Mechanical and Physical Risk Prevention

Studies and Research Projects

REPORT **R-869**

Overboard Falls of Crew Members on Québec Lobster Boats

Risk Analysis and Prevention Solutions

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Francis Coulombe
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ABSTRACT

Commercial fishing is one of the most dangerous industrial activities. Overboard falls occur each fishing season, usually with serious, or even fatal, consequences. In recent years, two deaths have occurred in Québec during lobster fishing activities under such circumstances. In general, the reported causes of overboard falls are loss of balance and being dragged by fishing gear. The objectives of the research are to (1) analyze the risks of and determining factors in overboard falls in lobster fishing; (2) document collective and individual prevention solutions that can be adapted to lobster boats; (3) identify the most promising risk reduction scenarios. These objectives underlie a deep understanding of the work activities involved in this fishery. The study was conducted over a period of one year.

An understanding of the fishing activity was gradually acquired by analyzing the responses to (1) a general risk perception questionnaire (39 respondents: 22 captains and 17 deckhands) for the Gaspé peninsula and Magdalen Islands regions; and (2) a descriptive questionnaire (14 respondents) administered to fishers who brought the researchers on board seven boats for 20 excursions at sea. Video recordings and direct observation were done on board and then analyzed within the framework of real-work ergonomics. These tools were used to assess the risk of falling overboard in lobster fishing conditions, and to identify fall-related accident scenarios (and their circumstances), and the main risk factors. The results were discussed in validation meetings with the captains and deckhands who took the researchers out on their boats. A follow-up committee of regional and sectorial fishing representatives guided the researchers throughout the study.

This study highlights and delineates six work situations associated with the risk of falling overboard: three at the opening of the fishing season (loading the lobster traps, travelling from the wharf to the fishing area and dropping (setting) the traps in the water) and three during regular fishing (hauling the traps, shifting trawls in the fishing area and dropping the traps back in the water). The initial setting of traps is the riskiest situation, although it is infrequent, happening only once during the fishing season. The main risk factors are the weather conditions, the crew's attitudes and behaviours, and working methods. The other two situations considered to be of high risk occur during regular fishing: setting the traps, mainly from the trap support table, and dropping them back in the water after the lines of traps (trawls) are shifted within the fishing area. In that case, the traps are often handled not from the support table, but from the deck. The traps are set about 40 times a day (40 trawls of 7 to 10 traps each) per crew; while the frequency with which the trawls are shifted in the fishing area varies greatly. The set-up of two important workstations, the support table and the hauler, have a significant impact on possible fall prevention strategies. The main solutions for preventing overboard falls are two-pronged: (1) transferring the knowledge gained from the research to assist workers (raising awareness, training and transfer of experiential and prevention knowledge). The knowledge acquired and the visual materials produced during this research may be of great assistance in this respect; (2) action in terms of setting up "hauler and trap support table" workstations.

In its risk analyses, this original study incorporates currently used and potentially applicable prevention strategies and methods, with reference to the general framework of real-work ergonomics. The research process mobilized two types of expertise: that of the researchers in risk analysis and in fishing, and that of fishers in their capacity as experts in managing risk on a daily basis.

TABLE OF CONTENTS

LIST OF FIGURES, TABLES AND PHOTOS

INTRODUCTION

Fisheries constitute an important sector of economic activity, particularly in eastern Québec. The sector is managed through the issuance of fishing licences, and through the many regulations in place to ensure the safety of both the vessels and the fishing activities themselves. However, the associated work activities have rarely been documented, even though they are extremely demanding. On fishing vessels, fishers are working on an unstable surface, at the mercy of waves and bad weather. They must move around and handle heavy, wet fishing gear on a slippery surface. On the water, the temperature is always cool or cold, even in the height of summer. A number of national and international organizations describe the commercial fishing industry as one, if not the riskiest, of all economic activity sectors, because of the fatality rates of workers recorded. There are many health and safety risks, and some are specific to the type of fishing. This study specifically targets the risk of falling overboard during lobster fishing.

In Québec, lobsters are generally harvested with a crew of one to three people on board. For the most part, the captains own their boats and in many cases, today's fishing families are the descendants of generations of people who carried out the same activity. Lobster fishers still follow the traditional methods, using boats to set ballasted (with approximately 40 kg) and baited lobster traps. Falls overboard by crew members are one risk among many, but one that may be fatal for the fisher. In the past years, two deaths have occurred under these circumstances.

The objective of this research is to understand and analyze the risk of a crew member falling overboard as well as to document prevention methods and strategies and ways of reducing risk. It strikes a balance between the expertise of the researchers in risk analysis and fishing, and that of fishers as professionals who manage risks on a day-to-day basis. The first section presents the issues, i.e., the organization of this fishery and the known risks of falling overboard, as well as the documented prevention methods and strategies. This review of the situation concludes with a presentation of the research objectives. The second part presents the methodology, including the characteristics of the participants and their vessels. In the third part, the results are then presented in six subsections, which include the work situations in this fishery, with the specific risks involved at the season's opening and during regular fishing, risk perception, incident scenarios, risk factors and possible avenues of prevention. The discussion deals with the principal recommended means of prevention, as well as the limits of the study.

1. BACKGROUND

1.1. Organization of Lobster Fishing and Its Workforce in Québec

Lobster fishing in North America is an industry worth C$1.5 billion. In fact, lobsters are one of the most important species in the Atlantic fisheries of Canada and the United States (Gardner, 2007). In the United States, slightly more than 7500 vessels are licenced to harvest lobster, providing jobs and income to some 15,000 captains and crew members. In Canada, there were 9700 boats, and 25,000 captains and crew members in 2007. There are many lobster fishers in the Maritime provinces: 3352 in Nova Scotia, 1289 in Prince Edward Island, 1563 in New Brunswick and 2923 in Newfoundland and Labrador. Between 2008 and 2010, the Québec fleet was composed of approximately 550 lobster boats (MAPAQ, 2012). Both the Canadian and US fleets respect the principles of owner-operator.

On the east coast of Canada, there are 41 lobster fishing areas distributed among the four Maritime provinces (Gardner, 2007). Fishing is mainly carried out close to the coastline, at less than 15 km from the coast. There is also one offshore fishing area, at approximately 90 km from the coast, in the deep basins and banks off south-western Nova Scotia. The type of fishing area has a direct influence on vessel size.

Coastal lobster fishing (the type targeted in this study) is managed by effort control rather than by quota. This type of management imposes restrictions as to gear and numbers of fishing days. In Québec, the season lasts from 9 to 12 weeks, depending on the area, and takes place in the spring. The opening date varies according to the lobster fishing area. In 2012 (when this research took place), the notices issued to fishers by Fisheries and Oceans Canada set the opening of the season as April 20 (at the earliest) and May 12 (at the latest). The fishing season ends in July, before lobster moulting season (MAPAQ, 2012). The opening date may, however, be postponed because of bad weather or late ice breakup. Weather changes from year to year and is very localized. In 2012, for example, bad weather in the Gaspé moved the season back one week for the main lobster fishing sub-areas, while the weather conditions were perfect in the Magdalen Islands during the same period. At the beginning of the season, mornings may be cold, with air temperature below freezing.

With respect to fishing gear, the size of lobster traps is limited, as is the minimum catch size (82 mm). In addition, traps cannot be hauled in more than once a day. However, the offshore fishery is open year-round and the total allowable catch quota is set at 720 tonnes (Fisheries and Oceans Canada, 2011). We shall see that these fishery management measures could have significant impact on risk-taking.

According to the monograph on lobsters prepared by the ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ, 2012), 629 lobster fishing licenses were issued in Québec in 2011. More than half the licenses (325) were allotted to fishers from the Magdalen Islands, almost a third (204) were to fishers in the Gaspé, and the rest of them (100) to North Shore fishers. Some fishers from these three regions operate around Anticosti Island. For a variety of logistical reasons, this study was carried out in the Magdalen Islands and the Gaspé peninsula. While there are exceptions, related to the characteristics of the seafloor and the

weather, a working week is generally six days for the Magdalen Islands and seven days for the Gaspé. On the Islands, some fishing grounds are more than an hour away at the start of the season[1] and working days can be up to 12 hours (six days a week). The number of daily working hours in the Gaspé is seven hours (seven days a week).

In Québec, in 2010, vessel size varied from 5.8 to 13.7 metres (from 19 to 45 feet). More than 50% of the fleet was made up of boats measuring from 10.9 to 13.7 m (from 35' to 44' 11"). The most widely used materials for the hull are fiberglass and wood, respectively. On average, the boats in the Québec lobster fleet are 17 years old (MAPAQ, 2012), which is less than those of 15 gross tonnes (12.2 metres and more), estimated at over 20 years old (according to Merinov's database). MAPAQ's (2012) analysis, using official data from Fisheries and Oceans Canada, shows that in 2000, the lobster fleet was dominated by boats of under 11 m (34' 11") while by 2010, boats of 11 m or more made up most of the fleet. These changes are not linked to licensing requirements, which have changed over time. We deduce that the characteristics of the lobster fleet change over time with some renewal, probably dependent on fishing income, which is never guaranteed from one year to the next.

Solo fishing is not very common; in most cases, crews are made up of two people. The largest vessels are found on the Magdalen Islands and are generally more multipurpose, because they are used to fish a variety of species (lobster, but also crab, mackerel, herring, etc.). On these vessels, there are sometimes up to three crew members. However, the general increase in operation costs tends to restrict crew size. The number of traps is limited and varies from 235 to 300 per license (MAPAQ, 2012). Since 1995, the use of traps larger than the standard (a standard trap measures 81 cm x 61 cm x 50 cm) has also been controlled, and is prohibited in the Magdalen Islands. The shape of and the materials used to make traps varies, as does their weight, which is between 36 and 45 kg. The traps are put in the water attached to a rope (line). The line of attached traps is referred to as a trawl or a string, and each trawl (made up of 7 to 10 traps) has one or two buoys. A trawl requires at least 150 metres of line.

The smaller size of boats[2] and the lack of a hold means that crews must travel back and forth to the wharf when the traps are initially set (at the opening of fishing season) to take them to the fishing areas. In these cases, the boats are loaded to capacity and according to everyone, there is competition to get to certain fishing areas first.

According to the most recent study carried out by the Comité sectoriel de la main-d'œuvre des pêches maritimes (CSMOPM, 2008), the labour force is aging. There are differences between the captains of lobster boats on the Magdalen Islands, who belong to the Association des pêcheurs propriétaires des Îles-de-la-Madeleine (APPIM), and those of the Gaspé, who belong to the Regroupement des pêcheurs professionnels du sud de la Gaspésie (RPPSG). Although the proportion of fishers aged 55 and over is practically identical, with 35.2% on the Magdalen Islands and 33.5% in the Gaspé, we see more captains who are under 35 years old in the Magdalen Islands (8.6%), compared to 3.9% in the Gaspé. The years of experience as captain

[1] Lobsters move to more shallow and warmer waters towards the end of spring and the beginning of the summer.
[2] The presence of a hold is also a determining factor with respect to the space available for the traps. No matter the size, not all vessels have a hold.

reflects the age structure previously noted. Most captains have at least 21 years of experience, and just under 20% have less than 10 years of experience.

Lobster boat captains need one to two deckhands to carry out fishing tasks. A fact of note is that only 24% of lobster fishers from the Magdalen Islands (APPIM) recruit exclusively outside of their families, while 41% of lobster fishers in the Gaspé do so (RPPSG).

With respect to the age structure of deckhands, in the Gaspé, 19.5% of deckhands are young (15 to 34 years old), while more than a third (35.7%) are in that age group in the Magdalen Islands. As with captains, the numbers of years of experience (fishing seasons) goes hand-in-hand with age, with many deckhands having over 20 years of experience, especially in the Gaspé.

1.2. Extent of the Problem of Falling Overboard in the Fishing Sector in General and on Lobster Boats in Particular

Fishing is a high-risk activity. It is clear from a comparison of fatality statistics in the fishing industry and those of other occupations that fishing is one of the most dangerous jobs (FAO, 2004). For the most part, this can be explained by the conditions under which fishers perform their tasks, i.e., boat movement, storms, confined spaces and long working hours (CSST, 2008).

The Occupational Safety and Health Branch of the International Labour Organization estimates that 24,000 fatalities occur every year in fisheries worldwide (FAO, 2004).

In Canada, that number is estimated to be one person per month (Bussières, 2010). In the United States, according to the Centers for Disease Control and Prevention (CDC-US, 2011), for commercial fishing in general, from 1992 to 2008 there was an average of 58 deaths per year, or 128 deaths per 100,000 workers/year, while for US workers in general, there was an average of 4 deaths per 100,000 workers/year.

The same report noted that 504 commercial fishers died between 2000 and 2009. Of that number, more than half (52%) died as a result of “vessel disaster” (shipwreck, collision, fire), while 31% of the deaths resulted from falls overboard. The causes of these falls were from tripping or slipping (33%), losing their balance (26%), and becoming entangled in gear (16%). The other cases (25%) were mainly associated with being struck by an object or being swept overboard by a wave.

In a study specifically targeting the eastern seaboard of the US (CDC–East Coast Region, 2011), the data makes it possible to identify falls overboard specifically linked to lobster fishing. In the United States, between 2000 and 2009, 18 lobster fishers died while working, of whom 11 (61%) died from falling overboard. Almost half of them (five) were entangled (and pulled or pushed overboard) in fishing gear. The fatality rate for lobster fishers was estimated as at least 14 per 100,000 license holders, or over 2.5 times the national average for all industries (CDC- NIOSH, 2005). As the figures for lobster fishers were not standardized in terms of full-time equivalent work, that fatality rate is underestimated.

Lobster fishing is a major industrial activity for the US northeast, with close to 2800 licenses being issued every year. The number of traps allowed per license may reach 800 units, with total

landings of over 43,000 tonnes in 2009 (National Marine Fisheries Service–Northeast Region, 2012). In comparison, in Québec, approximately 629 licenses were issued, with less than 300 traps per license, and landings of 3500 tonnes (MAPAQ, 2012).

The paucity of statistics and the difference between the characteristics of the two fisheries mean that it is not possible to assess whether the Canadian situation is comparable to that of the eastern seaboard of the United States. In Québec, from 2008 to 2012, there were six deaths at sea,[3] with two fatal accidents involving lobster fishers. In both cases, these were falls overboard and they occurred in two consecutive years, 2010 and 2011. No major change had occurred in the business environment over the years preceding these accidents (regulations, market, succession, etc.) and there had been no fatalities in the lobster fishery since 2000.

The first accident occurred in the Gaspé on April 24, 2010, at the opening of the fishing season when the traps were first set (CSST, 2011a). During the third and final voyage of the day, while dropping the first trawl of traps, the deckhand fell in the water, apparently dragged in by one of the components of the trawl (line or traps).

The second accident occurred off the Magdalen Islands on May 21, 2011 (CSST, 2011b). The captain was in the wheelhouse and was heading for the fishing grounds. The deckhand was on deck and began setting the trawl. A few moments later, when the captain turned around to check on how things were going, he saw that the deckhand was no longer there. He hauled in the traps that had been set to see if the deckhand was entangled in the lines, but did not find him. The captain then launched an emergency distress call and began searching. The crew of another vessel which had come to help found the deckhand, brought him on board and then immediately returned to the wharf. The deckhand was pronounced dead shortly afterwards.

The investigation led to the Commission de la santé et de la sécurité du travail (CSST) finding the following possible causes to explain the accident. First, the lobster boat design, which made it easier to drop the traps, appeared to increase the likelihood of a deckhand falling overboard. Second, the worker may have fallen into the water after losing his balance because of the boat's movements in the wind and waves, or by being dragged in by the fishing gear he was putting in the water.

These two recent back-to-back accidents led to the CSST's decision to enact new safety regulations for lobster fishers at the beginning of the 2012 fishing season, including requiring deckhands to wear a PFD at all times on deck, and measures to ensure that a fisher who has fallen overboard can be brought back into the vessel.[4] The Commission also wanted to learn more about the risks of falling overboard, and therefore consulted the IRSST about conducting a study on this issue, which led to this research.

[3] http://communiques.gouv.qc.ca/gouvqc/communiques/GPQF/Septembre2011/29/c6929.html, consulted on June 20, 2013.

[4] The summary of measures is provided at: http://www.csst.qc.ca/salle_de_presse/actualites/2012/Pages/3_avril_gaspe.aspx, consulted on June 18, 2013.

1.3. Prevention of Falls Overboard

There are few studies on prevention of overboard falls and those that exist are somewhat scattered over time. To our knowledge, only two separate research reports from Maine (Backus et al., 2001; Backus and Davis, 2011) provide information on the assessment and prevention of risks in a lobster fishery comparable to that in Québec.

The first research report, which the authors (Backus et al., 2000; 2001) qualified as preliminary, deals with entanglement in the lines and how to change working practices or implement prevention measures. With respect to working practices, the 100-odd fishers interviewed mentioned mitigation measures such as working slowly, paying close and constant attention to the position of the lines, using common sense, keeping feet and hands away from the lines as much as possible and being properly positioned when setting fishing gear or when moving it from one fishing ground to another.

With respect to measures to reduce the risks of becoming entangled in the lines, fishers clearly and strongly spoke out in favour of nonslip mats, of bulwarks above knee height, a rough surface on the deck and a line bin to hold the rope as it is hauled up. However, the research team only saw two vessels out of 100 using line bins. As well, 95% of fishers interviewed mentioned that having an extra hand on deck, in addition to the captain, provides the best insurance against becoming entangled in the lines.

Overall, the authors identify three primary means of preventing the type of entanglement that could cause a fall overboard and of making it easier to recover the person after an event: (1) controlling the work environment, including the lines; (2) halting the forces in play (kinetic energy), including cutting the motor; (3) saving the person by untangling or cutting the ropes.

The second more recent study by Backus and Davis (2011) provides information about risk perception, as measured by Maine fishers' responses to a questionnaire. As the study is dominated by lobster harvesters (206/259), it may be concluded that, overall, the results are applicable to that industry. We learned that the overall level of risk is assessed at 5.5 on a scale of 10. The authors were surprised that it was not perceived as greater, given that, according to recent statistics, the risk of fatality, estimated by the United States Labor Department for the occupation of fishers, is 60 times higher (200 deaths per 100,000 workers compared to 3.3 deaths per 100,000 workers in all industrial sectors combined).

In response to an open-ended question asking captains about what they think of the risks related to fishing, there was a strong tendency for them to suggest that only careless fishers are at risk, while rating their own activities as low risk. Several stated that workplace accidents did not affect small vessels, or that risks were only present in some offshore fisheries. The fishers constantly referred to "common sense" as being the best way to stay safe during fishing activities. The role that external factors play with respect to risk was generally ignored despite the fact that several fishers had survived life-threatening accidents, or even accidents that resulted in the deaths of some of their peers. Experiencing and having survived an accident unscathed appeared to reinforce the tendency that fishers have of minimizing risks, because, as they said, "since it happened to me and I survived, there's no reason to worry."

Here in Québec, the CSST published and disseminated a guide entitled *Health and Safety on Fishing Boats* (CSST, 2008). It contains measures to prevent overboard falls in fisheries that use fixed gear such as that required to handle lobster traps, including the following: (1) bulwarks or guardrails shall be of standard height, i.e., between 900 mm and 1200 mm[5]; (2) crew members shall wear safety harnesses attached to a lifeline; (3) all ropes shall be coiled and securely fastened and hoses shall be rolled on a reel to prevent fall hazards; (4) any equipment not being used shall not obstruct the work area, and (5) be careful not to put a foot in the bight of a rope or a cable. These precautions are, however, not obligatory and their application or respect of them remain at the discretion of owner-captains, who are responsible for the health and safety of both their crew and themselves.

1.4. Review of the Literature and Research on Means of Prevention under Development

During our research, we paid special attention to means of prevention being developed or that have been tested in the fisheries and that could be applicable to lobster fishing. The prevention measures refer to equipment, methods, guides, training, etc. recommended by these organizations to counter the risks associated with fishing in general and with falls overboard in particular. Consultation of the standard scientific reference sources were enhanced by direct contact with representatives from regulatory bodies, researchers involved in the field, and OSH experts and developers from the following organizations:

- Transportation Safety Board (TSB)
- Standing Committee on Fishing Vessel Safety, Québec Region
- Transport Canada, Marine Safety Branch
- Association des capitaines propriétaires de la Gaspésie (ACPG)
- Association des pêcheurs propriétaires des Îles-de-la-Madeleine (APPIM)
- Regroupement des pêcheurs professionnels du sud de la Gaspésie (RPPSG)
- Deckhand associations in Québec
- Marine Industry Human Resources Sectoral Committee
- Designers and builders of fishing boats and equipment manufacturers
- Training institutions
- Occupational injury regulatory bodies that implement prevention activities (the CSST in Québec and its equivalents in New Brunswick, British Columbia, Nova Scotia and Newfoundland and Labrador).
- Prevention organizations such as the Institut maritime de prévention (Lorient, France) and the NIOSH (in the United States).
- Fisheries research centres at Memorial University (in Newfoundland and Labrador) and the Université de Bretagne-Sud (France).

[5] Section 28 of the Government of Canada's *Small Fishing Vessel Inspection Regulations* states that "bulwark, rails, chains, wire rope or any combination of these shall be fitted around the weather deck of a fishing vessel at least 760 mm in height above the weatherdeck."

1.5. Conceptual Framework and Methodological Foundations

As soon as a human activity is carried out in proximity to a hazard (hazard event), the person or persons are in danger.[6] In such a situation, it is probable that events may occur that could harm people or material goods. OHSAS 18001 (sub-clause 3.21) defines the risk as being a "combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that can be caused by the event or exposure(s)." Thus, risk (**R**) is a combination of the probability that a hazardous event may occur (**P**) in a dangerous situation to which the person is more or less exposed (**E =** frequency of exposure) and which may lead to harm of a certain severity (**S**). The risk level is then expressed by the following relationship:

$$\mathbf{R} = f\ (\mathbf{S}\text{everity}, \mathbf{E}\text{xposure}, \mathbf{P}\text{robability})$$

The analysis of these risk components makes it possible to describe the principles guiding the methodological approach used here. Firstly, the only type of hazardous event we considered is that of falling overboard. We know that many people who fall into the water are able to get back into the boat with no physical injury. However, as our objective is the prevention of falls and not an assessment of the probability of survival, hypothesizing that this hazardous event will automatically lead to death does not alter the results of the study and enables us to simplify the analyses.

