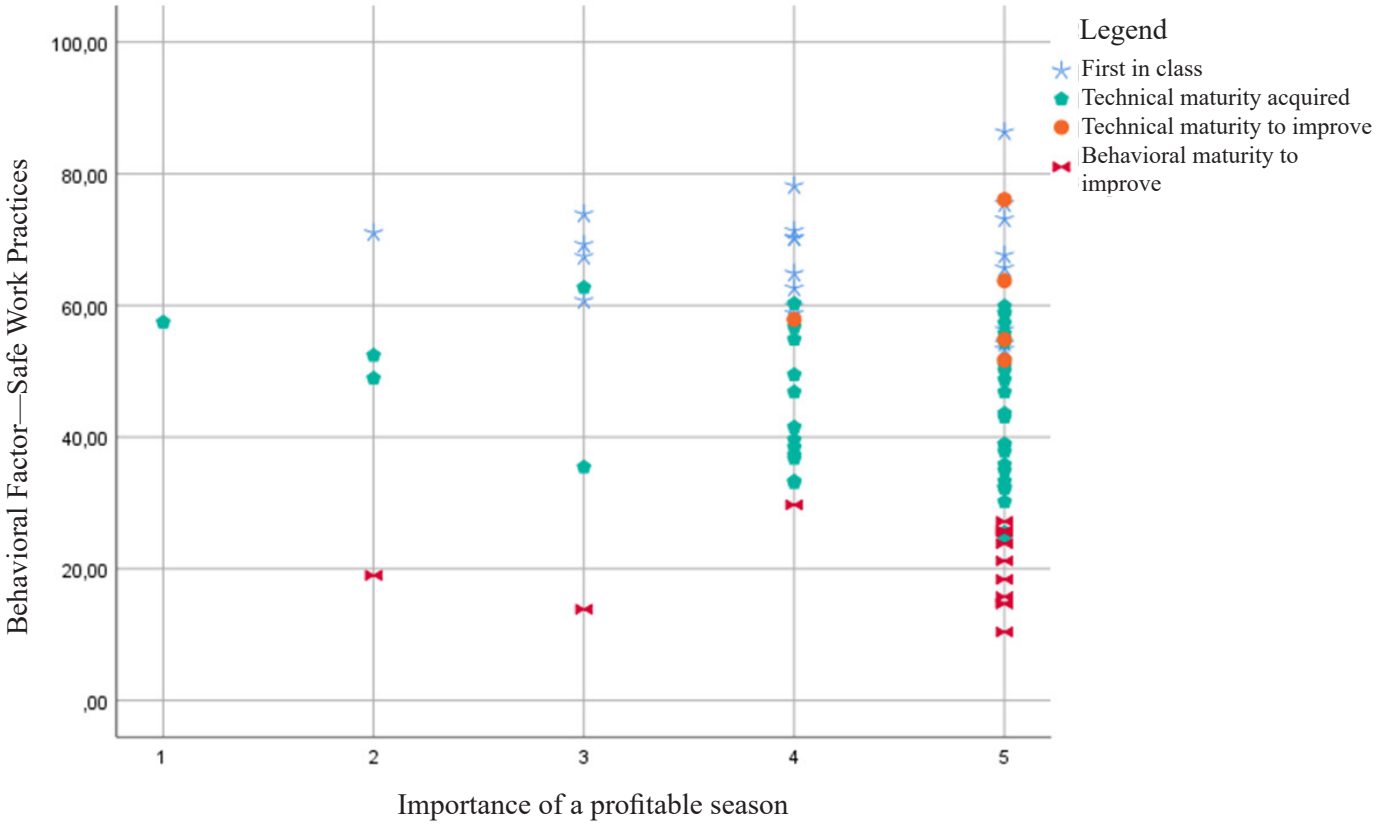


Figure 34: Correlation Between Question 47 and the Behavioural Artefact—Risk Management

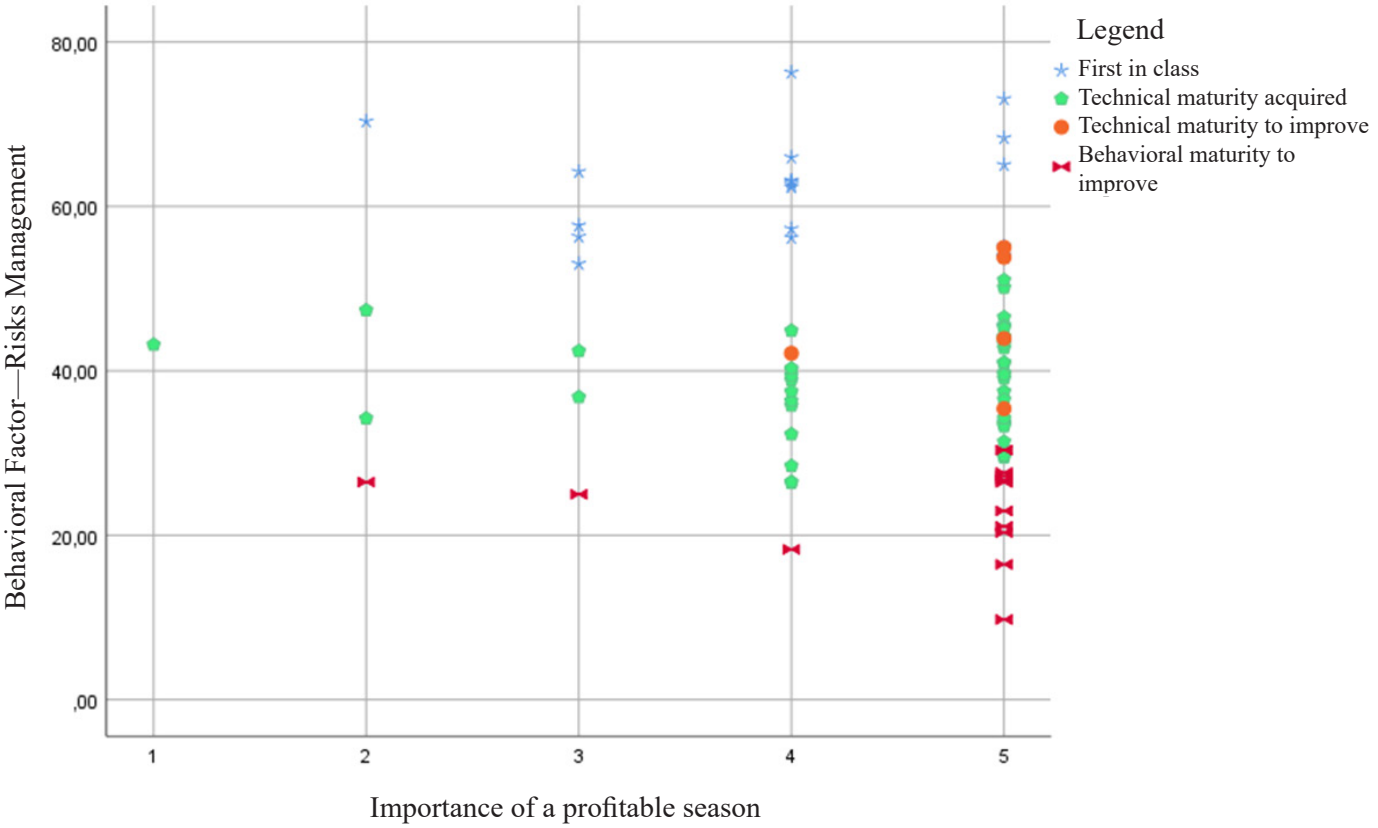


Table 62: Correlations Between Values and Artefacts in Masters

Technical Factor Predictors			
Question	**Wording**	**t**	**p**
46	Fisheries safety has improved significantly in recent years.	3 286	0.001
58	Alcohol and drug use is widespread in our industry.	2 730	0.008
48	My crew and I are a tight knit team.	1.589	0.116

Normative Factor Predictors			
Question	**Wording**	**t**	**p**
56	The laws and regulations that apply to our operations make work safer.	-2 268	0.026
62	Human life is more precious than anything.	2 167	0.033
49	Respect is a core value for our crew.	-2 131	0.036
46	Fisheries safety has improved significantly in recent years.	1.636	0.106