For an event to be considered hazardous, it must be an energy carrier. Aboard lobster boats, two types of energy may cause falls overboard: gravity, or gravitational energy, and moving masses, or kinetic energy. In the latter case, we mean the movements of the boat, the water (waves), lobster traps or other containers, rope, people and equipment (mainly the trawl hauler). Only a detailed study of the real activity of fishers will enable the frequency and intensity of exposure to these energies to be determined.

The study of work activity is, in fact, the very aim of ergonomics (Guérin et al., 2007; St-Vincent et al., 2011). The basic unit of this analysis is the "work situation," which can be defined as a task or a series of tasks to be performed and which includes the objectives to be reached, the prescribed activities, the difficulties of carrying them out, the real activities, the results (both in terms of production and occupational health and safety), in addition to the human resources and techniques available. For example, for the Institut maritime de prevention, the elements of a work situation on a fishing boat are the crew, the vessel and its fittings, the environment or physical surroundings, the task and the vessel's direction (IMP, 2009). These elements are all factors that will determine the activity and the resulting risks. Ergonomic methods help us understand work situations and provide the knowledge required to assess the probability that a hazardous event will occur and, ultimately, to assess the levels of risk. Our study uses this framework to reveal the relevant links among a number of work situations and the risks of falling overboard.

[6] The concepts presented here are from *Formation sur l'appréciation du risque* (risk assessment training), developed by J.J. Pâques, R. Bourbonnière and R. Daigle of the IRSST's Safety Engineering Program, and uses the terminology of the BS OHSAS 18001: 2007 for Occupational Health and Safety Management Systems.

The study of probabilities of occurrence pertains to risk analysis procedures and requires the identification of all scenarios that could lead to a hazardous event: in this case, falling overboard. In the case of an accident, there is **only a single scenario** that the investigator must reconstruct as closely as possible by analyzing all the factors that contributed to its occurrence. In risk analysis, **all scenarios** possible must be taken into account, which cannot be done without the knowledge and experience of the true work experts, those who actually do the job. The variability influencing the factors that determine the activity must also be taken into account. Finally, a study of accidents and "near misses" is indispensable in identifying these scenarios.[7]

A risk management approach has two steps: the analysis, which identifies the dangers and assesses risk levels, leading to a decision regarding its acceptability (risk assessment), and a step to reduce risk levels, if necessary. Malchaire (2001)[8] warns against methods that focus on quantification and measurement, which, while sometimes necessary, often have very little preventive value. These approaches are commonly used in engineering and risk analysis for machines and are mainly carried out by experts.

[7] For OHSAS 18001 (clause 3.9) an accident is an incident which has given rise to injury, while an incident where no injury, ill health or fatality occurs may also be referred to as a "near-miss," "near-hit" or a "close call." In terms of risk analysis, "close calls" (also referred to as "near misses") are as significant as genuine accidents.

[8] http://www.deparisnet.be/sobane/fr/txt_malchaire_de_la_theorie_a_la_pratique_2001.pdf. Consulted on January 23, 2013.

A risk analysis flowchart, as recognized by the CSST, is presented in Figure 1.

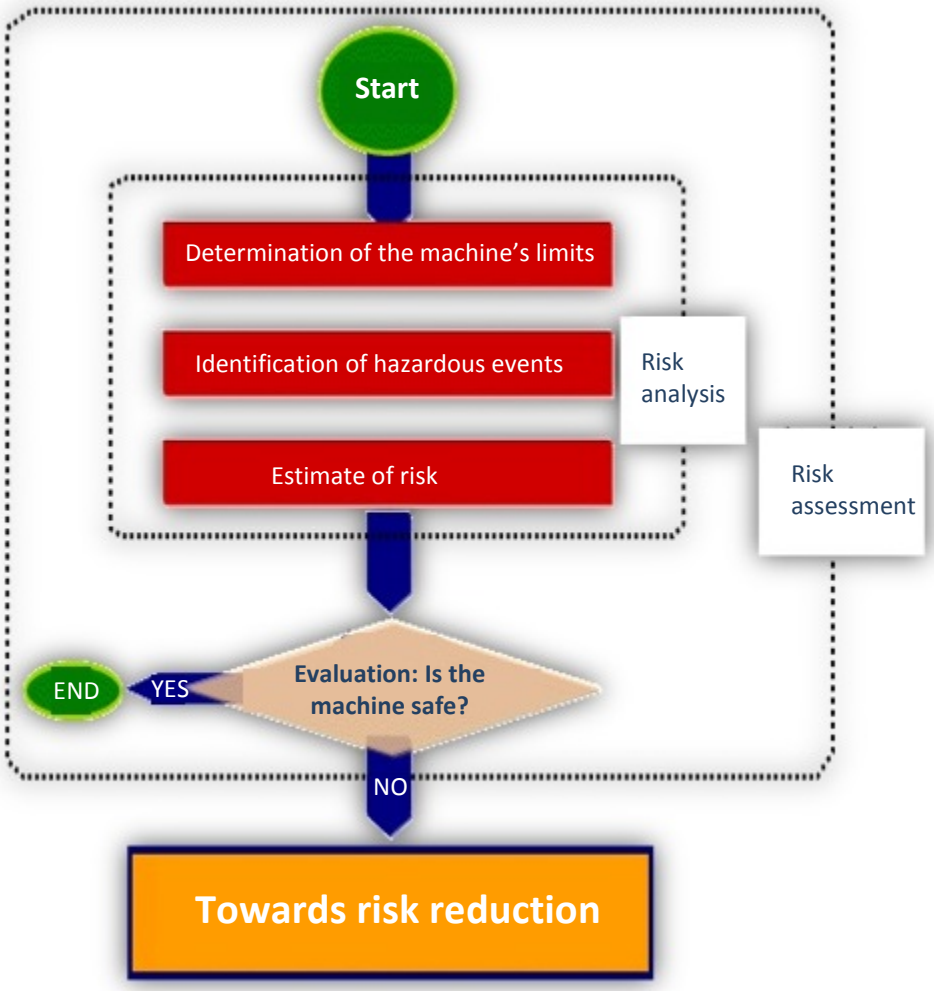


Figure 1 Risk analysis flowchart (from the CSST, 2004, p. 2)

However, the analysis of human activities from a prevention perspective shows that in a genuine situation, people continually manage risk, and to do so, they must assess its acceptability and modify their strategies accordingly. Ultimately, it is the worker who is on the front line and who makes the final decisions. Therefore, that person must be armed with the necessary skills and resources. In his study on risk perception among underground miners, Beaupré (2011) found that [translation]:

> When faced with risk, workers adopt a strategy essentially based on two criteria: (1) the estimated probability that an event could occur; (2) what is at stake, either with respect to possible gains, or to the losses they could incur. Across the board, social position, values and beliefs interfere with judgments made in a situation of risk. They influence

> the assessment of probabilities and what is at stake during the entire decision-making process, which, in the end, results in a strategy. (p. 85)

The author inferred that [translation] "risk at work is a social construct" and concludes that [translation] "individuals act according to subjective probabilities [and, accordingly] the probabilistic approach is no longer adequate and a more qualitative assessment of risk must be sought from workers' perceptions." (p. 88)

The above illustrates to what extent research into risk reduction must take into account the activity sector's culture and individual perceptions. However, the difficulties that external stakeholders in prevention see in the fisheries are that, much like underground miners, fishers tend to believe that their safety is their responsibility alone. After all, "the captain is the only master on board, after God." Moreover, as Dzugan (2005) points out, fishers are extremely independent and, as a group, are highly risk tolerant. The "zero risk theory" that he cites suggests that increased experience and confidence lead to a lower perception of risk. From our research, there is a high probability that this theory applies to fishers, as it appears to have been the case in the Backus and Davis (2011) study.

In such a context, it is extremely difficult to act on prescribed activities (by imposing safety regulations, for example). Instead, an attempt must be made to act on the determinants of the real activity by adopting a participatory approach that directly involves fishers in the search for means of prevention.

1.6. Project Objectives

The statistics presented above reveal the extent to which fishing is a high-risk activity and that falls overboard occur regularly as a result of losing balance or being dragged by fishing gear. In the 1990s, there was a jurisdictional transfer between the federal and provincial governments, which led to Transport Canada and the CSST signing an agreement protocol in December 2011.[9] In addition to redefining the roles and responsibilities of each, the agreement specifies that navigation activities come under federal jurisdiction, while work activities are a provincial responsibility (the CSST). The drafting of this agreement and the first stages of its application revealed the need to redefine approaches by relying on solid knowledge of the work on fishing boats and their inherent risks. It also led to the production of new prevention tools, such as the *Health and Safety on Fishing Boats* guide (CSST, 2008). Current research runs along the same lines and aims to

1. analyze the activities and the risks of falling overboard while lobster fishing, as well as their determining characteristics;

[9] Minutes of the seventh annual meeting of the Standing Committee on Fishing Vessel Safety, Québec Region. Organized by Transport Canada/Marine Safety, and Fisheries and Oceans Canada/Canadian Coast Guard. Rimouski February 16, 2012, page 11.
http://www.epaq.qc.ca/images/stories/CPSBP/Réunions%20annuelles/2012/Français/Compte%20rendu%20-%207451883.pdf (point # 9, p. 11). Consulted January 15, 2013.

2. document collective and individual prevention measures that can be adapted to lobster boats;
3. identify the most promising avenues for reducing risk.

Reaching these objectives involves a number of challenges:

1. Taking into account the wide variability of factors that determine the activity and its risks, such as the characteristics of the vessels, equipment, workers, environment (variable weather conditions), and work methods.
2. Having a good understanding of the dominant culture in the sector and being able to refer to it in our exchanges with fishers and their representatives, in addition to having in-depth knowledge of the real activity of fishers and the associated risks, in order to establish the usefulness, effectiveness and, above all, the acceptability of prevention measures.
3. Considering and integrating currently used and potentially applicable prevention strategies and measures into the analyses.
4. Ensuring that, despite the culture of self-sufficiency, self-reliance and resourcefulness specific to this sector of activity, fishers and their representatives will be able to support the conclusions of the research and to participate in the development of future prevention measures.
5. Generating knowledge and producing material (video extracts, photos, documents) that could be used afterward to disseminate the information, raise awareness and eventually provide training to fishers so that they adopt safer working practices.
6. The research team must combine knowledge in ergonomics, risk analysis, and the fishery, and, above all, be able to create the conditions for a successful participatory approach in a sector noted for its high degree of self-sufficiency and self-reliance (no tradition of participation).

The methodology used takes these challenges into account with an approach that recognizes and mobilizes two types of expertise: that of the researchers, in risk analysis and the fishery, and that of the fishers, who are experts in managing risk on a daily basis. Furthermore, special attention was paid to the social construction and networking in the industry.

2. METHODOLOGY

2.1. Social Construction and Ethics

Mobilization of the primary stakeholders in accident prevention in the lobster fishery began with the establishment of a follow-up committee made up of representatives from Transport Canada, Fisheries and Oceans Canada, the CSST, and the two most involved fishing associations: the Association des pêcheurs propriétaires des Îles-de-la-Madeleine (APPIM) and the Regroupement des pêcheurs professionnels du sud de la Gaspésie (RPPSG).[10] The committee met three times over one year while the research was being carried out. At the first meeting, we submitted the research design, to validate its relevance and to discuss the project's overall direction. The study was officially launched at the second meeting, and the participants contributed, with their suggestions and comments, to its planning and realization. At the final meeting, the results were presented and a discussion on avenues of knowledge transfer and possible research directions for a subsequent project took place.

As soon as the project was approved by the IRSST, a file was prepared and submitted to the research ethics committee at Université Laval. The list of documents that were examined by the committee is presented in Appendix 1.[11]

2.2. Recruitment and Selection of Participants

The research design was set up so that we could directly contact lobster fishers in the Gaspé peninsula and the Magdalen Islands to gather information about their practices and fishing equipment as it related to preventing falls overboard. It was important to learn the sociodemographic characteristics of the participants and those of the lobster fishing fleet in general.

Two lists of lobster boat captain-owners from the Magdalen Islands and the Gaspé, including their names and their addresses, were drawn up using Merinov's internal data sources. They included 311 (69%) captain-owners from the Magdalen Islands and 140 (31%) captain-owners from the Gaspé. The information included in the lists was validated by public information sources such as Transport Canada's Vessel Registration Query System.[12]

A variety of means were used to reach out to fishers. First, an article explaining the project was published in the newsletter, *Pêche Impact* (February-March 2012). The fact sheet targeting captains and deckhands was included with the article published. With a circulation of 3000, *Pêche Impact* is the main information source for Québec's fishing industry. Then, in April, invitations were mailed and individually addressed to the captains-owners of lobster boats in the two regions. They included the fact sheet about the project, a reply coupon and a stamped return envelope. The invitation letter was translated into English for English-speaking fishers, who make up a significant proportion of operators. Captains could express their interest in

[10] The RPPSG participated in the first two meetings, but withdrew before fishers were recruited.
[11] The ethical certificate obtained when the research began has the approval number 2011-306/30-01-2012. Two amendments were also requested and approved by this committee during the project, i.e., over one year.
[12] http://wwwapps.tc.gc.ca/Saf-Sec-Sur/4/vrqs-srib/m.aspx?lang=f – consulted January 15, 2013.

participating in one or the other of the two project components: responding to the risk perception questionnaire and/or accommodating members of the research team on their vessels to observe their fishing practices. A tour of the various fishing ports on the Magdalen Islands (two or three researchers and technicians, depending on the location) also took place in mid-April to raise awareness among fishers and to encourage them to contribute to the project's success.

Additionally, CFIM, the community radio station on the Magdalen Islands, broadcast an interview about the project. Another telephone interview was aired on the regional Radio-Canada radio station. The Radio-Canada interview could be heard by captains and deckhands in both regions. The team members also used their personal network of acquaintances among captains and deckhands in both regions, to invite them to participate in the study.

Two regional lists related to fleet category were drawn up from the favourable responses received from captains. Those who were interested were contacted one by one to confirm their participation. If someone no longer wished to participate, we went on to the next one. If the person agreed to participate, we noted the contact information of their deckhand(s) to verbally confirm with them as to whether they would also agree to be observed. These agreements were confirmed in writing by the captains and the deckhands, using a variety of consent forms at each stage that their contribution was required (see an example in Appendix 2).

A total of 39 people responded to these calls. Twenty-seven interviews were done on the Magdalen Islands and 12 in the Gaspé. In the Gaspé, the number of fishers interested in meeting us or welcoming us on board was higher at the beginning of the project. However, as a result of a disagreement (which is too complex to explain and is still not resolved) among various regional actors, the Regroupement des pêcheurs professionnels du sud de la Gaspésie (RPPSG) instructed its members not to cooperate in the research project. If we refer to the figures presented at the beginning of the section regarding the higher numbers (almost double) of lobster boat captain-owners from the Magdalen Islands compared to the Gaspé, our research sample presents a similar proportion of participants according to region.

There were 22 captains (including two retired captains) and 17 deckhands. They all filled out the risk perception questionnaire during a semi-structured interview that took place in their own regions. The distribution of the participants' sociodemographic characteristics is presented in Figure 2. We note that 67.6% (N = 25) of active fishers are 45 years old or over, while only 8.1% (N = 3) are under 30; 24% (N = 9) of them are between 30 and 44 years old.

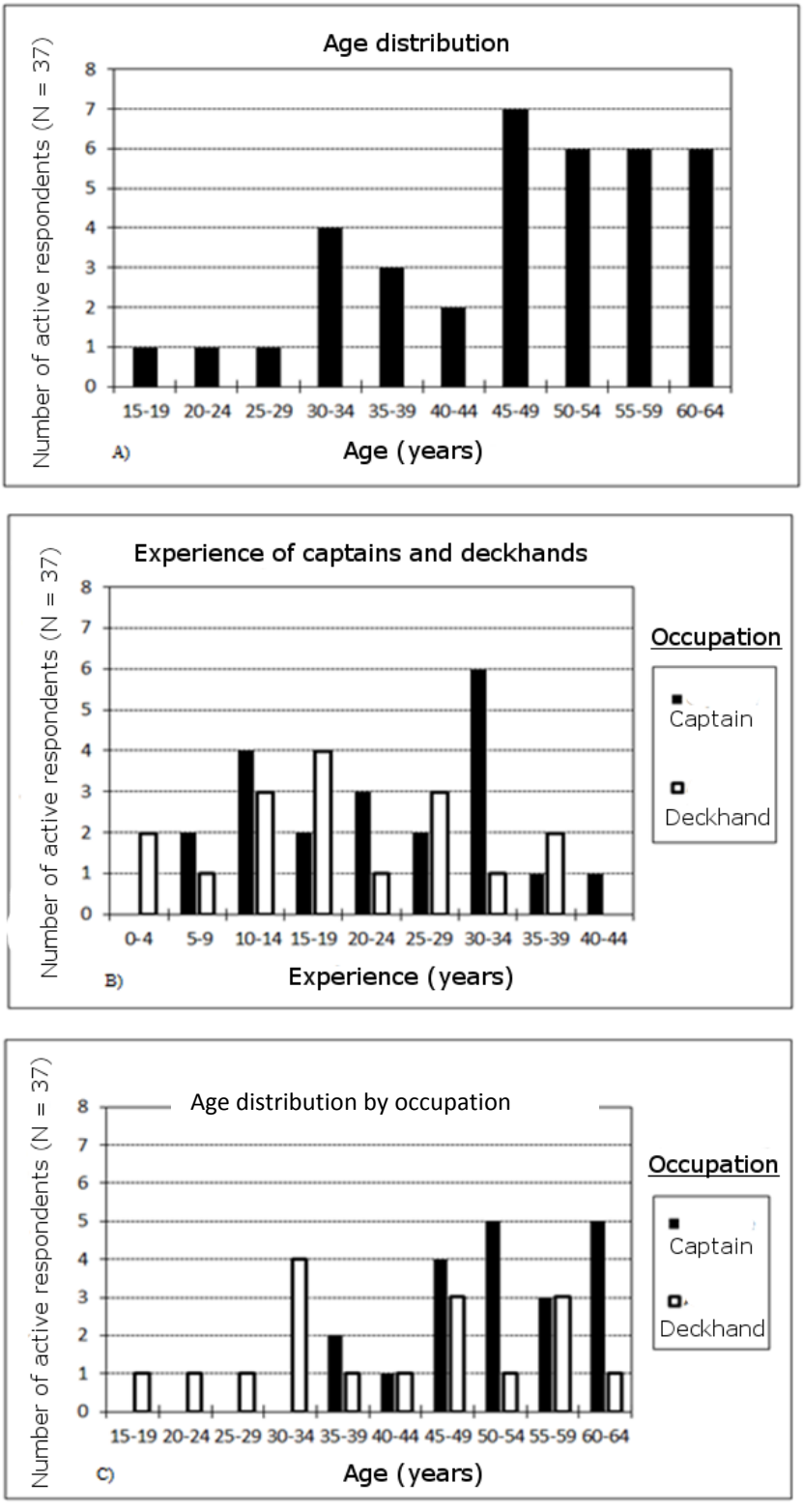


Figure 2 Sociodemographic characteristics of respondents to the general risk perception questionnaire (captains: black bars; deckhands: white bars)

The age distribution among captains and deckhands diverges slightly from this overall picture: all the captains are 35 or older, and the vast majority (90%) are over 45. Among the deckhands, there is a wide spread between respondents' ages: from 19 to 63 years old. Like the captains, almost half (47%) of deckhands are 45 years old or more. Only one woman participated in our study, a deckhand. The majority of active captains, or 65% (N = 13), have 20 or more years of experience; all of them have a minimum of 5 years experience. As with the age category, deckhands have a broader and more diverse range of experience.

An important investigation sponsored by Québec's Comité sectoriel de main-d'œuvre des pêches maritimes (CSMOPM, 2008) gave us access to the most recent and detailed data on the characteristics of the labour force to which the participants belong. We can see that more than two thirds (67.6%) of the lobster boat captains questioned (161/238) were 45 years old or more. The age structure of deckhands shows that the majority are 35 years old or over (68.6%). With respect to experience, the data from 2008 show that 100/188 (53%) of the lobster boat captains questioned had more than 21 years of experience, while 65% of the captains in this study's sample had reached the threshold of 20 years or more. The data for the deckhands are not presented specifically for lobster boats in the 2008 investigation. However, the authors mention a correlation between age and experience. It could be expected that the group of deckhands questioned in the scope of our study present an experience profile typical of the population. This reference data shows that the respondents' characteristics closely reflect the portrait of lobster fishers in the two regions.

2.3. Portrait of the Lobster Fishing Fleet and the Participants' Vessels

Technology databases dealing with the chief characteristics of the lobster boats in the Magdalen Islands and Gaspé fleet were assembled to define the profile. That step enabled the degrees of homogeneity or heterogeneity among the vessels to be measured in order to choose a sampling strategy that would respect the variability estimated from our basic knowledge. This information was supplemented through visits to the harbours in both regions.

Special attention was given to the classification of vessels with respect to length, degree to which they were multipurpose and the wheelhouse and hauler locations, because we felt that these parameters could have an influence on managing the risk of overboard falls. These are the criteria that guided the researchers in the final selection of crews and vessels that would accommodate an observer.

In 2010, the total number of license holders harvesting lobster off the Magdalen Islands and the Gaspé peninsula were, respectively, 329 and 199. On the Islands, there were 56 licenses (17%) for boats of less than 10.65 m (34' 11"), 265 licenses (81%) for boats between 10.65 and 13.7 m (44' 11") while eight license holders (2%) worked on boats larger than 13.7 m. In the Gaspé, the portrait is quite different, with 165 licenses (83%) being used for boats of less than 10.65 m, 35 licenses (17.5%) for boats in the 10.65 to 13.7 m category, while only one license belonged to a fisher operating a boat larger than 13.7 m.

Traditionally, lobster fishing takes place closer to shore in the Gaspé, because the nature and disposition of the seabed is favourable to commercial-sized lobsters, which are concentrated there. The coastal slope is relatively steep off the peninsula. The geomorphology of the archipelago of the Magdalen Islands is substantially different. The islands sit on the Magdalen plateau, with a sandy bottom close to shore, and the rocky seabed (better for harvesting lobster) is often situated further from the coast, meaning that larger vessels are better suited to the conditions. The professionalization of the sector has led to improvements and some modernization of equipment, so that smaller vessels may be well enough designed to deal with the local fishing conditions. These vessels also influence the duration of working days, which are generally longer on the Magdalen Islands, given the time it takes to get to and from the fishing grounds.

A portrait emerged of the distribution of boats by fishing port with their characteristics (category, length, power, position of the wheelhouse and the hauler, etc.) often accompanied by photos. All of the vessels were divided into three categories: skiffs[13] (flat-bottomed outboard motor boat), conventional, and multipurpose. Merinov's technology database counts approximately 210 lobster boats for the Magdalen Islands and 190 for the Gaspé (Appendix 5). This portrait guided the selection of boats included in the study and the verification of the sample's representativeness.

Description of the Participants' Vessels

The captains and deckhands on the Magdalen Islands interviewed about their perceptions of the risks of falling overboard use mainly multipurpose vessels (70.4%), the other boats being conventional lobster boats. The length overall (LO) of these vessels varies between 8.8 and 12.8 m (28' 10" and 42'). The fishers from this region who were observed at sea worked on four boats with the following characteristics: two were conventional lobster boats (LO of 8.8 and 12.8 m) while the other two were multipurpose boats, one with a wheelhouse in the centre of the deck (LO of 12.83 m) and the other with a wheelhouse closer to the bow (LO of 11.35 m). The hauler was installed near the stern of the four lobster boats, with three to starboard and one to port, i.e., the smaller of the two conventional lobster boats (LO 8.8 m).

With respect to the Gaspé, two thirds (8/12) of the fishers who responded to the general risk perception questionnaire worked on skiffs, while the others worked on both conventional lobster boats and multipurpose boats. The length of these vessels varied from 7.7 to 11.9 m (25' 3" to 39'). The fishers in this region who were observed at sea operated a boat from each of the categories, i.e., a skiff (LO of 7.7 m), a conventional lobster boat (LO = 9.1 m) and a multipurpose boat (LO = 11.34 m). The haulers were all situated at the stern, to port for the first and to starboard for the other two.

Origin (Harbours) of the Respondents to the General Perception Questionnaire

The 16 captains and 11 deckhands from the Magdalen Islands operate out of fishing harbours scattered all over the archipelago (see the map of fishing harbours in Appendix 8). The harbours concerned are Cap-aux-Meules, Grande Entrée, Grosse-Île, L'Étang-du-Nord, Millerand, Pointe-

[13] A skiff is an open or almost completely open flat-bottomed boat, with a shallow draught. It is generally small and can travel close to shore.

aux-Loups and Pointe-Basse. These cover a large portion of the fishing grounds that correspond to lobster fishing management area no. 22 (LFA 22), as defined by Fisheries and Oceans Canada.

The 12 people interviewed in the Gaspé, both captains and deckhands, were based out of six different fishing harbours: Anse-à-Beaufils, Anse-à-la-Barbe, Bonaventure, Chandler, Gascons, and Sainte-Thérèse-de-Gaspé. These harbours are spread out along the southern coast of the Gaspé peninsula, in LFA 20 A-6 to 20 B-8, with areas 20 A and 20 B being those where landings are most concentrated for this fishery (see the map of fishing harbours in Appendix 8).

2.4. Measurement Instruments: Questionnaires

A general risk perception questionnaire was drafted using information gleaned from the literature and the expertise of the members of the research team. The first version was tested and validated with five fishers who are members of the follow-up committee. It discerned four (4) high-risk work situations. The main value of the meetings resulted from the details provided by the fishers about work situations on lobster boats in which there were risks of falling overboard. These details enabled us to classify six (6) risky situations and to establish that they occurred during two distinct periods in the fishing season, i.e., three (3) at the opening of the season: when loading the traps, when travelling from the wharf to the fishing area and when initially setting the traps; and three (3) regular fishing situations: when hauling up the traps, when dropping the traps back in the water (resetting the traps), and when shifting the traps within the fishing area and the tasks related to it. Appendix 3 presents the final version of this questionnaire.[14] The definitive version contains the following, divided into five sections:

1. Information about the respondents, the boats and their fittings: occupation (captain or deckhand), gender, age, numbers of years of experience, fishing region, fishing port, fishing area (management area as defined by Fisheries and Oceans Canada), vessel category, material the traps are made of, number of traps and how many are set per trawl.
2. Data on incidents/accidents experienced by respondents or that they have heard about. That information is to be used to build a database of scenarios based on fishers' experiences, which, when added to those found in the literature, will assist in defining the circumstances that could lead to a fall overboard.
3. An assessment, on a scale of 1 to 10, of the perceived risk levels of falling overboard in six fishing situations (work situations).
4. An assessment, on a scale of 1 to 10, of the impact of 19 risk factors on the probability of falling overboard.
5. A description, by the respondents, of preventive measures that are now in use, and those that, according to the respondents, could be developed or implemented.

The information was gathered during semi-structured interviews that varied in length from 45 to 75 minutes. During the interviews, the participants were encouraged to expound on their responses, to help us better understand their choices.

[14] This second version is the final version of the risk perception questionnaire that was the subject of a request for amendments from Université Laval's research ethics committee, and their approval of it came just before the data gathering phase. The same changes were made to the descriptive questionnaire presented in Appendix 4.

After the selection of vessels that the researchers were to board as observers, during an individual recorded interview, the captain and his deckhand responded to a simplified descriptive questionnaire (Appendix 4), with five sections:

1. Information about the respondent;
2. Information about fishing (fishery, home port, movements, etc.);
3. Information about the equipment;
4. Information needed to plan observations and video recordings on the vessel;
5. A description of working activities.

Section 5 of the questionnaire asked the participants to describe, in detail, their real working activities for the six work situations that were used as the basis of analysis for this study. During these interviews, the respondents were to identify potentially risky situations or activities and explain how they would manage them. That information helped in planning how data would be gathered on the vessels and in discussions on the best ways of doing so with the captains and deckhands.

2.5. Analysis of Risks and Real Work Activities

The objective of this step was to document in detail the real work activity of lobster harvesting as carried out on vessels by deckhands, with respect to the risks of falling overboard. The framework used was that of an ergonomic analysis of the activity (Guérin et al., 2007; St-Vincent et al., 2011). This general framework included taking into account constraints present when activities are carried out, the equipment used, difficulties experienced, etc. The observations were not intrusive and did not interfere with the fishers' work and every measure was taken to ensure the confidentiality of the participants, in accordance with ethical principles concerning research.

The work situations on seven vessels were observed during 20 outings at sea. The vessels had one or two deckhands and one captain on board. An observer from the research team was on board for a total of 154 hours. Observation periods lasted from 5.25 to 6.5 hours and enabled 58 hours of video to be recorded.

The methodology provided for observations and video recordings on four vessels in the Magdalen Islands region and four others in the Gaspé region when traps were initially set and throughout two days of regular fishing. The withdrawal of one captain (in the Gaspé) a few days before the fishing season opened meant that, altogether, the observations and video recordings were carried out on seven vessels: one skiff, one conventional boat, and one multipurpose boat in the Gaspé; two conventional boats and two multipurpose boats in the Magdalen Islands. When the traps were initially set, regulatory or logistic restrictions meant that observations were not possible on one boat, while on the other, we were able to record working activities with a single fixed camera, in order to respect the life raft's carrying capacity.

2.6. Data Processing and Analysis: Activities, Risks, Incidents and Risk Factors

The analysis consisted of first classifying and summarizing all of the information gathered on the six typical work situations (the basic units for the analysis). For each situation, the real working activities were described and any malfunction or unexpected event was listed. The

incident/accident scenarios and preventive strategies identified by the participants during the perception interviews were also linked to each of these situations.

At the same time, the perceptions of risky situations taken from the general questionnaire underwent a summary statistical analysis through calculations and the analysis of frequencies, means and variances. It was thus possible to quantify fishers' perceptions of the risk of falling overboard according to work situations and to verify that distribution by occupation and region. Incident scenarios were recorded (occurrences) in accordance with the work situations and the circumstances under which they occurred. Risk factors were compiled and analyzed in accordance with the average rating provided by the 39 respondents.

Following this step, which led to an in-depth understanding of work situations, three members of the research team individually watched all of the video recordings and selected sequences of images showing tasks or actions with a potential risk of falling overboard. During a working session over several days, a risk analysis was performed for each of the sequences. Given the great variability of the situations encountered, a quantitative assessment of risk levels proved difficult to carry out, and of little use, with regard to the study's objectives. Instead, the exercise consisted of reaching a consensus among the team members on the possible scenarios of falling overboard, on the impact of various factors on the probability of occurrence, and on possible prevention measures and how to prioritize them. Through these exchanges, the researchers attempted to understand and explain the respondents' perceptions. Over 100 image sequences (clips) lasting from a few seconds to four minutes were used to show to the captains and deckhands during the validation sessions.

2.7. Validation with Participating Fishers

Two working meetings, of a day and a half each (one with participants from the Islands and another with those from the Gaspé) enabled us to validate the results of the researchers' analyses with the participants. Out of the 14 people who were observed or consulted at sea, 11 were able to participate in the validation meetings.[15] From the outset, the roles and responsibilities of the participants were identified, and they were encouraged to consider themselves as members of a group of experts in analysis and risk management of falls overboard, and not as fishers' representatives. Finally, all of the results of the questionnaires and the observations were presented and discussed. From a selection of videos of situations that the researchers deemed to be representative, the probabilities of falling overboard and means of prevention were discussed. These meetings helped the researchers to fine-tune their analyses and conclusions, based on the details provided by the participants.

2.8. Analysis of Avenues of Prevention

Several sources of information were used to establish a list of strategies and means of prevention used by captains and deckhands in both regions under study. To understand what strategies and means of prevention came spontaneously to the minds of the 39 captains and deckhands who

[15] By participants, we mean the captains and deckhands of the seven vessels on which the researchers carried out their observations. The three participants who were absent at the meetings did, however, have discussions on what was dealt with at the meetings with the researchers. They were unable to attend our meetings due to reasons beyond their control.

responded to the risk perception questionnaire, we compiled the responses to the following questions:

- Do you know other means of preventing falls overboard that could be used? If yes, could you describe and detail their advantages or disadvantages?
- Could you describe the means of preventing falls overboard that you are now using? What are the advantages? If applicable, do you see any disadvantages?

The responses to these strategies were classified by order of importance, according to the frequency they were mentioned. We also used the elements related to prevention that were mentioned by the 14 fishers who participated during the part of the interview covered by the descriptive questionnaire of activities. This portrait was completed by the practices observed while at sea, which were usually recorded by the video cameras.

That analytical work led to the production of statements related to the preventive knowledge used by this representative sample of the two fisheries under study. In order to judge their reliability, the statements were submitted for approval to the fishers who participated in the validation meetings. Following these meetings, the researchers presented the results of the study and means of prevention to the follow-up research committee (the third and final meeting).

A review of the literature was also carried out and contacts were established with specialists outside of Québec to identify other additional means of prevention. We focused our attention on the fisheries for lobsters and for other marine species caught with traps.

3. RESULTS

During the interviews carried out using the descriptive questionnaire, the 14 captains and deckhands who received the researchers on their vessels provided a detailed description of operating procedures used in each of the possible situations, incidents and malfunctions, the factors that could affect the risks of falling and the strategies that they use to manage them. To these descriptions were added the comments gathered through the 39 general questionnaires on risk perception. All this information, which came directly from the experience of the study participants, was completed by observations made during the 20 outings at sea and by the analysis of 58 hours of video recordings.

The observations and interviews revealed that the average working week in the lobster fishery is generally six days on the Magdalen Islands and seven days in the Gaspé, for nine to ten weeks, i.e., the duration of the lobster harvesting season in the areas where the research took place. During regular fishing, the vessel may leave the wharf between 3:30 and 5:00 a.m., which means that the crew must arrive earlier than that to prepare. Working days are longer on the Islands (8 to 12 hours), primarily because the fishing grounds are usually farther away than in the Gaspé. There is often an hour of travel from the wharf to the fishing area. Normally, a working day in the Gaspé is seven hours and the same crew is required as for the Islands, but for seven days a week.

This study focused on activities in which risks of falling overboard had been identified. It did not document other tasks that are included in the work of the captain and the deckhand, such as cleaning the vessel, mechanical, instrumental and vessel maintenance, dealing with the bait, and handling the catch. However, it is undeniable that these daily tasks lengthen the working day and are part of the workload of the captain and deckhand. Throughout the season, some fishers may also do other types of fishing, such as catching bait (herring and plaice, for example).

This section will first provide a descriptive analysis of the various situations surrounding the lobster harvest, at the beginning of the season and then during the regular fishing season. Afterward, the perception of risk in the six (6) work situations selected, related to the characteristics of the study participants, is presented. The fourth part describes the incident scenarios that were gathered by questionnaire. Finally, the risk factors and preventive measures are presented in reference to the situations described in the two first parts of this section.

3.1. Descriptive Analysis of Work Situations in the Lobster Harvest and Their Particular Risks—Opening of the Fishing Season

With the information gathered regarding the risks of falling overboard, we were able to distinguish two fishing periods: the opening of the fishing season, and the "regular" fishing season. This section provides a description of these main categories by identifying and analyzing the work situations involved for captains and deckhands with respect to the topic of the study.

1. Fishing season opening: loading the traps, traveling from the wharf to the fishing area and the initial setting of the traps.
2. Regular fishing: hauling in the traps, dealing with the catch and the bait, resetting the traps, shifting the traps within the fishing area and the related task of cleaning the deck.

All of these work situations cover most of activities at sea associated with lobster harvesting over a season. The subsequent sections deal with work situations that are more risky, according to the assessment of participants and researchers.

3.1.1. Opening of the Fishing Season—Loading the Traps

Loading the traps is a work situation that consists of several procedures: transporting the traps from where they are stored (generally outdoors on the fisher's property) assembling the trawls,[16] baiting the traps and loading the boats. We observed three different ways of preparing and transporting the traps.

1. The trawls are assembled directly at the storage site and then taken to the wharf a few days before the fishing season opens. When they are ready to be loaded, the traps are baited and put on the boat.
2. The trawls are assembled and baited directly on the wharf and then loaded onto the boat.
3. The trawls are assembled directly on the deck of the boat.

The first method requires much more management of the lines when the traps are being handled than the two others. However, it enables the trawls to be loaded more rapidly.

In the Magdalen Islands, the maximum number of traps per fishing license is 279, and in the Gaspé it is 235. The number of trips required to set out the traps usually determines how they are loaded and the sequence of activities. A single voyage allows all of the traps to be loaded the day before the opening day of fishing, thus minimizing time constraints. If several voyages are necessary, the trawls must be prepared beforehand, so that they may be rapidly loaded onto the vessel the first day of the fishing season. The number of voyages is determined by the capacity of the vessel to transport the traps safely to the fishing area. As can be seen from the information on the lobster boat fleet (Appendix 5), this capacity varies from region to region. Only some large

[16] This task requires attaching the first buoy to the buoy rope, then attaching the leader linking the main line to the first trap, and running the line between the two traps. The operation is repeated for all the traps on a trawl (from 7 to 10 traps) and finally, the last buoy is attached to the buoy rope at the end of the trawl. A trawl may thus have from 150 to over 200 metres of rope. A tag identifying the owner must also be attached to each trap.

boats, in the 11 m (34' 11") category and over, and of closed construction with a hold, can transport all the traps at once. The costs of traveling, the high degree of competitiveness in the fishing areas and the control over the numbers of days of fishing drive fishers into setting their traps as quickly as possible and limiting the number of voyages. However, captains must also take into account the risks of the vessel swamping and capsizing, and falls overboard, when traps are being set. The issue of load stability and, consequently, the risk of capsizing, are primarily the responsibility of Transport Canada and are not dealt with in this study.

Throughout all the activities required to prepare and load the strings of traps, people working on the wharf are at risk of falling into the water as a result of losing their balance, stepping on something slippery, putting their foot through a hole, tripping over the lines or being struck or pushed by a vehicle or another person. Depending on the tidal fall, the condition of the wharf and level of clutter, the risks may increase. For those on board who are receiving and stowing the traps, the risk of falling overboard occurs when they have to “get on and off the boat” and then when “moving from fore to aft” after the boat has been loaded.

Photo 1 Loading the traps: lines between the traps

The way the strings of traps (trawls) and the lines are laid out have a significant impact on the risk level when the traps are initially set. The two most common methods consist of either placing the lines of rope between the traps or coiling it directly on the deck on the side the traps are dropped overboard. Opinion is divided as to the level of risk involved in these methods. Some feel that the first method is safer. “It takes longer to load, but you are more in control of the lines. The rope is rolled up on the traps, so there’s no rope on the deck.” Others swear by the second method. These methods have been developed over time (often passed down from father to son), and, most importantly, according to the specific characteristics of the vessels. Analyses have shown that there is high risk in both cases, without proof of which is safer. Forcing crews to change their methods would be riskier.

Photo 2 Loading the traps: rope coiled on the deck

No matter the method used, it must limit errors and unforeseen events. In particular, the buoys at both ends of the trawl must be well identified and placed correctly, the order in which the traps are dropped must be respected, the rope must arranged so it does not form knots and the number of traps on each trawl must be identified. “It's important to pile the cable in the right order. If you pile (the cable) backwards, that's dangerous. Or, if you put a trap in the wrong place. The traps have to follow each other.”

Finally, the load must leave enough working space free so that the deckhand can drop the first trawls safely. Some vessels are so heavily loaded that the deckhand must place one foot on the traps and the other on the bulwark. In contrast, one captain states that he keeps a third of the boat

free at the back to provide enough space to work. When vessels are overloaded, there may be not be enough space to drop the first trawls, which affects safety and heightens the risk of falling overboard. The residual working space depends mainly on the characteristics of the vessel, such as its size and how it is loaded, which is generally decided by the captain. There is therefore some room for manoeuvre in this regard.

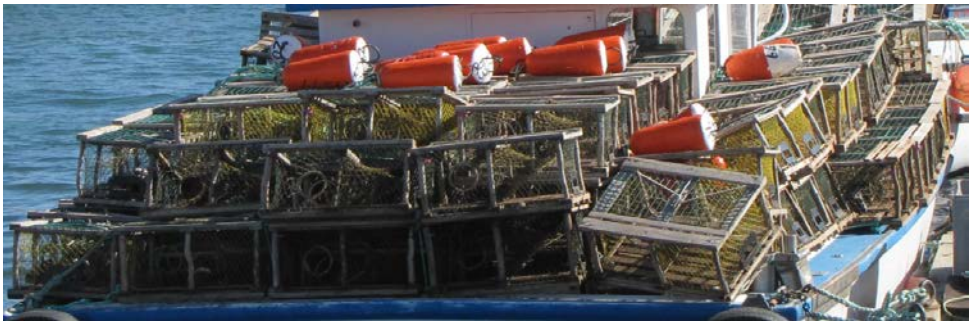


Photo 3 Loading the traps: little space available to drop the first trawl

Over the past few years, in the Magdalen Islands, an additional step, which consists of first soaking the traps before loading them on the vessels has come into use.[17] This operation requires reserving a place to soak the traps at the shoreline, submerging them and bringing them up after a few days, cleaning them off and then putting them on a trailer to take them to the wharf to load on the boats. This therefore adds a whole series of very physically demanding operations, with the goal of improving the effectiveness of the traps in the first two or three days of fishing. The two reasons given most often are that, when wet, the traps are heavier and therefore more stable on the seafloor, and that they reduce the emission of gases (after the wood traps or the cement used as ballast are waterlogged) in the first days of fishing. Because of the high degree of competitiveness in the fishery (especially in areas with large concentrations of trawls), fishers believe that this "presumed" increase in effectiveness is significant enough to change how they do things. This new practice, which is physically demanding and complex from a logistical point of view (lack of adequate sites for pre-soaking) is gradually gaining ground and illustrates how the culture of a community evolves under the effect of economic imperatives. Several of the fishers questioned have not yet adopted this practice, but are thinking of doing so, even though they feel that it would be much more logical if everyone agreed to eliminate the practice completely to ensure a level playing field. Although this remark is not necessarily related to an additional or a higher risk of falling overboard, it illustrates a change in the culture and how it takes form.

[17] Gendron and Archambault (1997: 9) mention a "soak period" for newly made traps, which consists of immersing the traps in water for a time before using them. It appears that this practice is broadening to include all traps.

3.1.2. Opening of the Fishing Season—Traveling from the Wharf to the Fishing Area

This work situation covers all activities involved in getting from the wharf to the fishing area, including when the deckhand moves from the wheelhouse to the workstation. While underway, the captain is in the wheelhouse and is responsible for navigating towards the first area where traps will be set, and for manoeuvring the vessel. Usually, the deckhand(s) also stay in the wheelhouse after detaching the moorings. The only exceptions appear to be when the travelling distances are short and that there is a relatively comfortable place astern. One of the captains mentioned that he worked with two deckhands and that one of them traveled in the back to keep an eye on the load of traps. This indicates that there are concerns about the stability of the load and the risk that the traps could shift. In fact, some fishers strap down the traps when the load is stacked high, to stabilize it. "I've seen a boat lose traps, the trawls got tangled up and it was dangerous for the deckhand on the deck."