Predictors of the Behaviour Factor - Safe Work Practices			
Question	**Wording**	**t**	**p**
58	Alcohol and drug use is widespread in our industry.	3 121	0.002
60	Accidents form part of the fishing profession.	-2 661	0.009
46	Fisheries safety has improved significantly in recent years.	1.713	0.090

Predictors of the Behaviour Factor- Risk Management			
Question	**Wording**	**t**	**p**
58	Alcohol and drug use is widespread in our industry.	3 515	0.001
60	Accidents form part of the fishing profession.	-1.797	0.075
57	The laws and regulations that apply to our operations make the work more complicated or difficult.	-1.915	0.059
56	The laws and regulations that apply to our operations make work safer.	-1.783	0.078

Table 63: Correlations Between Values and Artefacts in Crew Members

Technical Factor Predictors			
Question	**Wording**	**T**	**p**
51	The safety measures we apply are sufficient to prevent accidents.	1.783	0.091
57	Our fate depends heavily on Mother Nature.	-1.606	0.125
60	Caution can prevent most types of accidents.	1.612	0.124

Normative Factor Predictors			
Question	**Wording**	**t**	**p**
54	There is a lot of mutual help in our team.	-1.642	0.110

Predictors of the Behaviour Factor - Safe Work Practices			
Question	**Wording**	**t**	**p**
51	The safety measures we apply are sufficient to prevent accidents.	2 265	0.029
54	There is a lot of mutual help in our team.	1.73	0.091
42	Fisheries safety has improved significantly in recent years.	1.561	0.126

Predictors of the Behaviour Factor- Risk Management			
Question	**Wording**	**t**	**p**
59	It is possible to have fishing seasons without accidents.	2 313	0.026

Appendix Q
Summary of Descriptive Statistics of Accidental Events

Number of Accidental Events per Type and per Target Specie

Type of accidental event	Target specie																				
	Whelk	Sea cucumber	Common crab	Snow crab	Shrimp	Atlantic halibut	Greenland halibut	Herring	Lobster	Yellowtail flounder	Atlantic clam	Stimpson's clam	Mackerel	Cod	Sea urchin	Scallop	American plaice	Red plaice	Redfish	Unknown	TOTAL
Summary - Total of Accidents																					
Capsizing	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
Disabled	0	0	1	13	23	0	4	4	12	1	0	1	1	0	0	4	0	0	1	12	77
Grounding	1	0	1	4	0	1	5	3	4	0	0	0	0	0	3	0	0	0	0	4	26
Explosion	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Man overboard	0	0	0	1	1	1	1	0	4	0	0	0	0	0	0	0	0	0	0	0	8
Fire	1	0	0	3	3	0	2	0	2	0	0	0	0	1	0	0	0	0	0	4	16
Medical	1	0	0	3	7	0	0	0	6	0	0	0	0	0	1	1	0	0	0	1	20
Shipwreck	1	0	0	0	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	2	8
Leak	1	0	2	0	5	0	4	1	6	0	0	0	0	0	0	1	0	0	0	6	26
Collision	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	3
Allision	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	3
Bottom contact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	5	0	4	25	43	2	20	9	36	2	0	1	1	1	4	6	0	0	1	32	**192**
Summary - Total of Incidents																					
Capsizing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disabled	12	1	9	76	71	12	45	3	190	6	1	0	7	8	4	15	0	5	2	70	537
Grounding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Explosion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Man overboard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medical	0	0	0	2	7	0	1	0	0	0	0	1	0	0	0	3	0	0	0	2	16
Shipwreck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leak	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	2
Collision	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Allision	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bottom contact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	12	1	9	79	78	12	46	3	191	6	1	1	7	8	4	18	1	5	2	72	**556**
Summary - Total of Accidental Events																					
Capsizing	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
Disabled	12	1	10	89	94	12	49	7	202	7	1	1	8	8	4	19	0	5	3	82	614
Grounding	1	0	1	4	0	1	5	3	4	0	0	0	0	0	3	0	0	0	0	4	26
Explosion	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Man overboard	0	0	0	1	1	1	1	0	4	0	0	0	0	0	0	0	0	0	0	0	8
Fire	1	0	0	3	3	0	2	0	2	0	0	0	0	1	0	0	0	0	0	4	16
Medical	1	0	0	5	14	0	1	0	6	0	0	1	0	0	1	4	0	0	0	3	36
Shipwreck	1	0	0	0	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	2	8
Leak	1	0	2	0	5	0	4	1	7	0	0	0	0	0	0	1	1	0	0	6	28
Collision	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	3
Allision	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	3
Bottom contact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
TOTAL	17	1	13	104	121	14	66	12	227	8	1	2	8	9	8	24	1	5	3	104	**748**