Photo 4 Moving around in the boat when it is loaded with traps

When they arrive at the fishing grounds, the deckhand(s) who were travelling in the wheelhouse go back to their workstation, generally at the stern. To get there, they must manoeuvre around the side of the boat by walking on the bulwark, or, usually, walking on top of the traps. A deckhand said that he traveled in the wheelhouse when the weather was good and astern when it was bad so that he wouldn't have to move from the bow to the stern in bad weather.

Photo 5 Traveling to the fishing area

Almost all the participants seem to feel that there are very few risks of falling overboard when the deckhands are going to their workstation (e.g., in the back, behind the load). The only incident reported was when traps shifted, which caused a deckhand to fall (struck by a trap or pulled down when he tried to hold back the traps). However, having to move from fore to aft, once at the fishing area, is considered by many as being fairly dangerous.

3.1.3. Opening of the Fishing Season—Setting the Traps

When he arrives at the fishing area he has chosen, the captain reduces the vessel's speed and monitors the bottom with sonar, all the while checking for trawls belonging to other fishers. The reduction of the vessel's speed is a signal to the deckhand to get ready to set back the first trawl. Generally, the deckhand tosses out the first buoy, attaches it to the boat and leaves it to float while waiting for a signal from the captain. He gives the buoy number to the captain, who enters it into the electronic tracking system (GPS). At the signal (a call or a blow of the horn), the deckhand unties the rope holding the buoy, lets it out and drops the first trap. He must then drop the next trap before the line between the two of them tautens. The time that he has depends on the

speed of the boat. He must be aware of the number of traps on a trawl to know when to toss out the buoy at the end of the line. He then prepares the second trawl while the captain moves towards the next fishing ground.

Most of the participants feel that, at the opening of the fishing season, setting out the first trawls is most dangerous and that as time goes on, the risk decreases. “The first rows are the most dangerous; there’s less space, it’s harder to communicate and we can’t see each other as much.” While it is true that having more room facilitates the task, it also means that the crew has to move the traps over longer distances on a slick deck, all the while dodging the lines that are sometimes moving at high speed. To reduce the amount of moving around, the first trawls are often set at the stern and the next ones off the side. “At the beginning (up to about half), I drop them off the back. Then the other guy comes to help me and I drop them off the side (by putting them on the washboard).”

Photo 6 Initial setting of the traps

The opening of the fishing season is considered by most as a very hazardous and stressful time. “It’s a stressful day. There’s stress the first morning that lessens as you get more experienced.” The most significant risk factor is all the rope on the deck,[18] which is why the loading method is so important. Once at sea, the deckhand has to make do with how the rope was placed (which determines how it uncoils on the deck). Of course, the weather and the vessel’s stability can also considerably increase the levels of stress and risk.

To sum up, in a context in which there is a strong propensity to set the traps as quickly as possible, the analysis of the risks of falling overboard on the first day reveals that the size and certain other characteristics of the vessel determine the number of voyages out to sea. In addition, the preparation of the traps and the arrangement of the lines are determined, in part, by the number of trips that must be taken. The deckhands believe that the smaller the area available to set out the first trawls, the greater the risk of falling overboard. The residual space that the deckhand has to work in depends on how the traps have been loaded and thus, to a great extent, on the characteristics of the vessel. In addition, the traps are initially set at the end of April or the beginning of May—the first fishing activity of the season after spring thaw and nine months after the last lobster traps had been set the year before. In the validation interviews, the deckhands told us that the day before the traps are initially set, they don’t sleep well, because they are conscious of or worried about the inherent risks. Finally, to get maximal use of the vessel’s capacity, every fixture or fitting on the boat for the regular fishing season must be movable or designed to leave as much room as possible for the traps.

[18] A fishing licence corresponds to about 40 trawls and each trawl requires at least 150 m (about 500 feet) of line.

3.2. Descriptive Analysis of Lobster Fishing Work Situations and Their Specific Risks—Regular Fishing

3.2.1. Regular Fishing—Hauling the Traps

After the traps have been initially set, the crews install the equipment required for regular fishing, changing the layout on deck (see Photo 7 and Appendix 5). In addition to the sorting table for the catch, the live tank, the bait totes (trays), a few extra traps, a table is generally installed to receive an entire trawl of traps. In some cases, because of the length of the boat, the traps will not all fit on the table, and one or two must be placed on the deck or to the side. "When hauling them in, I put the cage on the bait tote because the table isn't long enough." Some owners of boats with a sufficiently wide rail do not feel it is necessary to install a table, and place the traps directly on the rail, which means they may not be stable.

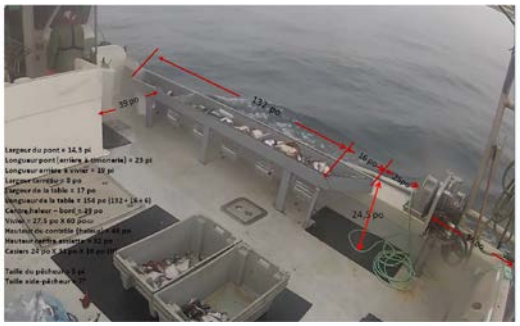


Photo 7 Illustration of the layout on board during regular fishing

A regular day of fishing starts with loading the bait and then travelling to the fishing area where the first trawl is to be hauled up. With modern instruments, navigation is much easier because the locations of all of the trawls appear on the screen. The fisher plots a course (a strategy that enables a minimum of travel) and heads to the first buoy using GPS.

When the buoy is located, the captain approaches, taking the wind direction and currents into account to make it easier to retrieve it. The deckhand snags the buoy with a gaff, draws it up into the boat, places the rope between the sheaves of the hauler and then sets the buoy and the gaff down in the boat. Using the hauler's speed control, the deckhand begins hauling up the first traps. Here, two scenarios are possible: (1) the deckhand stays at the hauler to bring up the entire trawl or (2) the captain, who has put the boat in neutral, takes over.

Photo 8 First trap set down and slid onto the table

When the trap gets close to the boat, the person operating the hauler slows its speed and gets into position to catch the first trap. Ideally, the trap should be positioned so that there is less need to lean outside of the boat, as well as less effort required of the back or the upper limbs to pull the trap onto the table. With a single movement, the trap is lifted and placed slightly at a slant on the table to make it easier to remove the catch and the bait. Generally, as soon as the second trap is brought up, whoever is at the hauler helps remove the catch while the next trap is being reeled up automatically to the boat (with the hauler in gear without someone at the controls). As soon as a new trap appears, that person takes control of the hauler again and pulls the next trap onto the table, and so on, until the last trap is in. The second buoy is generally not brought into the boat, but simply tied onto the hauler (or to wherever else it can be attached) and left to float behind the

boat. The captain goes back to the wheelhouse to reposition the boat so the traps can be set again, while the deckhand continues to deal with the catch and the bait.

The participants feel that this situation is not very risky. The most hazardous part is snagging the buoy, because it requires leaning outside the boat. All of the fishers feel that it would be enough to just let go of the gaff if a problem occurred. Holding onto the hauler while hauling in the traps to keep one's balance is considered to be a safety factor. As well, most of the fishers mentioned that handling the traps on the table and dealing with the catch and the bait are tasks performed at some distance from the side of the boat, where there is no risk of falling overboard.

The analyses show that, effectively, if the layout is safe (especially with respect to the height of the washboard[19]) and the prevention strategies identified are applied, the risk is quite low. However, the actions required when there are incidents or malfunctions can considerably increase the risk. The main examples of these that were mentioned or observed are as follows:

- Another trawl is sitting on top of the one that is being hauled up: "if one trawl is on top of another, you have to lean outside of the boat. I'll try to lift it as much as possible to be able to work on the washboard.";
- A trawl line that breaks (because a trap is stuck);
- The rope is caught under the boat;
- A trap snagged on a rock;
- Line that comes out of the hauler sheaves. "If a trap is hooked on something on the bottom and the rope jumps out of the hauler, the last trap onboard could be pulled back in the water if there's not a lot of slack.";
- Traps that fall back into the water when they are being hauled up or when moving them. "The traps may fall back in the water when they're being hauled up or when moving them because of wind or the sea.";
- A trap that must be reset.

[19] "Washboard" is the vernacular term used to describe the wide railing on top of the bulwark used to place the hauled traps.

3.2.2. Regular Fishing—Handling the Catch and the Bait

Once the trap is set down, slightly tilted, on the table, the door is opened and the lobsters and any other catch are removed. Lobsters that are not the minimum length or that are females with eggs are thrown back. The others are placed upright in short lengths of PVC tubing set up on the table used to band their claws. Other catch (small crabs and fish) are put into a tray to be later thrown back in the sea. Generally, the person who is not working at the hauler does most of the work of removing the catch from the traps, at least the first few. When the last trap has been hauled up, the captain returns to the wheelhouse and the deckhand finishes the job. While travelling to the next trawl site, the deckhand bands the lobsters' claws and places them in the live tank.

Photo 9 Handling the catch

The bait is dealt with at the same time as the catch. If it needs changing, the old bait is removed and replaced. Morsels of bait are inserted on a stake (bait iron) placed for this purpose in the trap.

When the catch has been removed and the bait changed, the trap is moved to the end of the table (farthest away from the hauler). To do this, the deckhand pulls the trap towards himself, to ensure that the trap is within his grip, and to limit physical effort and slipping on the table. If the table is not long enough, either the traps must be tilted (see Photo 9), or one or two must be placed on the deck.

The deck layout (position of the sorting table, the live tank, the bait totes, etc.) determines how the crew moves about. As the activities take place around the middle of the vessel, the participants feel that the risks of falling overboard are minimal.

3.2.3. Regular Fishing—Resetting the Traps

If a trawl's yield is satisfactory (numbers of lobsters trapped), it will be reset in the same location. The captain repositions the boat and gives a signal to the deckhand to begin dropping the traps. "The captain gets back in position. He yells 'okay' and I drop them." The captain may decide to move the trawl to a new fishing ground, which entails longer trips on the boat. Promising areas are found with the sonar. The captain may also decide that all of the traps should be put on the deck to shift the trawl towards a fishing ground much further away. That situation will be dealt with later.

Photo 10 Resetting the traps

The task of "dropping" the traps is quite simple. Normally, the last buoy is left floating behind the boat. At the captain's signal, the deckhand detaches the buoy and pushes out the first trap. When the rope attaching that trap to the next has completely run out, he pushes the next and so on. Sometimes after setting a few traps, the captain will ask the deckhand to hold the line. The deckhand then attaches the rope to the hauler and the boat pulls the traps that are already in the water (sometimes the whole trawl) over a certain distance. At the captain's signal, the deckhand frees the rope and continues setting the traps.

During this operation, there is definitely a risk of being dragged by gear in movement (rope and traps). We will see further on how the layout of the working area and the method used have a significant impact on the level of risk.

3.2.4. Regular Fishing—Shifting the Trawls Within the Fishing Area

During the regular fishing period, there are two reasons why fishers may shift their trawls within the fishing area. The first is to optimize their harvest by seeking locations more highly populated by lobsters and by following the lobsters as they move (generally from deep waters towards the coastline as the season advances). The second reason is to protect the traps when storms are on the way. During large storms, traps sitting in shallow water are tossed about by the waves and can be damaged or filled with debris.

If the captain feels that they are not catching enough lobster and decides to try his luck a bit further out, a single trawl may be hauled on board to be shifted to another spot. The captain may also decide to move several trawls at a time over a greater distance. In that case, one or several trawls must be brought on deck. "If we move two trawls, I have to put one on the deck. I haul up the line, I put the buoy on board in the back, I pile up the traps on the stern, then we haul up the other and set it on the washboard."

If a storm is coming, and most of the trawls are in shallow water, the captain may decide to shift them all. The number of trips (and thus the number of trawls aboard) will vary, especially depending on the travel distance. "We sometimes move them one or two at a time. If it's two at a time, I pile six on the ground (on the deck), leaving myself some space to work, then I put a trawl

on the washboard. That happens as soon as a storm is forecast and we're close to shore (say at 3 to 4 fathoms, which is about 20 to 25 feet from the shore). We go out in the morning and move it out deeper. When the storm passes over, we bring it back on board." This is a serious situation, with respect to the risk of falling overboard, because the tasks may have to be carried out in bad weather and rough seas.

The interviews reveal that the frequency with which the traps are moved varies enormously: "Over 10 weeks, we could steam around with two trawls on board for the equivalent of two weeks. We might do that 50 times a season, sometimes three or four times a day, sometimes not at all." The same goes for the number of traps on board: "Yes, we shift them. We can shift four to five trawls at a time. We could put 15 to 20 pots on deck (two trawls, one on the table and one on the deck). Often, it's the captain who works the hauler and I put my pots on the deck. In the south, they can basically fill up the boat and go to shore."

All these movements considerably increase the difficulties of the task. "Two trawls on the deck, it's tiring at our age; they have to be picked up off the ground.[20]" And, of course, the risks of falling overboard increase accordingly and may vary a great deal from one situation to the other. The deck of the boat is quite congested, so the traps must be piled up, while ensuring they are stable, and above all, large warps of rope must be managed, all while work activities are underway (with time constraints, fatigue, etc.). "The traps are wet, and have to be placed differently with all the other gear. The rope must be dealt with accordingly. Stowed in the right place." Under these circumstances, resetting the traps is certainly more risky than in normal fishing situations, when they are all on the table and the rope is arranged correctly. "To drop them, I put the traps back on the table and I drop them like I normally do, except that the rope isn't laid out like usual."

3.2.5. Regular Fishing—Related Task of Deck Cleaning

After the day's work, during the return to port, the deckhand cleans and tidies up the deck. If the boat is equipped with pump, the deck is hosed down. Otherwise, sea water must be hauled up. "The deck and the trays must be washed down, everything picked up, you have to check that there's enough water for the lobsters in the live tank, and that they have enough oxygen, prepare the rope to moor the boat, and so on." Upon arrival at the wharf, the boat must be moored, the lobsters and any leftover bait must be unloaded and the task of cleaning up the boat must be finished.

In summary, the start of regular fishing requires the deck to be set up differently (table, live tank for the catch, bait totes, etc.). According to our observations and from what the participants say, the main risk of falling overboard when the traps are hauled up is when the buoy is snared. We feel that leaning outside of the boat to grasp and haul up the traps is also risky. Here again, the boat's characteristics (more or less low on the water) and the installation of the hauler (which determines the posture) are determining factors. Resetting the trawls may entail a high risk of falling overboard if someone is dragged by the lines. The captain and the deckhand must be aware of what the other is doing at all times. For example, the deckhand's position and the number of traps on the table that the captain can see provide clues and help determine what step

[20] Meaning off the deck instead of off the table or the washboard.

has been reached in the task of resetting the traps, so that the captain can adjust how he pilots the boat. For deckhands, variations in the vessel's speed, perceived from the sound of the motor, can give them the signal to prepare to snare the buoy or to reset the traps. When the weather is bad, the situation is more dangerous. Shifting the trawls in the fishing area is a risky situation, mainly because the deck is cluttered and slippery, the deckhand must manage a large amount of rope, and fatigue is greater when extra activities are added on top of the regular tasks.

3.3. Perception of the Riskiest Work Situations

During the semi-structured interviews required to fill out the general risk perception questionnaire, the 39 participants (22 captains and 17 deckhands) assessed the level of risk of falling overboard in different fishing situations on a scale of 1 (low) to 10 (high). Table 1 shows the mean obtained for each work situation with a minimal level of 1. The situation deemed to be the riskiest by the captains and the deckhands is when traps are set at the beginning of the fishing season, with an average perceived level of risk of 4.8 out of 10. Appendix 6 presents the bar charts that show the frequencies for risk perception, broken down according to occupation (captain or deckhand). Captains and deckhands do not assess risk in the same way. We note that no deckhand assesses the risk as being low (level 1 or 2) in that situation, while five captains did (Appendix 6, Figure 1A).

Table 1 Risk perception according to work situations

Work situations	Risk perception: Scale of 1 to 10
SEASON OPENING – Setting the traps	4.8
REGULAR FISHING – Resetting the traps	3.1
REGULAR FISHING – Shifting trawls within the fishing area	3.0
SEASON OPENING – Traveling from the wharf to the fishing area	2.6
SEASON OPENING – Loading the traps	1.7
REGULAR FISHING – Hauling up the traps	1.6

The second situation deemed as risky is also associated with setting traps, this time during the regular fishing season, where the mean risk level is assessed at 3.1. Some captains feel that this activity is less risky for deckhands, but their opinion is not shared by all. Although six captains assessed the risk at 1, we could find as many who assessed it at 5. The majority of deckhands assessed it at 2 or 3, or around the mean value (Appendix 6, Figure 1B).

The third highest risk of falling overboard according to the ratings occurs when trawls are shifted within the fishing area during regular fishing (Appendix 6, figure 1C). The mean risk level is

assessed at 3.0. Captains and deckhands have a similar assessment, except that a higher number of captains felt it was less risky, giving it a value of 1.[21]

At the opening of the fishing season, when travelling from the wharf to the fishing area, the mean risk level fell to 2.6. It is notable that 13 of the 17 captains felt that this activity was not very risky (level 1), while some deckhands gave it values of 5 or more, and even up to 8 or 9 on the measurement scale (Appendix 6, Figure 1D).

Finally, loading the traps at the beginning of the season and hauling them up during regular fishing are activities deemed to be less risky (1.7 and 1.6 respectively). In both cases, the perception of risk level by captains and deckhands is about the same (Appendix 6, Figures 1E and 1F).

Interregional Comparison

The perception of mean risk level (for the six targeted fishing situations) differs depending on the region where the fishers are harvesting (Appendix 6, Figure 2). At first glance, captains and deckhands on the Magdalen Islands appear to feel that the risk they face is greater than their peers in the Gaspé in every situation.

However, this perception is not statistically measurable except for the two riskiest situations, i.e., setting the traps on the first day of fishing and resetting them during regular fishing. In fact, there is sufficient homogeneity in the variances (Bartlett test to $P \geq 0.05$) to perform a two-way (i.e., the region and the job) analysis of variance (Table 2).

The results of this analysis show no meaningful difference in the mean risk level assessed by captains and deckhands in both regions. The P values generated by the calculations are all above the P-limit value (0.05), indicating that the difference is not statistically significant.

At best, when the traps are set at the start of the fishing season, the difference between the Magdalen Islands and the Gaspé (P=0.072) nears the significance threshold for the mean level of risk perceived by the fishers. With respect to the occupation, it does not appear to have a notable influence, especially for setting the traps during regular fishing, meaning that the captains and deckhands feel that the risk of falling overboard is similar from day to day. However, the number of fishers interviewed was low (N=39), especially in the Gaspé (N=12); a higher number would have enabled more robust conclusions for this statistical test.

With respect to other activities, the lack of uniformity in the responses does not enable us to put together the conditions necessary for a two-way analysis of variance.

Qualitatively, according to Figure 2 (Appendix 6), it is interesting to note that deckhands on the Magdalen Islands appear to perceive a higher level of risk than the captains for each work situation about which they were questioned. Although it cannot be statistically demonstrated, it is a finding that was observed.

[21] The final step in shifting trawls is that of resetting the traps. Each time there is movement involving kinetic energy and gravity, the situation becomes hazardous.

Table 2 Summary of values generated by the analysis of variance of risks, estimated by region and job

Activity	Risk/region	Risk/job	Interaction	Bartlett's Test
Season opening–initial setting of traps	F = 3.432 P = 0.072	F = 1.985 P = 0.168	F = 0.504 P = 0.482	0.33
Regular fishing–resetting of traps	F = 2.085 P = 0.158	F = 0.006 P = 0.94	F = 0.631 P = 0.432	0.08
Regular fishing–shifting traps within the area	F = 1.955 P = 0.171	F = 1.257 P = 0.270	F = 0.407 P = 0.528	0.02
Season opening–moving from wharf to fishing area	F = 0.297 P = 0.589	F = 4.358 P = 0.044	F = 1.335 P = 0.256	0.003
Season opening–loading traps at the wharf	F = 0.127 P = 0.724	F = 0.347 P = 0.560	F = 0.648 P = 0.426	0.0007
Regular fishing–hauling up the traps	F = 2.504 P = 0.123	F = 1.022 P = 0.319	F = 1.712 P = 0.199	0.003

Where degree of freedom is always equal to 1; F = inter-group difference; P = degree of significance

Risk and Work Experience

Overall, no real trend is observed in the mean level of risk perceived during fishing situations, with respect to experience, for either captains or deckhands (Appendix 6, Figure 3). However, the most experienced deckhands believe that they face greater risk than that perceived by the captains with the same numbers of years of experience. This observation holds for the three situations deemed to be the riskiest, while the patterns are not as clear in the other cases.

Risk and Type of Vessel

The captains and deckhands on skiffs, which are concentrated in the Gaspé, believe they are at lower risk than fishers on conventional lobster boats and coastal multipurpose vessels (Appendix 6, Figure 4) in five of the six situations identified (the exception being loading traps at the wharf at the season's opening). In four of the six fishing situations, conventional lobster boats received

higher ratings. The perceptions of both captains and deckhands are similar in this regard. However, not enough fishers working on conventional lobster boats and multipurpose vessels in the Gaspé were questioned to say whether this is a regional effect or due to the type of vessel.

To sum up, the perception of the riskiest work situations as determined through the responses to the questionnaire is consistent with the analysis of the observations presented in the previous section. Both reveal that work situations in descending order of risk of falling overboard consist of setting the traps at the beginning of the season, resetting the traps, and shifting the trawls within the regular fishing area. Certain differences in perception exist: generally, experienced deckhands assess their risk level as being higher than the other captains or deckhands. Differences exist between the two regions, but because of the small number of participants, we are unable to determine whether they can be explained by the characteristics of the vessels or by differences between the regional fishing conditions.

3.4. Incident Scenarios

Context

An important step in risk analysis is the identification of all scenarios of dangerous events that may occur. However, it is difficult to predict all these cases. Therefore, this study began by referring to the experience of respondents, who were asked the following questions:

1. Have you ever fallen overboard?
2. Have you ever come close to falling overboard?
3. Do you know anyone who has either fallen overboard or came close to falling overboard?

When the respondents answered yes to one of these questions, the researchers asked them to describe the situation surrounding the accident or incident. Positive responses were grouped into one of the following four categories:

C	A fall overboard experienced by the respondent
C-E	A fall overboard that the respondent had heard about or had seen.
PP	The respondent had come close to falling overboard.
PP-E	A close call that the respondent had heard about or had seen.

Only the first two categories (C and C-E) refer to actual falls overboard; the other two (PP and PP-E) refer to close calls or quasi-accidents. Even though the latter two did not result in falls overboard, they show the chain of events that could lead to an accident, as illustrated in the following example: “When the traps were being set at the start of the season, I was going from fore to aft when the boat rolled and I lost my footing. Luckily, my foot went through a trap, which kept me from falling in the water.”

This section reports on the descriptions provided by 39 captains and deckhands in response to three questions dealing with falls overboard that they had experienced themselves, that they had

come close to experiencing, or that they had heard about from someone who had fallen overboard or who had come close to falling overboard.

3.4.1. Overall Results

Table 3 presents the distribution of the situations surrounding the 50 incidents reported, by category and by work situation.

In each of the situations, there are falls overboard or close calls. By considering only events that were **directly experienced** by the 39 respondents, i.e., the C and PP categories, we get a total of 22 events, or 0.56 events per respondent. Although the season opening lasts only one day, the respondents reported several events on that day. Nevertheless, the most numerous reports occurred during the regular fishing season, which lasts several weeks.

Table 3 Distribution of 50 cases of falls overboard or of close calls by work situation, according to whether the respondent experienced them personally or heard about them from someone else

Fishing period	Work situation	C	C-E	PP	PP-E	Total
Opening of the season	Loading the traps and getting in and out of the vessel	1	3	1		5
	Travelling from the wharf to the fishing area			2	1	3
	Setting the traps		2		3	5
Regular fishing	Hauling up the traps		4	2		6
	Resetting the traps	1	5	4	1	11
	Travelling within the area			3	1	4
Others	Unknown situations		1	4	4	9
	Other situations	1	2	3	1	7
Total		**3**	**17**	**19**	**11**	**50**

C A fall overboard experienced by the respondent
C-E A fall overboard that the respondent had heard about or had seen.
PP The respondent came close to falling overboard.
PP-E A close call that the respondent had heard about or had seen.

3.4.2. Results by Work Situation

Table 4 identifies the key circumstances or factors that played a role in the event's occurrence by work situation, while Table 5 groups the circumstances or factors enumerated in Table 4. When rope was involved, we indicate (if the respondent was able to specify), whether the traps were dropped directly from the deck or from a table.

Most of the events recounted (34/50) identify a loss of balance (12 events, or 24% of the cases) or rope (22 events, or 44% of the cases) as the most significant factors. This result provides some insight, because rope could be in part associated with risks of becoming entangled or dragged by fishing gear, as is found in the scientific literature.

In terms of causes, it is possible to link the loss of balance to vessel speed. In addition, bad weather increases the vessel's roll and pitch and wets down the surfaces, so it could also play a role. Thus, prevention could be focused on elements related to piloting the boat (speed reduction) and using caution when seas are rough, i.e., not going out to sea when the weather is bad. Loss of balance may also be associated with the boat's structure (a low bulwark height for example). Prevention measures could focus on elements related to vessel layout.

With respect to rope, it is central to the work activity and is discussed in Section 3.5. It is worth noting that the action of snaring the buoy was identified five times (10%), while five other events (10%) were related to tasks performed when the boat was moored at the wharf (embarking or disembarking: 4; pushed by a vehicle on the wharf: 1).

Table 4 Compilation of information about known overboard fall scenarios obtained from respondents

Fishing period	Work situation	Circumstance/factor	Number
Season opening	Loading traps and getting in and out of the boat	Pushed by a vehicle (on the wharf)	1
		Fall while embarking/disembarking	4
	Traveling from the wharf to the fishing area	Moving fore and aft	1
		Loss of balance when moving	2
	Setting the traps	Loss of balance due to the boat's movement	3
		Dragged by the lines (traps on the deck)	2
Regular fishing	Hauling in the traps	While snaring the buoy	5
		While disentangling a trawl set on top of another	1
	Resetting the traps	Rope (traps on the deck)	2
		Rope (traps on the table)	7
		Dragged by the lobster measurement gauge	1
		Unknown	1
	Shifting the traps within the area	Rope (traps on the deck)	4
Other	Unknown work situations	Loss of balance	2
		Rope (on the deck or table)	7
	Other work situations	Loss of balance	5*
		Pulled in by a pail (while cleaning the deck)	1
		Struck by the hauler pulley	1
Total			**50**

* Including twice while fishing for mackerel

Table 5 Occurrence of the circumstances identified in the 50 scenarios described

Circumstance	N
Loss of balance	12
Rope (traps on the deck)	8
Rope (traps on the table)	7
Rope (on the deck or the table)	7
Snaring the buoy	5
Fall while embarking/disembarking	4
Dragged by (other than rope: pail, lobster measurement gauge)	2
Moving fore/aft	1
While disentangling a trawl set on top of another	1
Pushed by a vehicle (on the wharf)	1
Struck by the hauler pulley	1
Unknown	1
Total	**50**

3.5. The Risk Factors and the Determinants of the Activity

The questionnaire put forward 19 factors that could have an impact on activities and the corresponding levels of risk, based on a review of the literature. During semi-structured interviews carried out with the general perception questionnaire, the participants were to respond to the following:

On a scale from 1 to 10, assess the impact of the following factors on the probability of falls overboard while lobster fishing.

- *A rating of 1 means that, for you, that factor has no impact on the probability that a fall overboard could occur.*
- *A rating of 10 means that, for you, that factor has a significant impact (it greatly increases the risk of falling overboard).*

Table 6 presents the average rating obtained for each of the previously identified factors in the questionnaire, from the responses of the 39 participants. The researchers explained to the respondents that they were to use their own experiences to judge the importance of the factors from their perception of the situation in general. For example, the deckhands were to assess the importance of the factor of "captain's attitude" in general and not the attitude of their own captain in particular.

Table 6 Average rating of factors in descending order of importance according to their impact on the risk of falling overboard

Order of importance	Factors	Rating
1	Weather	6.5
2	Captain's attitude	6.4
3	Rope management	6.2
4	Deckhand's attitude	5.9
5	Deckhand's experience	5.6
6	Captain's experience	5.6
7	Deck condition–traction	5.3
8	Work methods	5.1
9	Washboard height	5.0
10	Vessel's seaworthiness	4.9
11	Deck condition: clutter	4.6
12	Vessel layout	3.9
13	Hauler condition	3.0
14	Wharf layout	2.9
15	Washboard width	2.7
16	Equipment available	2.7
17	Access to toilets	2.0
18	Hauler position	1.8
19	Traps	1.7

The ratings vary from 1.7 (low risk: traps) to 6.5 (high risk: weather). The discussion section provides a more detailed explanation of how the respondents rated the factors. At this stage, despite certain limits, the researchers believe that the order of importance of the factors in terms of risk level, in addition to how they were quantified against each other, has a non-negligible indicative value in understanding the risks of falling overboard.

The questionnaire used to assess fishers' perceptions does not include "macro" type factors related to the overall context of lobster fishing, as the research team felt that it would be difficult to obtain a rating for something so broad. Instead, an analysis of the specific factors (mainly attitudes and methods) was planned to take the overall context into account. Following suggestions from experts, we felt it relevant to integrate the general factor of "fishery management measures" into the discussion. For example, the competition observed among

fishers to get to the good fishing areas first at the opening of the season when traps are initially set exacerbates some other factors, such as the captain's attitude. Captains may be tempted to increase vessel speed to get to the best fishing areas first, or to load their boat with as many traps as possible to reduce their trips to and from the wharf, which in turn limits the space the deckhand has to drop the first trawls in the water.

It is also important to note that the fishers made few or no allusions to fatigue, a factor that can increase the risk of falling overboard. This was despite the fact that the extremely early start to the work day may reduce captains' and deckhands' sleep time, in addition to the long work weeks (six days a week for the Islands and seven days a week for the Gaspé). The questionnaire did not specifically ask about fatigue. Given current occupational health knowledge on the subject, recognized analysis models explaining the determinants of working activities, and at the suggestion of experts, we integrated the factor of "condition" of the deckhand and the captain to the other factors referring mainly to level of fatigue or lack of sleep.

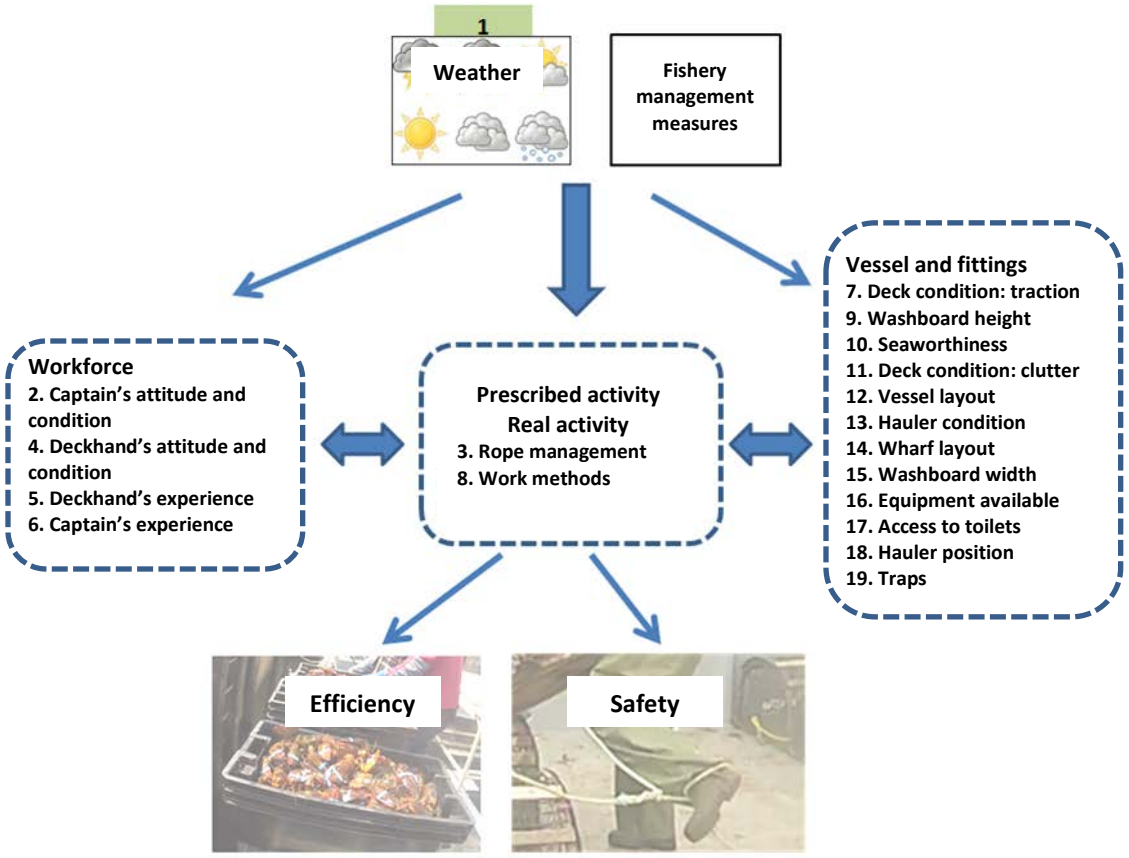
To facilitate an understanding of these factors and the relationship among them, 18 of these factors were grouped into three categories, while the other factors, such as weather and fishery management measures (e.g., fishing season opening and license issuance), were dealt with separately.

3.5.1. Combination of Risk Factors and Work Situations

This section is divided into four parts that correspond to the combinations of factors that interact in lobster fishing activities and that could contribute to falls overboard. The four parts are as follows:

1. The factors associated with prescribed and real activities (two factors: #3, #8)
2. The weather (one factor: #1) and fishery management measures (unrated)
3. Factors related to the workforce (four factors: #2, #4, #5, #6)
4. Factors related to layout of the boat and wharf, as well as fittings (12 factors: #7, #9 to #19).

These categories of factors and their interactions are presented in Figure 3, and are based on classic ergonomic representations of a work situation (Daniellou et al. 2010; St-Vincent et al. 2011—see Appendix 9). The diagram is structured around prescribed and real activities that are strongly determined by the available material resources (boat and its fittings), by the characteristics of the workforce (especially experience and attitude) and their condition at the time (fatigue, for example). Here weather holds a prominent position because, as we shall see, it affects the other aspects of the situation, as does the macro-level factor, that of fishery management measures. The manner in which work is organized and carried out (methods, for example) produces more or less efficient results and influences the level of safety. In the diagram, the number associated with each factor corresponds to its position (in descending order of importance) according to the mean rating given by the respondents and presented in Table 6.



The number associated with a factor corresponds to its level, as presented in Table 6.

Figure 3 Categories of factors that have an impact on the risk of falling overboard and their interactions in the work of lobster fishers

To illustrate the interactions between factors and activities, consider the case of worsening weather conditions, with heavy rain and winds of over 20 knots. The stability of the boat, traction on the deck, the movements of rope and other gear, as well as visibility, are affected. All this considerably increases the amount of attention and the effort required to perform tasks. The stress and fatigue levels of the workers rises accordingly, while the efficiency of operations drops and the level of risk significantly rises.

3.5.2. Factors Associated with Prescribed and Real Work Activities

Work Methods

Work methods are gradually developed by integrating rules, both formal (procedures to be respected) and informal (such as work practices), and the multiple restrictions related to fishing and the resources available. This factor received a rating of 5.1, putting it in eighth place. In their comments, several participants emphasized the necessity of teamwork, involving good coordination based on a method worked out together. "Working as a team is important and keeps

us safe. Safe methods must be established with employees and they must be respected." A great deal of emphasis is also put on the "work routine" and not straying from it.

The analysis shows that risk management is largely based on the ability to predict events. Respecting a routine is a way of reducing the aspects of variability that arise from the method itself. The following event, a close call reported by a participant, illustrates this aspect. "My foot got jammed in the rope at the same time as the other deckhand was dropping a trawl. It was a careless mistake but it also happened because the captain had decided that the rope should be placed differently." Good communication among the crew also plays an important role in risk management. "Always do things the same way, in a safe way. Always communicate clearly and be able to see each other." For example, deckhands' posture or movements show other crew members where they are in the performance of their tasks or whether they are encountering any difficulties.

Rope Management

Because of its importance, the methods used to manage rope have been assessed separately. The rope and the traps they are attached to carry energy, the intensity of which depends directly on vessel's speed. Fishers are very conscious of this danger, as can be seen by the rating of 6.2 they gave it (in third place, immediately after weather and the captain's attitude). The typical situation that can lead to a fall overboard is getting caught in a loop of rope. "Once my guy caught his foot in the rope, but I stopped right away and nothing happened. I saw him and he shouted at me at the same time."

Rope is managed in two stages. First, it must be arranged in such a way that the steps involved in setting the traps will be able to be carried out safely. This involves constantly checking on it and putting it back in place if necessary. "The lines move during bad weather, you always have to be putting your ropes back in place. Especially when you set the traps." Then when setting the traps, the ropes' movements must constantly be checked and crew members must position themselves accordingly.

It is clear that the design of the table, the position and the operation of the hauler (the way the lines are removed from the hauler) and the general layout of the boat determine how the rope is managed. Every crew develops its own strategies in accordance with their vessel's layout, strategies that all are based on keeping the lines away from the feet when the traps are set. "Most people leave it on the ground, but in my case it goes on the table." Analyses and some of the comments show that when the traps have to be put on the deck, the risk increases. "Having to put one or two pots on the deck increases the risk of falling because of the ropes." In addition, vessel speed when the traps are set has a direct impact on risk level.

3.5.3. Weather and Fisheries Management Measures

Fishers see weather as the predominant risk factor in falls overboard (rating of 6.5). All the comments gathered corroborate this high rating. As is apparent in the following quote, fishers are well aware of the consequences of bad weather on activities and on risk levels. "In bad weather,

you have to be more careful. Its dangerous, everything's moving, and you don't see the waves coming because you're working." Bad weather conditions thus considerably increase the risk of falling overboard, both because of loss of balance and being dragged by the fishing gear. Vessel stability and factors such as traction on deck, movement of gear, visibility, and the stress and fatigue levels of the crew are all affected.

Everyone acknowledges that there are weather conditions beyond which no one should go out to sea. The decision about whether or not to go out is generally made in the morning. The fishers gather on the wharf with the weather forecast and make their decision about going out. There appears to be a strong chain reaction; if one crew decides to go out, the others will follow. "If one goes out, everybody else goes out too. There are the brave ones (those who have experience and know what they're doing) and the followers (those who take risks, without having the experience)." A participant goes farther in his description of this decision-making dynamic. A captain may decide to go out, and once out of port, discount the risk so he doesn't have to admit that he was overconfident. "If the seas are rough, he may decide to keep going, even if the work isn't going well. He wants to show off as being better than the other guy." In that case, he risks communicating his bad assessment of the sea conditions to others, prompting them to go out in very dangerous conditions.

Fishers may also deal with conditions that worsen once they are at sea. Then a decision must be made as to whether to return to port or to continue fishing. It is fair to assume that once out at the fishing area (especially if it is far from shore), there is a strong temptation to continue fishing. To that temptation is added the need to move trawls out of the path of the approaching storm; another reason for going out to sea under difficult conditions. "Once, they went out to haul up 100 traps, and halfway out a storm blew in. Very dangerous."

The objectives of fishing management, as defined by government structures, are to ensure the sustainable exploitation of the resource and the economic viability of the industry. However, some fishery management measures set up a situation with potentially negative impacts on safety. The day the fishing season opens is a day in which there is a high risk of deckhands falling overboard. The regulatory measures governing the issuance of licenses dictate the day and time that the fishery will open. That context generates competition among fishers and encourages them to rush out as quickly as possible into the most productive fishing areas to set the most traps possible. To do so, the boats tend to steam at high speeds while carrying heavy loads that leave little room for the deckhands to drop the first trawl. During the regular fishing season, captains may underestimate the impact that weather has on risk levels so as not to lose the day's catch. The study shows that this impact varies, depending on the fishing area, which complicates the decision as to whether or not to go out to sea.

3.5.4. Factors Related to the Workforce

The four factors associated with the workforce received relatively high and quite similar ratings (varying from 5.6 to 6.4). Attitude was felt to have a slightly higher impact on the risk of falling overboard than experience. The captain's attitude was considered as having the greatest effect on the risk of falling. As noted by a deckhand, "the captain is the heart of the boat." In the culture of seafarers, "the captain is the only master on board, after God." There is an acknowledgement that

he has an immense responsibility for managing safety, especially with respect to supervision and control over what takes place on his boat: it is the captain's responsibility to be watching out for the deckhand everywhere, especially when it is dark out (at night and at dawn).

Overall, the participants acknowledged that there are captains who are more firmly and unyieldingly cautious than others. "If the captain is a risk-taker, there may be more of a chance of falls overboard." Their manner of recognizing risk (deciding whether the risk level of a situation is acceptable or not) influences the two most important behaviours: the decision of whether or not to go out during bad weather (and to turn back if the weather worsens), and the choice of how quickly the various tasks are executed.

Deckhands' attitude is considered as having a greater impact on risk than their experience (a rating of 5.9 versus 5.6). In analyzing the comments received, we note that physical condition trumps attitude. One captain sums this up as follows: "Deckhands should get on the boat well rested and with their wits about them." Several other comments, both from captains and deckhands indicate the importance of physical capabilities and level of concentration on the task: "you have to be alert, in shape and focused." This gives us some insight into the level of difficulty, demands and risks inherent in the work of a deckhand. To get to work in the morning well rested, both the captain and the deckhand must have had a long enough period of sleep, estimated as a minimum of seven and a half hours a night.[22] However, given that the fishing boats leave the wharf between 3:00 and 5:30 in the morning, it is very probable that sleep time has been quite short, and even more so during the months of May and June, as daylight hours are lengthening until the summer solstice. In a similar vein, the fatigue that results from fishing activities as the day goes on is a factor that influences physical capacities, mental acuity and consequently, the level of risk. Difficult sea or weather conditions also increase the demands and, accordingly, levels of fatigue as the working day goes on.

Several respondents insisted on the need to adopt a cautious attitude. Even more interesting, with respect to prevention strategies, several noted the importance of some kind of behavioural self-analysis: "Deckhands should take a close look at their behaviour and make use of their experience." This indicates the importance of thinking of ways of helping fishers identify high-risk behaviours. Some respondents noted that motivation and satisfaction at work play a role as factors in being cautious.

3.5.5. Impact of Factors Related to the Vessel and Fittings

The "deck condition: traction" factor received a rating of 5.3. This factor is involved in fall scenarios when there is a loss of balance or because of slipping.[23] Everyone agrees on the

[22] See the table presenting sleep durations according to age, adapted by the Douglas Mental Health University Institute. http://www.douglas.qc.ca/info/sommeil-et-enfant-donnees-scientifiques?locale=en–consulted June 20, 2013

[23] The analysis of scenarios of falling or close calls mentioned by the participants indicates that rope is involved in 22 of the 50 incidents reported, or 44% of cases, while loss of balance is noted in 24% of cases. Snaring a buoy causes 10% of incidents.

importance of a well-maintained working surface with good traction (paint containing an abrasive material and/or installation of a rubber mat in the working area).

The washboard height (rating of 5.0) is felt to be a factor with a direct bearing on the risk of falling overboard. In most cases, respondents assessed this factor with the height of the hauler in mind and thus linked to the action of "grasping the trap and pulling it onto the table." It appears that fishers believe that the risk of falling in other areas of the boat is negligible. The main reason given is that the activities are concentrated on the side with the hauler and the table that receives the traps. This issue should be examined further, because sometimes the traps are dropped elsewhere than from the table (initial trap setting and sometimes when the traps are shifted within the fishing area). There is a consensus among the study participants as to the ideal height of the washboard. It should be above knee height, between 610 and 711 mm (between 24 and 28 inches). Section 28 of the Government of Canada's *Small Fishing Vessel Inspection Regulations*, requires that bulwark, rails, chains, wire rope, or any combination of these, must be fitted around the weather deck of a fishing vessel at least 760 mm in height above it. This minimal height is thus relatively high compared to the practical suggestions of the participants, whose aim is to facilitate handling of fishing gear.