Nunmber of Accidental Events per Type and per Fleet

Type of accidental event	Crabber, Lower North Shore	Crabber, Area 12	Crabber, Area 16	Crabber, Area 17	Shrimper	Lobster boat, Anticosti	Lobster boat, Baie-des-Chaleurs	Lobster boat, Lower North Shore	Lobster boat, North of Gaspésie	Lobster boat, South of Gaspésie	Lobster boat, Magdalen Islands	Lobster boat, Mid North Shore	Multifisheries	Scallops and other molluscs	Groundfish	Unknown	TOTAL
Fleet																	
Summary - Total of Accidents																	
Capsizing	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3
Disabled	1	7	4	1	20	0	0	0	1	0	12	0	24	4	3	0	77
Grounding	0	1	3	1	0	3	0	0	0	1	1	0	10	3	3	0	26
Explosion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Man overboard	0	1	0	1	1	0	1	0	0	0	3	0	1	0	0	0	8
Fire	0	0	2	2	3	1	0	0	0	0	1	0	6	1	0	0	16
Medical	0	0	4	0	6	1	0	0	0	0	5	0	3	1	0	0	20
Shipwreck	0	0	0	0	2	1	0	0	0	0	0	0	1	0	4	0	8
Leak	0	1	0	0	5	2	1	0	0	0	4	0	7	2	3	1	26
Collision	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	3
Allision	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	3
Bottom contact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	1	11	13	5	38	8	2	0	1	1	28	0	55	12	15	2	**192**
Summary - Total of Incidents																	
Capsizing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disabled	2	29	33	7	81	8	2	0	1	1	190	0	126	24	32	1	537
Grounding	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Explosion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Man overboard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medical	0	1	0	0	7	0	0	0	0	0	1	0	4	2	1	0	16
Shipwreck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leak	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2
Collision	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Allision	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bottom contact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	2	30	33	8	88	8	2	0	1	1	192	0	131	26	33	1	**556**
Summary - Total of Accidental Events																	
Capsizing	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3
Disabled	3	36	37	8	101	8	2	0	2	1	202	0	150	28	35	1	614
Grounding	0	1	3	1	0	3	0	0	0	1	1	0	10	3	3	0	26
Explosion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Man overboard	0	1	0	1	1	0	1	0	0	0	3	0	1	0	0	0	8
Fire	0	0	2	2	3	1	0	0	0	0	1	0	6	1	0	0	16
Medical	0	1	4	0	13	1	0	0	0	0	6	0	7	3	1	0	36
Shipwreck	0	0	0	0	2	1	0	0	0	0	0	0	1	0	4	0	8
Leak	0	1	0	0	5	2	1	0	0	0	5	0	8	2	3	1	28
Collision	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	3
Allision	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	3
Bottom contact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2
TOTAL	3	41	46	13	126	16	4	0	2	2	220	0	186	38	48	3	**748**

Number of Accidental Events per Type

Summary per year			
Year	**Accident**	**Incident**	**Total**
2005	22	37	59
2006	20	47	67
2007	21	47	68
2008	20	50	70
2009	19	52	71
2010	13	49	62
2011	22	52	74
2012	11	50	61
2013	15	58	73
2014	16	64	80
2015	13	50	63
TOTAL	**192**	**556**	**748**

Summary per vessel age			
Age	**Accident**	**Incident**	**Total**
10 and less	44	74	118
11 to 20	47	154	201
21 and more	96	314	410
Unknown	5	14	19
TOTAL	**192**	**556**	**748**