The "seaworthiness" factor received a rating of 4.9. There is a consensus that the more the boat moves, rolls, heels and pitches, the more the risk of falling increases. The more seaworthy the boat, the lower the risk of falling. Of course, "you have to make do," which, in terms of prevention, involves "working according to the boat's characteristics."

The "deck condition: clutter" factor has an influence on the risk of "colliding with" and above all of "being struck by" moving objects. The mean rating received was 4.6 and the aspect mentioned most often was the need to ensure that nothing moves. For this, two strategies are used: attaching objects and equipment or ensuring a good friction coefficient between the object and the deck (generally by using rubber).

The "vessel layout" factor received a rating of 3.9. There were several comments about the fact that a good set-up of the working area decreases risk. The comments also showed us that fishers are concerned about the ergonomics of the layout: "most [fishers] set up their space so they can work better." These arrangements must take into account the need to move trawls of traps within a fishing area (frequency and number of trawls). Several respondents also stressed the importance of keeping work spaces clear, and ensuring that there is no risk of catching one's feet in traffic areas. Developing benchmarks for workstations and deck layout that would integrate safety and efficiency aspects (ergonomics) would possibly contribute to improving preventive measures.

The condition of the hauler also received a low rating (3.0). The comments pointed out the importance of it working well, and of the difficulties associated with rope coming out of the sheaves (while hauling in traps), without it being directly related to the risks of falling overboard. It seems mainly to be an inconvenience and a source of frustration. Those who feel that this equipment is dangerous refer mainly to the risks of injury and not of falling overboard. Furthermore, the way the rope comes out of the hauler determines how and where it will wind up on the deck.

Generally, the participants feel that the width of the washboard or the table has little impact on the risk of falling overboard (rating of 2.7). However, in most cases, the participants have a table to work on. It would have been be interesting to begin by asking about the need to have a table and to rate situations with and without one. There are two reasons that probably motivate the decision to install a table: to ensure the stability of the traps and to have a more "ergonomic" work surface. Several mentioned that if traps slipped and began falling into the water, a fisher may, by reflex, try to hold onto them and be dragged in.

In terms of the equipment available, the only tool that could play a direct role in the risk of falling overboard is the gaff used to bring in the buoy. Its impact was deemed to be relatively low (rating of 2.7). However, some of the events identified in the perception questionnaires and the fact that at least one fatal fall could be attributed to the action of snaring a buoy[24] lead us to believe that the risk of this activity is underestimated. The description of the procedure clearly shows that one must lean outside of the boat to grapple and bring the buoy back to the boat. The posture and the strength required depends on several factors, with the most significant being the way the captain approaches the buoy (especially its distance from the boat), the length of the gaff and the tension on the rope (sometimes, the current can be so strong that the buoy is pulled underwater). It goes without saying that having to grapple a buoy with a gaff that is 10 or 12 feet long or more while leaning over the side of a moving boat, and having to pull with a great deal of force is a very high risk action. The comments received indicate to us that fishers do, in fact, acknowledge this.

During the planning phase of the research (October 2011), a renowned solo sailor narrowly escaped death following a fall overboard when she was getting ready to "take a pee."[25] Given that the initial information gathered showed that the practice of urinating overboard was common on fishing boats, participants were asked to rate the factor of having access to a toilet. Even though the comments received showed that, effectively, urinating overboard is a common practice, its impact on the risk of falling overboard was deemed to be low (rating of 2.0). This can be explained by the fact that fishers believe that they control the risk, by holding onto something solid. In case of bad weather, a toilet is used, if it is available, or another recipient if not.

The perception of respondents is that hauler position has little impact on the risk of falling overboard (rating of 1.8) (see the compilation in Appendix 5). We hypothesize that because most respondents have always worked with a hauler positioned in the same place (especially those from the Magdalen Islands), they are unable to assess the impact. For the rare fishers who have experience with two positions, the stern position was deemed safer.

Of the 19 factors assessed, the one related to traps obtained the lowest rating (1.7). Few respondents were able to link this factor to a risk of falling, of which the main one was being

[24] An accident that occurred on April 30, 2012 in New Brunswick (http://www.cbc.ca/news/canada/new-brunswick/story/2012/05/01/nb-lobster-fisherman-died.html).

[25] Florence Arthaud, 54 years old, was alone on her 10 metre yacht, about 15 km off the north of Cap Corse, when the incident occurred. "I quite simply fell into the water while preparing to take a pee, without attaching my harness as I usually do," she told TF1 (French television station) upon leaving the hospital. http://www.lemonde.fr/sport/article/2011/10/30/la-navigatrice-florence-arthaud-a-frole-la-noyade-au-large-de-la-corse_1596188_3242.html

dragged by a broken trap and/or having protruding parts that could catch on clothing or another piece of gear.

3.6. Prevention

3.6.1. Strategies and Means of Prevention According to the General Risk Perception Questionnaire—All the Fishers

The captains and deckhands queried in the general risk perception questionnaire spontaneously identified about ten strategies and means of prevention (Table 7). They are described in detail in Appendix 7. The participants identified them mainly from practices in use or by already approved methods used on their boats.

Improvement of traction on the deck is possible by laying rubber mats at the workstations or in traffic areas. Their surface must be calculated so that they do not weigh down the vessel unnecessarily, be reasonably priced and not get in the way of cleaning of the deck. Otherwise, fishers advocate the application of a non-skid product and, at all times, the use of good work boots.

Strengthening cohesion among the crew can be assured by defining work methods together and establishing them according to the circumstances. At the beginning of the season, the hiring of an extra deckhand is suggested. Other recommendations include the use of equipment to improve visual and hearing communication between the captain and the deckhand. Appropriately arranging the rope according to the position of members of the crew is advocated. Several suggested ways of raising the lines off the deck, or guiding them to areas that are more likely to reduce the risks of getting entangled.

Table 7 Strategies and means of prevention identified by the respondents

Strategies and means of prevention	Frequency evoked
Improvement of deck traction	22
Improvement of cohesion among crew members	16
Rope arrangement	11
Improvement of the table or washboard	11
Working patterns adapted to the situation (when hauling up or paying out the lines, and boat speed)	11
Installation of safety devices around the boat’s circumference	9
Adequate layout of working areas	7
Avoidance of stacking the traps high, and securing them	6
When shifting trawls, during regular fishing, always using the trap support to drop them	4
Others: cleat to tie up the lines, sobriety, etc.	9

Improvement of the design of trap supports (table or washboard) is felt to be key in controlling how the rope is arranged, while ensuring that the traps are stable when seas are rough. When weather conditions are difficult, fishers will significantly reduce vessel speed to help manoeuvres, while adjusting the work pace of the crew.

Around the circumference of the vessel, fishers would like the bulwark height to be designed to provide enough support to avoid going overboard, while ensuring that the traps can be easily handled[26] when they haul them up and when they drop them. Some favour the idea of installing a guardrail to reduce the risks of accidental falls, notably in areas where there are not many tasks carried out above the bulwark.

A tidy arrangement of gear on the deck is regarded in a positive light to facilitate movement. It then follows that everything must be well secured to avoid crew members being struck by an object in movement.

Finally, when trawls are shifted during the regular fishing, some fishers advise placing the string of traps on the rail or the washboard, as if they had just been hauled up, before setting them back in the water.

We thus note two major categories of actions in preventing the risk of falling overboard that are related to the normal aspects of work on a boat. One category consists of the actions related to human behaviour and that require decisions to be made by members of the crew and cooperation among them: communication, work methods, teamwork and work pace. The other consists of actions that depend on the material or equipment available to catch a maximum amount of lobsters safely every day.

3.6.2. Preventive Measures According to the Analysis of the Activities of Participating Fishers During Validation

Other preventive measures were identified by captains and deckhands during the interview carried out by using a detailed descriptive file of their fishing activities. This information was completed by images recorded during outings at sea and everything was corroborated by the participating fishers. As before, we will first present the activity deemed by fishers to be the most risky followed by those that are less risky.

Opening of the Fishing Season

As previously noted, the risk of falling overboard is greatest at the opening of the fishing season. With that in mind, the Association des pêcheurs des Îles-de-la-Madeleine came up with a different way of doing things to reduce some of the safety risks associated with competition and bad weather on the first day of the fishing season. Following a particularly tense situation that

[26] It bears repeating that traps weigh from 36 to 45 kg. The bulwark height is a determining factor, not only for preventing falls overboard, but for limiting awkward postures and optimizing the forces in play by the muscles in the back and the upper limbs when the traps are being handled. These traps are heavy and even more difficult to handle on a wet moving surface.

occurred in some fishing ports, the Association and the Department of Fisheries and Oceans (DFO) drew up a weather condition monitoring protocol. The acceptable wind strength limit was established at less than 25 knots. Environment Canada's marine forecasts for the areas adjacent to the archipelago are monitored by DFO from the Thursday morning before the anticipated season opening on Saturday. When wind strength is above that limit, the situation is reviewed during the daily broadcasts of the forecast, at 10:00 a.m. and again at 3:30 p.m. Notices are broadcast over the local radio station, CFIM. If, on Friday at 3:30 p.m., the forecast for Saturday morning is still 25 knots or more, a notice is broadcast to the effect that the beginning of the fishing season will be delayed, with information on the process that will be followed. The protocol is included in the *Integrated Fisheries Management Plan: Lobster Fishing Area 22 from 2010 until 2014* (Fisheries and Oceans Canada, 2013).[27]

With regard to the three work situations that were previously analyzed, the strategies are identifiable and are presented below.

[27] http://www.qc.dfo-mpo.gc.ca/publications/documents/PGIP%20homard%2022%202010-2014_%2020140729_ENG.pdf — See Appendix 7, entitled *Weather Condition Monitoring Protocol*, updated May 23, 2013. Website consulted on February 10, 2014.

Loading Traps

The arrangement of the traps, lines and buoys onboard is extremely important, to ensure that the lines will pay out without risk when the trawls are being set. Fishers are unanimous in agreeing that the deckhand must be in charge of this, although the general supervision is the responsibility of the captain. The goal is to have complete knowledge of the load to be dropped. If necessary, extra people are hired to carry out the associated tasks on the wharf. Correct arrangement of the rope on the deck and with respect to the traps is imperative to avoid the risks of being dragged in. Three different methods were observed: 1) the rope is coiled, and the coils are placed inside or between the traps; 2) the rope is coiled and left more or less free on the deck and pushed up against the bulwark, either port or starboard; 3) the rope is placed under the rows of traps over the width of the cargo, but this technique is rarely used now. The rope must be coiled in the same direction that its strands are twisted to avoid the formation of loops that could cause members of the crew to get their feet caught in them.

The way the buoys are stored is another preventive measure identified to reduce potential entanglement. Some fishers place the buoys, generally two in number, inside the last trap on a trawl. They can be attached two by two to make them easier to find, in the planned order they will be set. The buoys can also be placed on top of the load to make them easier to find and to handle.

Systematically arranging the traps in a predetermined order facilitates work and reduces the risk of being dragged overboard. Captains must adapt the height of the loads of traps according to weather conditions and to enable them to see the deckhands working on the deck. The crew must secure the columns of stacked traps to avoid movement that could harm them or cause them to lose their balance.

Travelling from the Wharf to the Fishing Area

Fishers recommend that the deckhands be in the wheelhouse when steaming to the fishing grounds. Travel duration, weather and lack of space in the cabin are factors to consider. Deckhands travelling astern must support themselves on the bulwark or the washboard by firmly holding onto the load, which is itself ballasted. Once they arrive at the fishing ground, the captain must stop and position the boat to minimize movement to make it easier for the deckhand to move between the wheelhouse and the workstation to begin dropping traps. Deckhands must keep their centre of gravity as low as possible (“on all fours”) holding on to a restraint cable or the straps holding down the load of traps.

Setting the Traps

In this situation, it is advisable to reduce the speed of the lobster boat and to adapt the work pace to the environmental conditions. Having a large enough clear area on the deck is essential in making the deckhand's work easier. For this critical time of the year, hiring a second deckhand is a solution that is applied or envisaged by many captains.

Regular Fishing

Resetting the Traps

Fishers consider this activity to be only moderately risky, despite the fact that they must deal repeatedly with gear that could drag them overboard, such as the rope and the traps. In addition, the boat's propulsion and the movements of the sea increase the risks because of the powerful energy in play. The crew must therefore adapt their behaviour correspondingly and use the appropriate equipment.

Numerous preventive measures are suggested. The first buoy and its rope must be placed away from the deckhand's feet. The location depends on the design of the boat and the work method that has been agreed upon between the captain and the deckhand. Ideally, the fisher will place the rope (the main line and the leaders (segments of shorter rope that link each trap to the trawl) on the table that supports the traps. Fairleads to guide and hold the rope may be provided. As well, the addition of a line bin mounted along the washboard or table will help to guide the rope and to raise it above the deck, keeping it out of the way of the fishers' feet. If the rope cannot be raised up off the deck, it is possible to line it up, under the washboard or the table, as long as the legs of the table are slanted towards the bulwark. In that case, laying a rubber mat near the washboard would reduce the possibility of the rope moving with the spray or waves splashing through the freeing ports.[28] The fishers' feet should be kept a good distance from the rope and constant attention must be paid. Like the first day of the fishing season, boat speed should be reduced when the trawl is dropped. In addition, fishers must not rush this job, as it is not a task that takes up much time in the entire fishing day. Another caution formulated by fishers is to avoid wearing clothing (rain slickers, gloves, PFD) or carrying equipment (measuring gauge, knife) that could get caught in the ropes or the traps. Finally it is recommended to always place the traps securely on the washboard or the table before dropping them.

Shifting the Trawls in the Fishing Area

This is another activity that fishers consider to be moderately risky in terms of falling overboard. The risk comes from the fact that one or several trawls of traps are hauled up and placed on deck while moving to another fishing ground. At the same time, the working space on the deck is full of other pieces of equipment such as the banding table (for putting the elastic bands around the lobster claws), the live tank, the bait trays, garbage can, and of course the table for the traps. At that moment there is not much space and the set-up is different than that normally observed. The crew must deal with all these obstructions and adjust their working practices.

[28] The freeing ports may be equipped with valves or check valves. The *Small Fishing Vessel Inspection Regulations* sets out the requirements regarding freeing ports (section 29.1).

Some preventive measures have been suggested by the crews. First off, this task must not be carried out during bad weather, which is often forecast by weather alerts. Next, only the number of trawls that fit the space available on the deck of the boat should be brought aboard. The crew must develop a way of arranging the lines to keep them away from their feet (placing the rope along the sides of the boat or under the traps. Ideally the traps and the rope should be placed on the washboard or the table, in the same way as when they are usually set.

Loading the Traps from the Wharf

According to the fishers, the risk of falling overboard is relatively low at this stage because the boat is moored at the wharf. In the Magdalen Islands, it is common practice to have the stern flush against the wharf. The small tidal range in this region makes this practice feasible. In the Gaspé, fishers instead moor their vessels to the side, parallel to the wharf, because the tidal range is greater. Fishers must therefore ensure that the vessel is tied up as close as possible to the wharf to ensure the traps may be loaded safely. If fishers have to get off the boat onto the wharf and vice versa, it could help to have the washboard covered with non-skid material. Other fishers put a stepladder near the bulwark as a stairway and to make it easier to keep their balance.

Hauling the Traps (Trawls)

The respondents view this situation as holding less risk of fishers falling overboard, although it entails several operations to carry it out properly. Therefore, several good practices are suggested by fishers to reduce the potential risks of falling overboard during this step.

The first step is hooking the trawl. Captains must ensure that they have slowed down the boat and positioned it correctly to help snare the buoy using the gaff, or more rarely, manually. The goal is to reduce the tension on the buoy rope. Deckhands must have an appropriately sized gaff for the size of the boat in order to catch the buoy without having to reach too far over the rail. At any time, if the tension increases above a certain threshold, deckhands must let go of the gaff to avoid being pulled overboard. A good option would be to use the hauler to support themselves or to hang on to in case they lose their balance. Some fishers advocate the design of a new flexible and buoyant model of gaff.

The second step consists of hauling in the traps. If there is too much tension (from lines that are snagged, tangled, or have been swept under the hull), fishers recommend working in teams of two and using a knife if necessary to cut the line and then splicing it. This method would limit the amount of time of having to work leaning over the bulwark, a position that should be avoided. Fishers should anchor their feet solidly on a rubber mat and avoid stepping on the rope. Ideally, having a kill switch for remote engine shut off installed near the hauler would be an asset, to be able to react rapidly. The hauler is used as an additional support to hang on to and it would be even more effective if the bulwark were of a safe and practical height. If the lines are taut, fishers recommend jamming the rope between the sheaves of the hauler, or even better, using a cleat to attach it until the problem is resolved. In order to avoid an accidental manoeuvre, the hydraulic control of the hauler should be protected. Overall, the layout of the area around the hauler should

be designed to reduce the probability of the rope deviating from its proper course when the trawls are being dropped. Once the traps are on board, they must be kept in place no matter the weather conditions. To ensure this, the support (table and/or washboard) should be tilted towards the interior of the boat and anti-slip material should be added, as long as it enables easy handling of the traps, which are quite heavy to move.

Regular Fishing: Handling the Catch

In order to lower the risk of falling overboard it is recommended that equipment, such as the sorting table and the live tank, be set up in the medial axis of the vessel, to keep the crew away from the bulwark and the other areas where the rope is stored before the traps are reset. All equipment must be anchored or attached, or placed on anti-slip surfaces. The working area must be kept clean by periodically eliminating all debris (lubricants, seaweed, fish) that falls on the deck.

Regular Fishing: Baiting the Traps

During this operation, the traps must be kept immobile through various means. Adding a table to the washboard or enlarging it and tilting it towards the medial axis of the boat are suggestions, as is using anti-slip material.

Regular Fishing: Cleaning the Deck

When the weather is bad, it is better to wait until the vessel gets back to the wharf to clean the deck or, if possible, to clean it in coastal areas where the sea is calmer. A hose or a pail is recommended when the boat is moving at a moderate speed. Slowing the vessel will avoid it pounding and the deckhands losing their balance. At all times, visual contact must be established between the captain and the deckhand.

4. DISCUSSION

This study highlighted and delineated the work situations during lobster fishing associated with a risk of falling overboard. It is the first study of its kind to be carried out in Québec and Canada. Six work situations were studied: three at the opening of the fishing season (loading the traps, traveling from the wharf to the fishing area, and setting the traps) and three others during regular fishing (hauling the traps, shifting trawls in the fishing area and resetting the traps). An understanding of the fishing activity was gradually acquired, starting with an analysis of the responses to the two questionnaires administered through semistructured interviews, observations at sea and discussions with the fishers during the validation meetings.

The initial setting of traps is the riskiest situation, although it is infrequent, occurring only once during the fishing season. The other two situations considered as having the highest risk are during the "regular" fishing season when the traps are dropped from the table that supports the traps or directly from the deck when the trawls are shifted within a fishing area. For these work situations, the main risk factors are the weather conditions, the attitudes and behaviours of the workers (including their state of fitness) and the work methods. A crew may set up to 40 trawls every day during the regular fishing season (approximately 40 trawls containing 7 to 10 traps each), while the frequency the traps are dropped when trawls are shifted is variable, but can be high. The deck and workstation set-ups that could prevent falls overboard are not the same for these three situations, a fact that changes some of the factors and puts new ones into play.

Backus et al., (2000), specifically studied the risk of being dragged by the lines, which causes falls overboard among lobster fishers in the state of Maine. These authors determined that the following four work situations could be at cause: (1) snaring the buoy; (2) disentangling a trawl line set on top of another one; (3) baiting the traps and dropping them in the water; (4) shifting the lines within a fishing area. There is no mention of the opening of the fishing season. Canadian fishing license regulations lead to a particular circumstance that generates competition when the traps are initially set, creating a situation that incites fishers to get to the best fishing areas first. These activities were documented in our study and placed in perspective with the identified situations, including a solution that applies to fishers of one region: postponing the first day of the season when the weather is bad. That solution was adopted by consensus between the members of a fishing association in one region and representatives of the Department of Fisheries and Oceans Canada.

In the Backus et al. study, Maine fishers perceived the riskiest situations as setting the traps (82%), and shifting them from one area to another (68%), which corresponds to our results, in which the two activities are found in the top three rankings of perception of risk level by fishers (we differentiated between the initial setting of traps at the season opening and that carried out during regular fishing).

With respect to assessment of risk levels, risk analysis experts realize that this type of evaluation is very difficult because of its highly subjective character and the influence of individual and collective cultures. In this study, there were two additional difficulties: fear of the potential impacts of the study, and a strong tendency to evaluate risk situations according to the respondent's specific situation instead of according to these situations in general. To understand

the first difficulty, it is important to note that the roles and responsibilities of regulatory agencies in the fishing industry have changed over the past years. At the time of the semi-structured interviews, new actors in prevention had begun to intervene and new requirements with respect to equipment and layouts had been established, but they were poorly accepted by fishers. The interviewers noted that many respondents feared that the results of this study would be translated into new demands by regulatory agencies. The impact of risk factors was therefore probably underrated by the participants.

The researchers wanted the respondents to use their knowledge and experience to assess the importance of various factors according to their perception of the situation in general. For instance, that a deckhand would assess the importance of the "captain's attitude" factor in general and not the attitude of their own captain. However, the respondents found it very difficult to assess the factors this way. Their first inclination was to assess them as they applied to their own particular situation. When the interviewers insisted that they make broader generalizations, they often obtained responses such as "our work methods are safe and I would give them rating of one, but if I look at all the fishers I'd give them five." In such cases, the interviewers gave the factor a rating of five. However, in a number of cases, it was impossible to refine the responses to that point. It would have required much more time to get the respondents to "extract" themselves from their own circumstances and to consider all the fishing situations. Generally, the respondents tended to consider their own situation as being much safer than that of other fishers. Backus et al. (2011), also noted the same kind of approach to assessing risk levels in a second perception study carried out with the crews of 259 fishing boats. There was a strong tendency among the captains consulted of attributing risky behaviour to captains who do not pay attention, while considering themselves to be at low risk.

Given these difficulties, we can hypothesize that, if we could have dispelled the respondents' fears regarding the impact of this study and helped them to detach themselves from their own situation, the ratings would have been higher. However, we believe that the order of factors, and consequently, their relative importance, would not have changed.

Our classification of risk factors into four major categories is based not only on the semi-structured interviews, but also on the observations and the validation meetings. That classification is as follows: (1) factors associated with activities related to managing rope and work methods (two factors); (2) the weather and fishery management measures; (3) the factors related to workers (attitudes and experience, four factors); (4) the factors related to the layout of the vessel, the wharf and fittings (12 factors).

In total, the fishers reported 50 incident scenarios. They were analyzed in order to identify the circumstances, to understand how the events occurred and the main factors that contributed to their occurrence. Because of the significant variability in how detailed the descriptions obtained were (for example: "there was a guy who got caught in the rope and got dragged overboard"), it was impossible to use a systematic analysis grid (such as a root cause analysis tree diagram). The analyses of a qualitative nature mainly aimed to better understand the scenarios reported or presumed in the accident reports and to identify some that did not appear in the literature or in discussions with people involved in accident prevention (such as in the following example: "the

buoy rope was caught up in the rudder and the boat veered sideways. The gaff went behind his back and pushed him in the water.") The questions did not specify that the respondent should provide an approximate time period (such as in the past year), which meant that, first and foremost, the scenarios are quite clear about the various possible contexts, but less so in terms of the probabilities of occurrence related to their frequency.

Our study identifies the principal approaches that could help prevent falls overboard. They can be divided into two areas:

1. Transferring the knowledge gained from the research to assist workers (raising awareness, training and the transfer of experiential and preventive knowledge);

The respondents identified ten prevention strategies. Among them, five have to do with work methods and cohesion among the crew. Validation meetings using videos to show various fishing contexts resulted in fruitful discussions among the fishers on ways of working and preventing falls overboard. It is important to note that, thanks to the videos, this was not only the first time that all the participants were able to see themselves working, but they were also able to see other fishers in action. The videos sparked debate and led to an analysis of the choices or compromises they must make to ensure they are working as safely as possible. The results of this study provide a wealth of new material that could be disseminated and used to support training or awareness-raising activities. Activities to transfer the knowledge acquired are envisaged with members of the follow-up committee and representatives from training schools in the fisheries sector.

2. Action in terms of setting up the "hauler and trap support table" workstations.

Four other prevention strategies identified by the fishers were related to material aspects, with regard to layout: traction on the deck, set-up of the table or washboard, bulwark height in addition to safety devices along the circumference of the vessel, adequate layout of the working areas. In this study, the workstations were not analyzed systematically or in a detailed manner. However, during visits to various wharfs, certain workstation set-ups were photographed. The analyses from existing databanks also enabled us to identify a number of characteristics of the lobster fishing fleet for two of the three regions where lobsters are harvested in Québec.

It should be noted that the NIOSH research on safety risks related to lobster fishing gear (mainly rope) in Maine (NIOSH 2005; Backus et coll., 2001) led to suggestions for set-ups or equipment that would (1) keep the deck clear of loose lines by adding equipment (line lockers to capture the line, line bins, upright poles (fairleads) drilled through the washboard or rail to "lead" line out of the boat); (2) help deckhands free themselves if they become entangled in line. Our research concentrated on understanding the risks of falls overboard (in order to prevent them) and not on the ways of dealing with them after they have occurred. As the NIOSH publication dates from 2005, we contacted the authors to find out if there had been any follow-up or if they had any feedback from the advice given to fishers, but there was none. Therefore, we do not know whether these solutions were conclusive and we were unable to obtain details about the characteristics of the boats that may have successfully implemented the measures.

The research results provide indispensable information to pursue reflection on how the “hauler and the trap support table” workstations are set up. The layout of these two workstations has an impact on effort, postures and the risk of falling, primarily because it determines how the rope is managed. More research is needed to develop design and layout parameters for these workstations and the traffic areas around them.

CONCLUSION

This research project took place over one year and covered the fishing season of the summer of 2012. It is the first stage in targeting preventive actions in Québec's lobster fishing sector. To that end, the study addressed the specificities of Québec's lobster fishing industry: the fleet, the structures and organizations involved, the characteristics of the workers, the real activities of work at the opening of the season and during regular fishing, work methods, etc. One of the challenges is to take into account the variability of the factors determining the activity and the risks, especially the characteristics of the vessels, the equipment, the workforce, the environment (variable weather conditions), the fishing areas and the work methods.

Data gathering and the relationships that it enabled us to establish with the fishers and the various institutional actors in the fishing industry throughout the project gave the researchers a better understanding of the prevalent culture in the industry and its influence on risk management measures. The further phases of this study that have been planned to continue implementing prevention activities could be built on this knowledge.

The research shows that the main approaches to preventing falls overboard are two-pronged. The first is that of transferring the knowledge gained from the research to assist the workers (raising awareness, training and transfer of experiential and preventive knowledge). This study provided information and visual material (videos and photos) that could be used to enlighten, raise awareness and, ideally, train experienced and novice fishers alike. The second deals with activities respecting the layout of the "hauler and trap support table" workstation. The researchers suggest that this avenue should be the subject of the next stage of research.

The possible approaches and the means of prevention that the researchers perceived as practicable were validated by the participants during our meetings. Possible approaches to improve safety were discussed during exchanges with the follow-up committee. Thus, the subsequent phases of the study will have solid foundations, ensuring the relevance and applicability of the results. Nonetheless, carrying out this study has shown us that a participatory approach and concerted efforts with respect to the social construct are required and will always be important in order for the conclusions of the research and the results of future studies to have a genuine impact on fishers and their representatives, with respect to means of preventing falls overboard.

To conclude, it should be noted that this study is original in the sense that in its risk analyses it incorporates currently used and potentially applicable prevention strategies and methods, with respect to the general ergonomic framework. The realization of this study mobilized two types of expertise: that of the researchers in risk analysis and fishing, and that of fishers as experts in managing risk on a daily basis.

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Appendix 1 – List of Documents Drafted for the Research and Reviewed by the Université Laval Research Ethics Committee

1	Recruitment announcement published in the *Pêche Impact* newsletter, spring 2012.
2	Recruitment announcement poster
3	Information leaflet for fishers and deckhands participating in the general component of the research
4	Information leaflet for fishers and deckhands participating in the specific component of the research
5	Written consent form for fishers and deckhands, for their participation in the general risk perception questionnaire
6	Information leaflet for deckhands, for their participation in the specific component of the research—verbal consent
7	Written consent form for fishers and deckhands, for their participation in an individual interview, including a general perception questionnaire and a questionnaire to describe the work on board lobster boats
8	Written consent form for fishers and deckhands, for their participation in observation sessions of real work situations on board lobster boats
9	Specific written consent form for fishers and deckhands, for the diffusion of images from video recordings
10	Written consent form for fishers and deckhands, for their participation in collective interviews to validate the results
11	Written consent form for fishers and deckhands, for the diffusion of images seen during the collective validation interviews
12	General risk perception questionnaire
12	Simplified descriptive questionnaire
14	Observation sheet
15	Collective interview guide for the validation meetings

Appendix 2 – Consent Form for Fishers and Deckhands

General Risk Perception Questionnaire

Researchers

This research, funded by the Institut de recherche Robert Sauvé en santé et sécurité du travail (IRSST), is a joint effort by MERINOV and Université Laval. The two chief researchers are **Francis Coulombe,** from MERINOV, and **Sylvie Montreuil,** from Université Laval. The project was approved by the Université Laval research ethics committee: Approval no. 2011-306/30-01-2012.

Before agreeing to participate in this research project, please take the time to read and understand the following information. This document explains the goals of the research project, its activities, and the advantages, risks and drawbacks of participation. Please feel free to ask the person who provides you with this document any questions you may have.

Nature of the Study

The goal of the research is to better understand the work performed aboard Québec lobster boats in order to prevent lobster fishers from falling overboard. Specifically, it aims to analyze the activities and the risks of falling overboard and their determining factors; to document collective and individual means of prevention that could be adapted to lobster boats; and to identify the most promising avenues for reducing risk.

Participation

Your participation in this study consists of completing a 30 to 40 minute-long questionnaire on risk perception and identification of accident scenarios, which includes the following:

- Elements involved in the perception of the risks of work on lobster boats
- Possible accident scenarios
- Possible causes of these accidents
- Means used to minimize these risks and possible solutions.

Advantages, risks or drawbacks related to your participation

Participating in this research will give you the opportunity to think about the risks of falling overboard while working on a lobster boat, and to suggest means of prevention. Your input will help advance health and safety issues on fishing boats. Your participation will assist the researchers and organizations involved in identifying risk factors and suggesting solutions that will help prevent accidents on lobster boats.
There is no known risk in participating in the research, especially since the confidentiality of the data gathered is guaranteed.

Voluntary participation and right to withdraw

You are free to decide whether or not you wish to participate in this research project. No financial compensation will be provided for completing the questionnaire. You may withdraw from the project with no adverse consequences or prejudice and without having to state your reasons for doing so. However, if you decide to withdraw, it is important to inform the researcher, whose contact information is included in this document. All personal information pertaining to you will then be promptly destroyed.

Confidentiality and data management

The following measures will be applied to ensure the confidentiality of the information provided by the participants:

- The participants' names will not appear in any report;
- The various research documents will be coded and only the researchers will have access to the list of names and the codes;
- The electronic files will be protected by a password;

- The individual results of the participants will never be communicated;
- The research material, including the data and information, will be kept under lock and key in a site accessible to the research team only. All the material will be destroyed five years after the end of the research.
- The research will be published in scientific journals, and it will not be possible to identify or recognize any participant;
- A short summary of the research results will be sent to participants who make the request by providing the address where they wish the document to be sent, in the space provided just after their signature.

Additional Information

If you have any questions about the research or the implications of your participation, please contact Ms. Sylvie Montreuil, researcher, at the following telephone number: (418) 656-2131 extension 2800, or at the following email address: sylvie.montreuil@rlt.ulaval.ca, or Francis Coulombe at (418) 368-7666, or the following email address: francis.coulombe@merinov.ca.

Acknowledgement

We greatly appreciate your invaluable cooperation in this study, and we thank you for your participation.

Signatures

I, the undersigned _____freely consent to participate in the research questionnaire entitled ***Overboard Falls of Crew Members on Québec Lobster Boats: Risk Analysis and Prevention Solutions: phase 1***. I have read the form and I understand the goal, the nature, and the advantages, risks and drawbacks of the research project. I am satisfied with the explanations, clarifications and responses provided by the researcher (if applicable), with respect to my participation in this project.

_____ _____

Participant's signature Date

A short summary of the results of the research will be sent to participants who request it by providing a forwarding address. **The results will not be available before March 1, 2013. If there is a change of address before then, you are asked to provide your new address.**

Please use the following address (email or regular mail) to provide me with a short summary of the research results:

_____

_____

_____

A second phase of this project may be initiated in the next 5 years, based on the results of this research. Could we keep your contact information to contact you when we initiate phase 2? Check off your choice below.

Yes, someone may contact me again to request my participation in phase 2 of the project _____

No, I do not wish to be contacted again. _____

If you answered YES, please tell us how you wish to be contacted:_____

_____

I explained the goal, the nature, and the advantages, risks and drawbacks of the research project to the participant. I responded to the questions asked to the best of my knowledge and I verified that the participant understood.

_____ _____

Researcher's signature Date

Complaints or criticisms

All complaints about or criticisms of this research project may be addressed to the office of the ombudsman of Université Laval:
Pavillon Alphonse-Desjardins, bureau 3320
2325, rue de l'Université
Université Laval
Québec, Québec G1V 0A6
Toll free: 1-866-323-2271
Email: info@ombudsman.ulaval.ca

Participant's copy

Appendix 3 – General Risk Perception Questionnaire

Information about the respondent

Male ☐ Female ☐ Age: _____

Experience 1 – Number of years: _____ Occupation: Fisher ☐ Deckhand ☐ Vessel category[29] 1 _____

Experience 2 - Number of years: _____ Occupation: Fisher ☐ Deckhand ☐
Vessel category 2 _____

Main fishing area (home port): _____

Type of traps: Metal: ☐ Wood: ☐ Total number: _____ Number by trawl: _____

Past experience with respect to falls overboard

Have you ever fallen overboard? Yes ☐ No ☐
If yes, how many times? _____

If yes, describe the circumstances of the accident(s):_____

_____

_____

_____

_____

_____

_____

29 Refer to the list drawn up by M.T. for the project. Note G + No. or I = Number to identify the location (Gaspé or the Magdalen Islands)

Past experience with respect to falls overboard (continued)

Have you ever come close to falling overboard? Yes ☐ No ☐
If yes, how many times? _____

If yes, describe the circumstances of the accident(s): _____

_____

_____

_____

_____

_____

Do you know anyone who either fell overboard or who came close to falling overboard? Yes ☐ No ☐

If yes, how many times? _____

If yes, describe the circumstances of the accident(s): _____

_____

_____

_____

_____

_____

Perception of the risks of falling overboard according to fishing activity (for all vessels)

Based on your own experience, we ask you to assess, on a scale of 1 to 10, the level of risk of falling overboard in the following fishing situations.

- A rating of 1 means that you believe that there is a **low** risk of a fall overboard
- A rating of 10 means that you believe that there is a **high** risk of a fall overboard

	Situations	Rating from 1 to 10	Don't know	Explanations—comments
1	Opening of the fishing season—Loading traps from the wharf			
2	Opening of the fishing season—When traveling to the fishing area			
3	Opening of the fishing season—During the initial setting of traps			
4	Regular fishing—When traps are hauled up			
5	Regular fishing—When traps are reset			
6	Regular fishing—When traps must be shifted within the fishing area (following the lobsters, storms, etc.)			
7	Other situations			

Perception of the causes of falling overboard (for all vessels)

On a scale of 1 to 10, assess the impact of the following factors on the probability of falls overboard while lobster fishing.

- A rating of 1 means that, for you, this factor has no impact on the probability that a fall overboard could occur.
- A rating of 10 means that, for you, this factor has a major impact (it greatly increases the risk of falling overboard)

	Factors	Rating from 1 to 10	Don't know	Explanations—comments
1	Layout of the wharf			
2	Weather conditions			
3	Seaworthiness of the vessel			
4	Vessel layout: work areas, traffic areas, etc.			
5	Washboard height			
6	Washboard width			
7	Deck condition: traction/cleanliness			
8	Deck condition: clutter, loose objects (risk of being struck by them)			
9	Hauler: location			
10	Hauler: condition and how it works			

Perception of the causes of falling overboard (continued) (for all boats)

On a scale of 1 to 10, assess the impact of the following factors on the probability of falls overboard during lobster fishing.

- A rating of 1 means that, for you, the factor has no impact on the probability of falling overboard
- A rating of 10 means that, for you, the factor has a significant impact (it greatly increases the probability of a fall overboard)

	Factors	Rating from 1 to 10	Don't know	Explanations—comments
11	Arrangement and management of the lines			
12	Traps: weight, shape, condition (broken or not)			
13	Equipment available or used (hook-gaff, gloves, etc.)			
14	Access to a toilet			
15	Work methods			
16	**Captain**: experience			
17	**Captain**: attitude, behaviour			
18	**Deckhand**: experience			
19	**Deckhand**: attitude, behaviour			
20	Other factors:			

Means of preventing falls overboard

Please describe how you prevent falls overboard now. What are the advantages? If relevant, do you see any drawbacks?

Do you know other means of preventing falls overboard? If yes, please describe and detail their advantages and drawbacks.

May we contact you in the future if we require more information for the research? Yes ☐ No ☐

If yes, how can we reach you?

Appendix 4 – Simplified Descriptive Questionnaire

Question no.: _____
Completed by: _____
On (date): _____

Section 1: Information about the respondents

Fisher

Male ☐ Female ☐ Age: _____

Number of years of experience: As a fisher _____ As a deckhand _____

Comments: _____

Deckhand # 1

Male ☐ Female ☐ Age: _____

Number of years of experience: As a deckhand _____ On this boat _____

Comments: _____

Deckhand # 2

Male ☐ Female ☐ Age: _____

Number of years of experience: As a deckhand _____ On this boat _____

Comments: _____

Section 2: Information about the fishery

Fishing area/Home port

_____

Maximum distance from shore _____ Average depth _____

Minimum distance from shore _____ Average depth _____

Total number of traps _____ Type of traps _____

Minimum weight of a trap _____ Maximum weight of a trap _____
Number of trawls _____ Number of traps on a trawl _____

Number of voyages required for initial trap setting _____

Duration of a regular voyage: Minimum time _____ Maximum time _____

Comments: _____

_____

_____

Section 3: Information about equipment

Year of purchase by current owner _____ Vessel category _____

Adjustments or changes made to lessen the risk of falls and/or to make work easier: _____

_____

_____

_____

_____

_____

_____

Comments: _____

_____

_____

_____

_____

_____

_____

_____

Section 4: Planning for fishing activity observations

Is it possible for you to accommodate an observer on your boat when you first set traps?

Yes ☐ No ☐ If yes, where should the observer be positioned? _____

If not, could we install a fixed camera? _____

Camera installation: Where? _____

Camera installation: When? _____

Camera installation: How? _____

During regular fishing, where can the scientific team's observer be positioned? _____

_____

What rules must the observer respect so as not to interfere with activities?[30]

_____

_____

_____

_____

_____

What rules must the observer respect to ensure his/her own safety and that of the fishers?

_____

_____

30 Note to researchers: Here, the importance of being able to observe the real work activity must be kept in mind, and therefore, it is important that the observer not interfere with the activities in any way.

Section 5: Description of working activities

Using the following tables, please describe the activities of each crew member for each task to be performed. If relevant, detail the risks of falling overboard, and the possible difficulties and malfunctions.

Tasks	Activities			Risks Difficulties Malfunctions
	Fisher	Deckhand # 1	Deckhand # 2	
SEASON OPENING— Loading the traps				
SEASON OPENING— Traveling from the wharf to the fishing area				

Tasks	Activities			Risks Difficulties Malfunctions
	Fisher	Deckhand # 1	Deckhand # 2	
SEASON OPENING— Setting the traps				
REGULAR FISHING— Hauling the traps				

Tasks	Activities			Risks Difficulties Malfunctions
	Fisher	Deckhand # 1	Deckhand # 2	
REGULAR FISHING— Handling the catch				
REGULAR FISHING— Replacing bait				
REGULAR FISHING— Resetting the traps				

Tasks	Activities			Risks Difficulties Malfunctions
	Fisher	Deckhand # 1	Deckhand # 2	
Related task # 1				
Related task # 2				
Dealing with the unexpected **Such as "moving the traps because of a storm"**				

Appendix 5 – Information About the Lobster Fishery Fleet

A- Description of Vessels

Québec's lobster fishery fleet can be divided into three major categories of vessel. The motorization of the fishing fleet led to the development of coastal vessels mainly used for trap fishing. Their primary characteristic is a hull that sits low on the water to facilitate handling of traps. We can still find vessels that have more or less the same characteristics and vessels that are derived from them.

Flat-bottomed skiff

An open-construction vessel, mainly of fiberglass and resin, and generally between 7 and 9.5 m long. The bottom of the hull (the keel) is flat, which gives it a shallow draught. It is powered by an outboard or semi-outboard motor. The operator generally stands, at water level, and may or may not be sheltered by a cockpit. Traps may be hauled from the front, the centre or the back.

Example of a flat-bottomed skiff

Conventional or traditional lobster boat

The design of this type of boat is based on the skiff, being also open and sitting low on the water. Traps may be hauled in from the front, the centre or the back of the boat. Fishers may also work near water level. These vessels are specifically adapted to local sea conditions. The Northumberland, a model common in Québec, was adapted to the conditions found in the waters of the strait of the same name off Prince Edward Island, which are like those of the coastal waters of the Gulf. Its bow, shaped like an inverse-ploughshare, is adapted to the short choppy waves of the Gulf, and the pronounced flare of the sides push the spray away. The other widely-used type is the Cape-Islander, originally from Nova Scotia. It is more adapted to high sea conditions, with a high and wide planing bow. Conventional lobster boats are propelled by inboard motors, coupled with propeller shafts, which drive them.

Example of a “conventional” vessel

Multipurpose vessel

Over time, because of changes made to the lifting gear and, of course, the needs of the fishers, the original hulls have been modified to adapt them to other fisheries. Other changes were then made to the afterdeck or work deck. One of the major changes made to these vessels to become more multipurpose is the addition of a hold, which results in a generally closed-deck vessel. As the fishers work farther from the water level, the freeboard is higher. Multipurpose vessels use the similar types of propulsion as conventional lobster boats.