Summary per ethnicity			
Native owner	**Accident**	**Incident**	**Total**
Yes	18	22	40
No	142	462	604
Unknown	32	72	104
TOTAL	**192**	**556**	**748**

Summary per type of fishing licence use			
Type of use	**Accident**	**Incident**	**Total**
Owner	124	412	536
Tenant	31	67	98
Unknown	37	77	114
TOTAL	**192**	**556**	**748**

Summary per type of fishing licence allocation			
Tracking type	**Accident**	**Incident**	**Total**
Global (Competitive)	78	285	363
Participation (Quota)	82	199	281
Unknown	32	72	104
TOTAL	**192**	**556**	**748**

Summary according to wind strength			
Winds (Beaufort)	**Accident**	**Incident**	**Total**
0	9	30	39
1	12	40	52
2	34	112	146
3	42	137	179
4	29	125	154
5	11	56	67
6	11	34	45
7	5	13	18
8	8	2	10
9	0	0	0
10	2	1	3
11	0	0	0
12	0	0	0
Unknown	29	6	35
TOTAL	**192**	**556**	**748**

Summary according to wave heights			
Waves (Douglas)	**Accident**	**Incident**	**Total**
0	3	16	19
1	1	1	2
2	30	52	82
3	52	192	244
4	44	175	219
5	5	6	11
6	0	0	0
7	0	0	0
8	0	0	0
9	0	1	1
Unknown	57	113	170
TOTAL	**192**	**556**	**748**

Number of Accidental Events per Type

Summary per target specie			
Target specie	**Accident**	**Incident**	**Total**
Whelk	5	12	17
Sea cucumber	0	1	1
Common crab	4	9	13
Snow crab	25	79	104
Shrimp	43	78	121
Atlantic halibut	2	12	14
Greenland halibut	20	46	66
Herring	9	3	12
Lobster	36	191	227
Yellowtail flounder	2	6	8
Atlantic clam	0	1	1
Stimpson's clam	1	1	2
Mackerel	1	7	8
Cod	1	8	9
Sea urchin	4	4	8
Scallop	6	18	24
American plaice	0	1	1
Red plaice	0	5	5
Redfish	1	2	3
Unknown	32	72	104
TOTAL	**192**	**556**	**748**

Summary per period in the fishing season			
Time of season	**Accident**	**Incident**	**Total**
Before	0	0	0
Start	29	111	140
Middle	16	70	86
End	11	53	64
After	0	3	3
Transit	30	65	95
N/A	104	244	348
Unknown	2	10	12
TOTAL	**192**	**556**	**748**

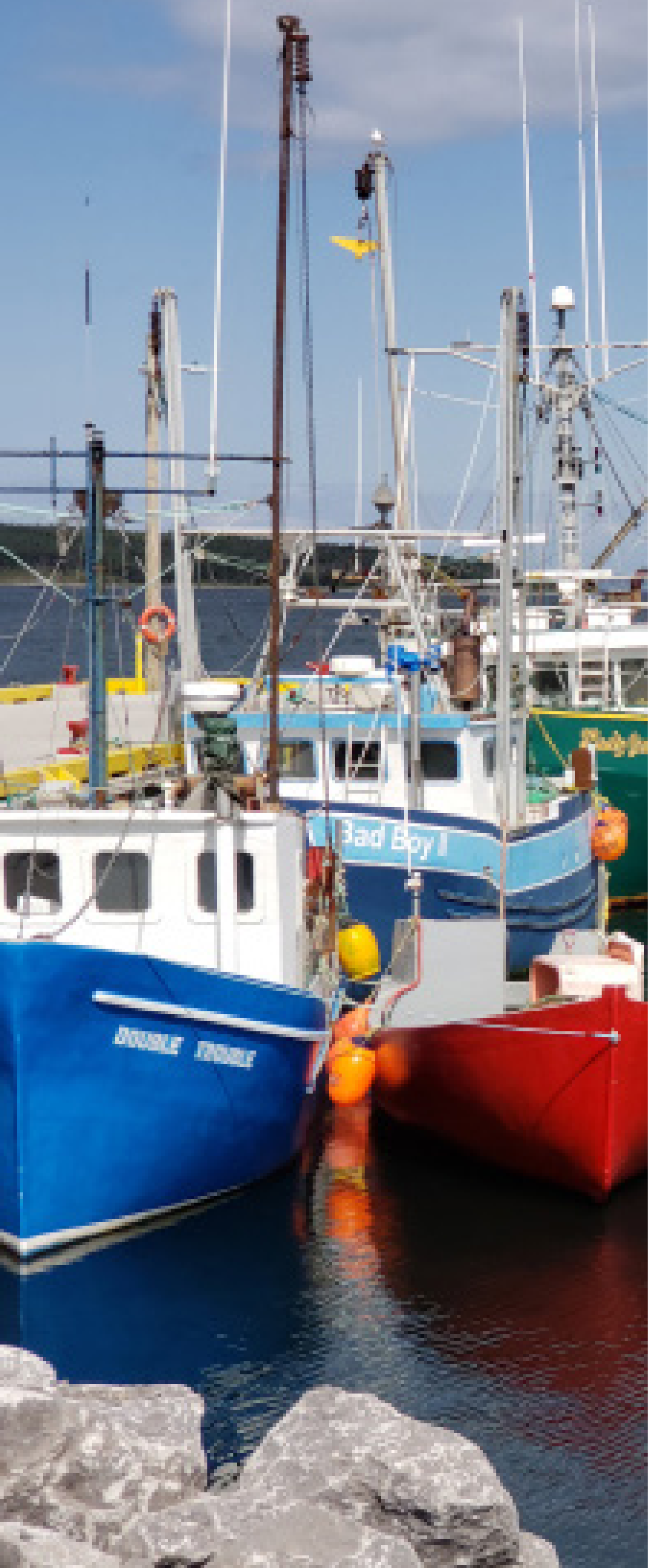
Summary per type of fishing activity			
Fishing type	**Accident**	**Incident**	**Total**
Experimental	0	4	4
Regular	160	479	639
Sentinel	0	1	1
Unknown	32	72	104
TOTAL	**192**	**556**	**748**

Summary per fleet			
Fleet	**Accident**	**Incident**	**Total**
Crabber, Lower North Shore	1	2	3
Crabber, Area 12	11	30	41
Crabber, Area 16	13	33	46
Crabber, Area 17	5	8	13
Shrimper	38	88	126
Lobster boat, Anticosti	8	8	16
Lobster boat, Baie-des-Chaleurs	2	2	4
Lobster boat, Lower North Shore	0	0	0
Lobster boat, North of Gaspésie	1	1	2
Lobster boat, South of Gaspésie	1	1	2
Lobster boat, Magdalen Islands	28	192	220
Lobster boat, Mid North Shore	0	0	0
Multifisheries	55	131	186
Scallops and other molluscs	12	26	38
Groundfish	15	33	48
Unknown	2	1	3
TOTAL	**192**	**556**	**748**

Summary per community			
Community	**Accident**	**Incident**	**Total**
Bas-Saint-Laurent	3	3	6
North of Gaspésie	49	126	175
South of Gaspésie	23	34	57
Upper North Shore	2	3	5
Mid North Shore	30	47	77
Lower North Shore	9	20	29
Magdalen Islands	38	246	284
Out of Québec	5	5	10
Unknown	33	72	105
TOTAL	**192**	**556**	**748**

Summary per length			
Length	**Accident**	**Incident**	**Total**
12 m and less	83	299	382
More than 12 m	109	257	366
Unknown	0	0	0
TOTAL	**192**	**556**	**748**

Summary per gross tonnage			
Gross tonnage	**Accident**	**Incident**	**Total**
15 and less	100	336	436
More than 15	92	218	310
Unknown	0	2	2
TOTAL	**192**	**556**	**748**



MAKING PREVENTION A PRIORITY: TOWARDS THE DEVELOPMENT OF A SAFETY CULTURE IN THE COMMERCIAL FISHING INDUSTRY

AN INITIATIVE OF

COMITÉ PERMANENT
SUR LA SÉCURITÉ DES BATEAUX
DE PÊCHE DU QUÉBEC

IN PARTNERSHIP WITH

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