Example of a multipurpose vessel

B) Summary of the technical characteristics of Gaspé peninsula lobster boats[31]

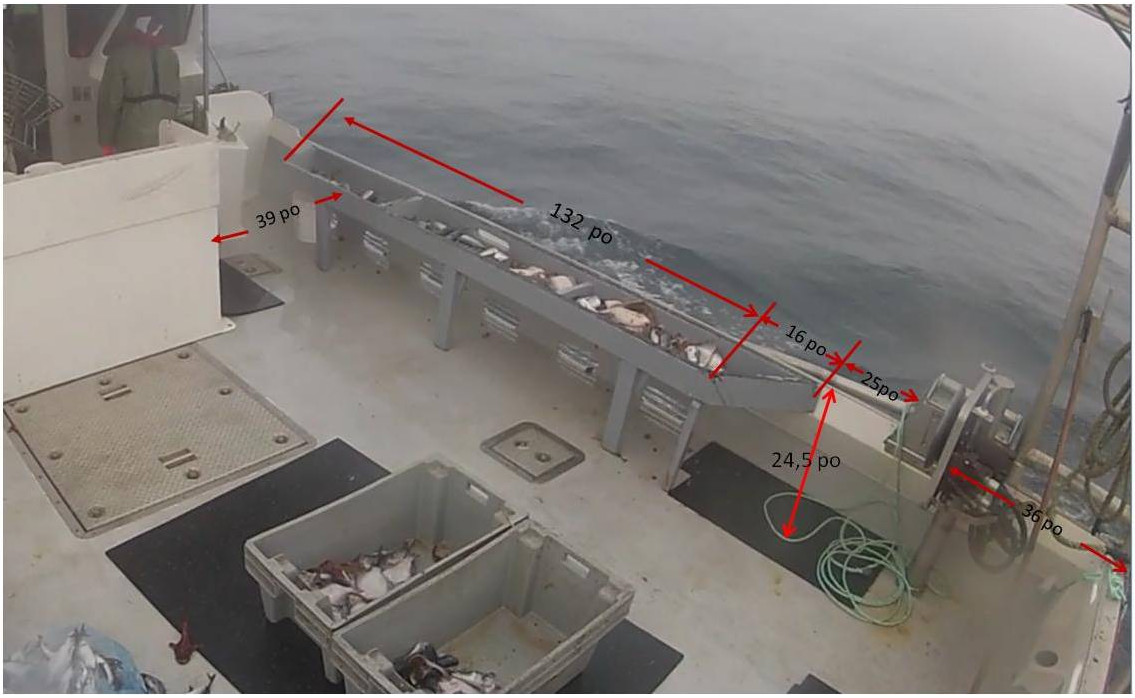
Type of vessel	Total number documented	Position of hauler on the deck						Cockpit/wheelhouse		
		Fore		Centre		Aft		Yes		No
		Port	Starboard	Port	Starboard	Port	Starboard	Fore	Aft	
Skiff (flat bottom)	134	10	53	4	2	26	19	98		17
Traditional	39	1	2	-	-	18	14	38	-	-
Multipurpose	16					12	8	16	-	-
Total	189	11	55	4	2	56	41	152		17

C) Summary of the technical characteristics of Magdalen Island lobster boats

Type of vessel	Total number documented	Position of hauler on the deck				Cockpit/wheelhouse	
		Fore		Aft			
		Port	Starboard	Port	Starboard	Fore	Aft
Traditional	N/A		1	18	188	184	26
Multipurpose	N/A						
Total	210	4 (including 3 in the centre)		206		210	

[31]This information was obtained from Merinov's existing data banks. Some information was not available (N/A), as it had not been recorded. The summation of the totals differ because some of the characteristics of the vessels were not documented, or a single vessel may be represented twice, such as with respect to the number of haulers installed on board (one to the port side, the other starboard)

D) Possible configuration of various elements on the deck of a lobster boat



Deck width = 14.3 ft.
Deck length (behind the wheelhouse) = 23 ft.
Length behind the live tank = 19 ft.
Washboard width = 8 in.
Table width = 17 in.
Table length = 154 in. (132 + 16 + 6)
Centre of hauler to side = 19 in.
Live tank = 27.5 in. X 60 in.
Hydraulic control height (hauler) = 43 in.
Height to centre of hauler sheave = 32 in.
Traps 24 in. X 31 in. X 19 in. (H)

Appendix 6 – Captains' and Deckhands' Assessment of Risk

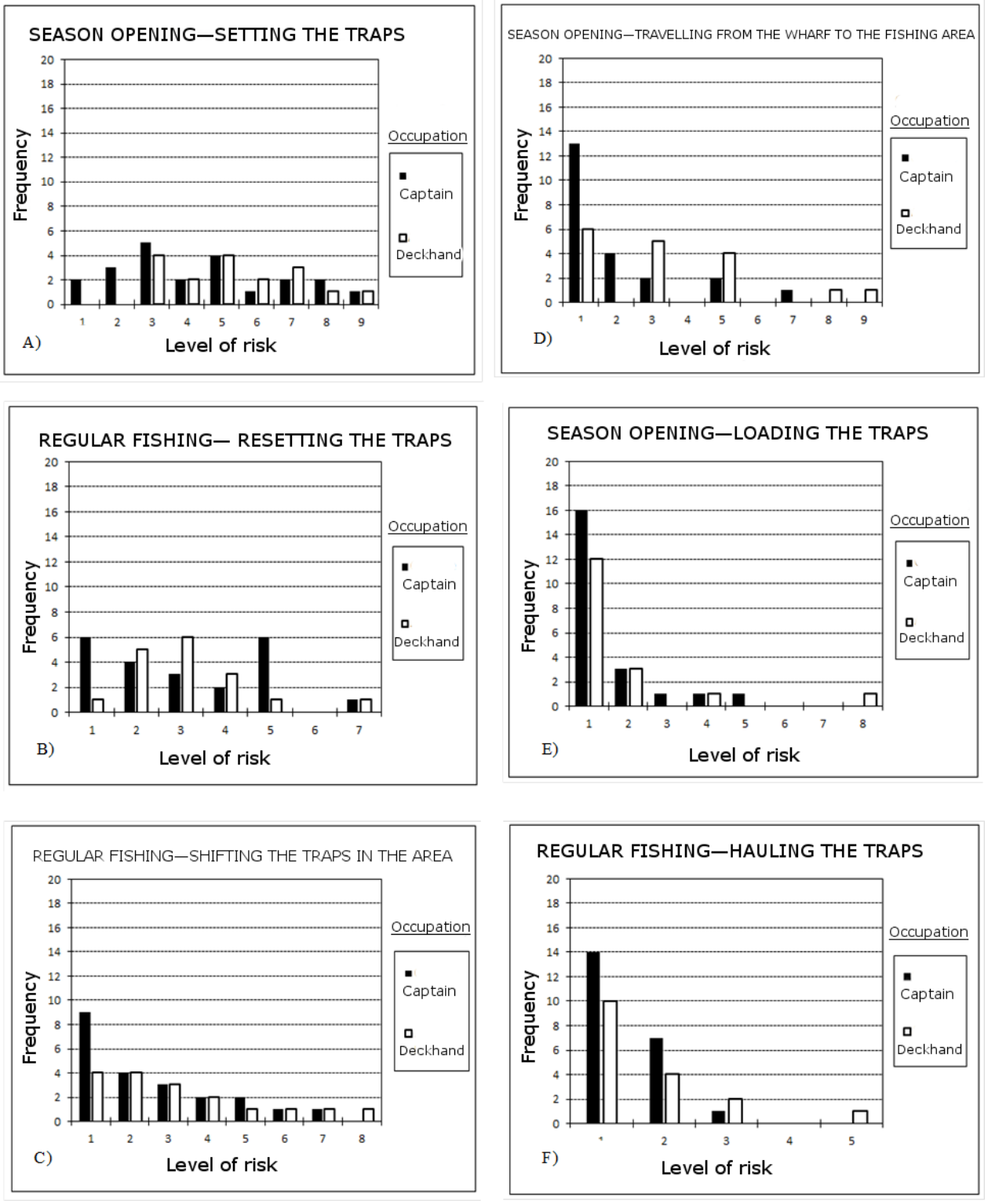


Figure 1 – Global assessment of perceived risk levels according to work situation for all captains (black bars) and deck hands (white bars) (in all regions)

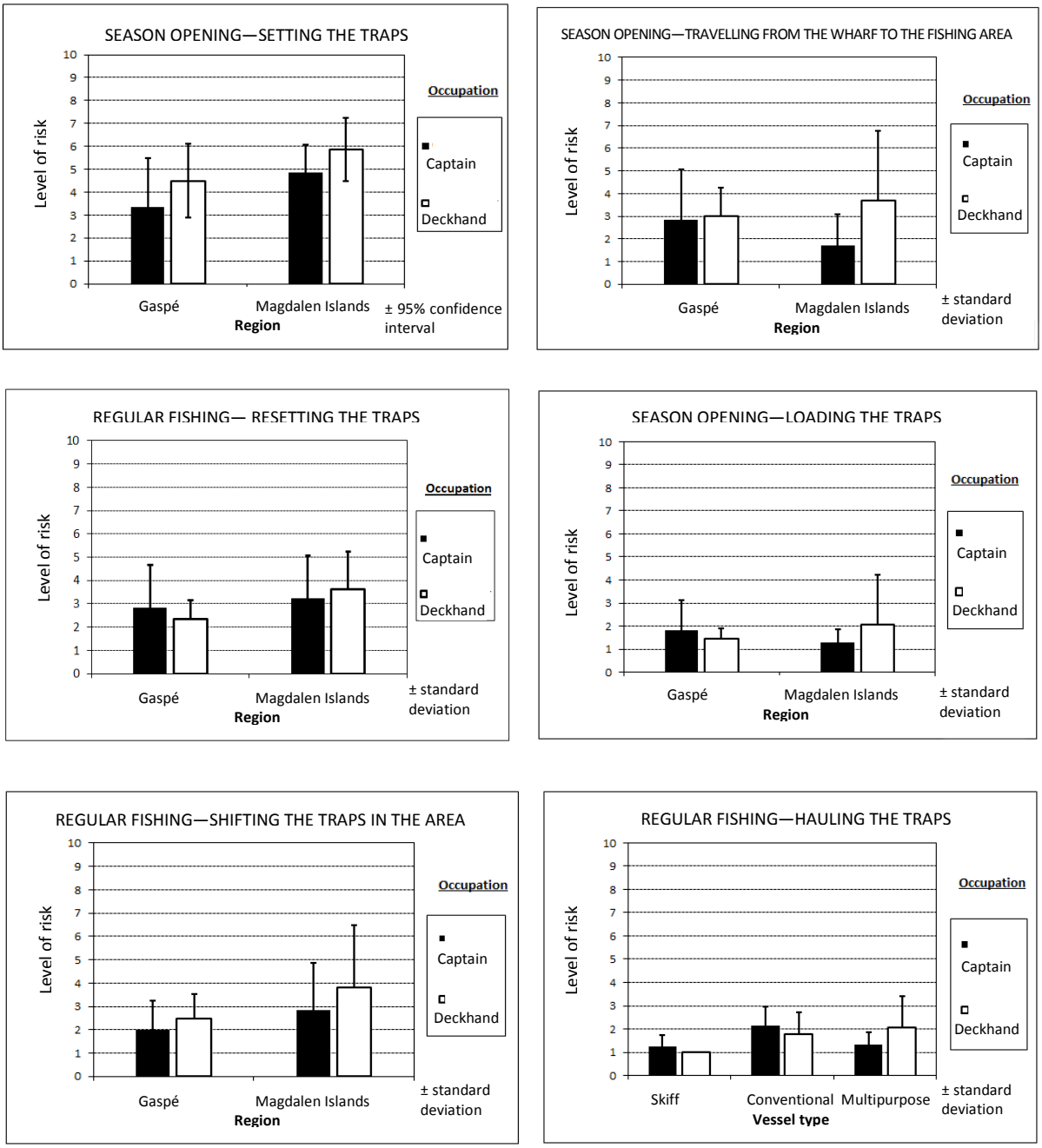


Figure 2 – Mean risk level perceived by work situation, according to occupation, for the Magdalen Islands and the Gaspé (captains: black bars; deckhands: white bars)

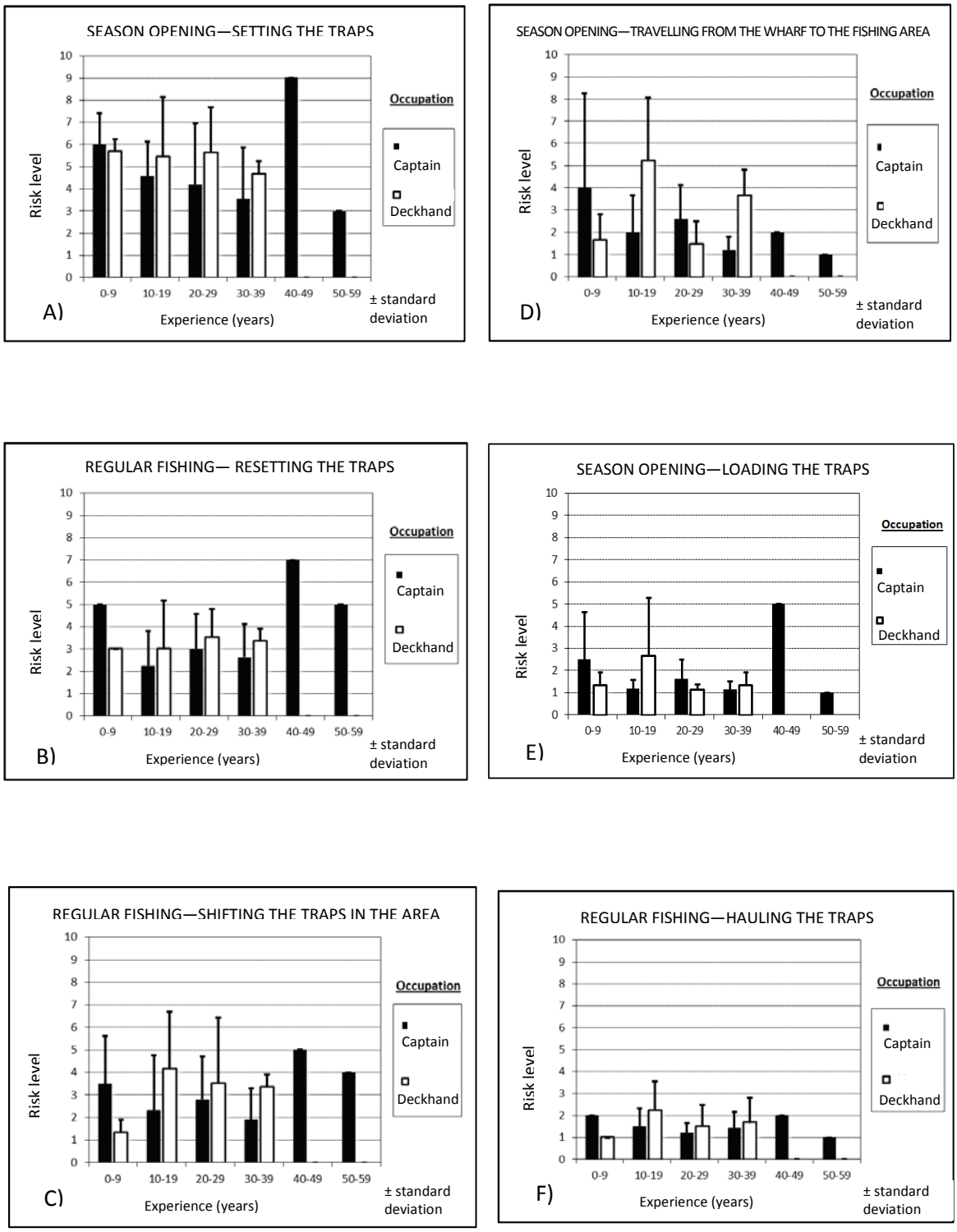


Figure 3 – Mean risk level perceived by work situation, according to level of fishing experience (captains: black bars; deckhands: white bars).

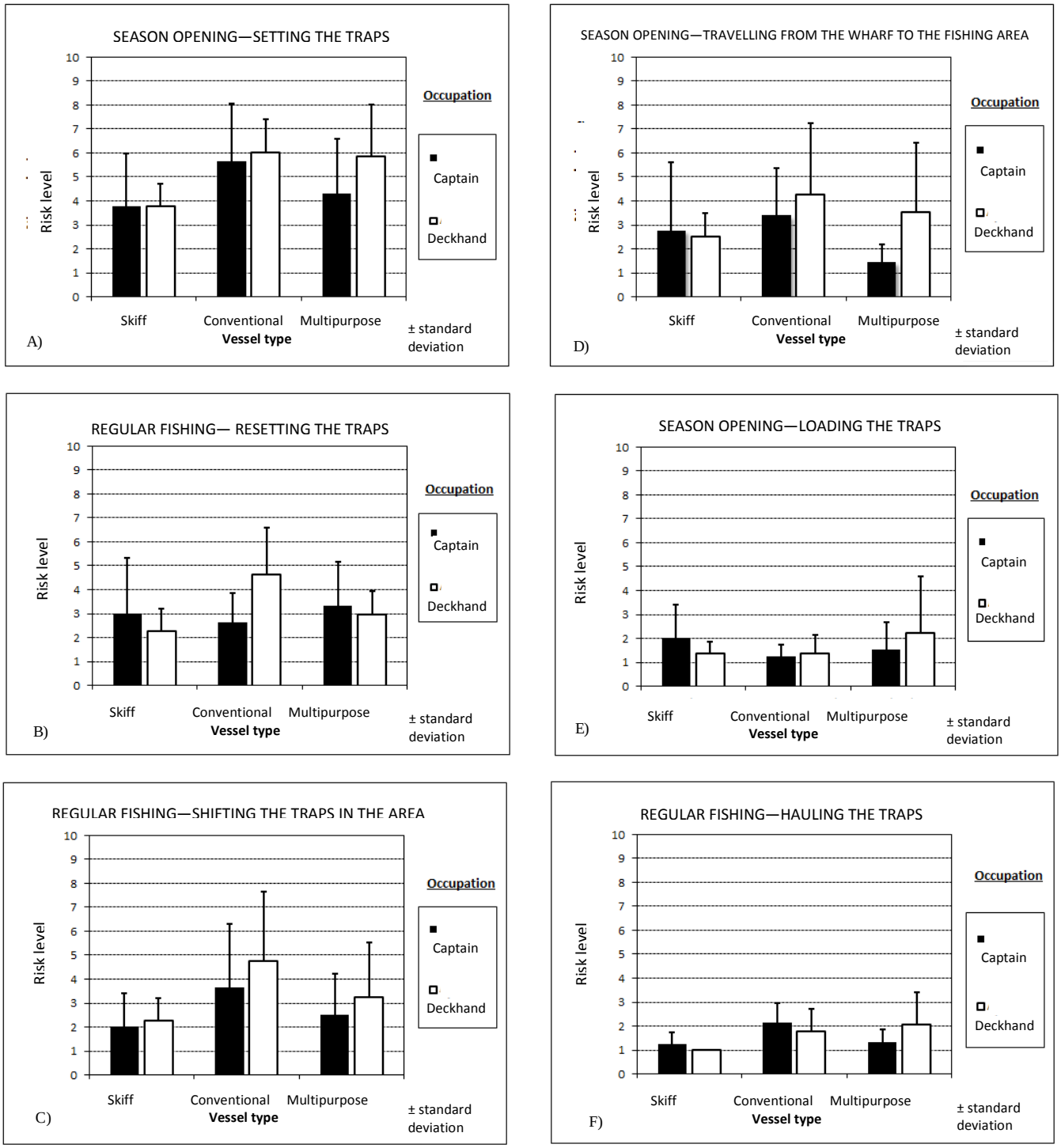


Figure 4 – Mean risk level perceived by work situation, according to occupation, by vessel category (captains: black bars; deckhands: white bars).

Appendix 7 – Compilation of Strategies and Means of Prevention Taken from the General Risk Perception Questionnaire (in descending order)

Strategies	Means	Frequency mentioned	Remarks
Improvement of deck traction	1. Placement of rubber mat (16) 2. Application of an anti-slip product (6)	22	Is this applicable to all flat-bottom skiffs in the Gaspé?
Improvement of communication	1. Application of a working method (7) 2. When traps are first set, presence of at least two crew members on deck (2) 3. Slanted windows in the wheelhouse (2) 4. Use of a horn (1) 5. Adequate lighting on deck (1) 6. Eventual installation of a surveillance camera in the wheelhouse (1) 7. Presence of a mirror (1) 8. When traps are being set, frequent glances back by the captain (1)	16	
Rope placement	1. Lines placed on the table supporting the traps (4) 2. Lines placed in the right place (3) 3. “Suspended” lines (1) 4. Lines placed under the table or washboard (1) 5. At season opening, lines coiled up on the same side (1) 6. Arrange the lines properly (1)	11	Including when trawls are shifted during the season To avoid picking the wrong trap

Strategies	Means	Frequency mentioned	Remarks
Improving the table or washboard	1. Installation of a line bin (5) 2. Design the table so that the lines pay out smoothly and can be controlled when traps are dropped (3) 3. Tilt the table or the washboard towards the interior of the boat and add a ridge to keep the traps from slipping (2) 4. Slant the table legs towards the bulwark (1)	11	
Working patterns (hauling and dropping traps)	1. Optimize or reduce the vessel's speed (4) 2. Adjust the crew's work pace (4) 3. Manœuvre the vessel adequately (3)	11	Don't run When approaching the buoy
Safety devices around the periphery of the work deck	1. Raise the height of the bulwark (6) 2. Railing or netting above the washboard in areas where the traps are not handled (1) 3. Rope run front and back as a grip line (1) 4. Installation of a guard rail in front of the boat (1)	9	The height prescribed by the CSST, following fatal accidents, varies from 90 to 120 cm.
Adequate layout of working areas	1. Clear work areas (2) 2. Good work table (1) 3. Optimal distribution of workstations (1) 4. Table at the stern to drop the trawls (3)	7	
At the opening of the season, loading the traps	1. Avoid loading traps excessively high; leave room at the back (4) 2. Stow the lines along the bulwark (2)	6	Stability of the load Regulations (from Transport Canada) are desirable

Strategies	Means	Frequency mentioned	Remarks
During regular fishing, when shifting the trawls	1. Always put the traps on the table (4)	4	
Other	• Safe behaviour • Cleat to hold fast the line on the hauler or the washboard • Hatch cover flush with the deck • A manoeuvring station for the vessel near the hauler • Departure at 5:00 a.m. • Rubber mats below the storage bins • Avoid stepping on the washboard • Sobriety • Design of a boot with a rigid collar	9	Avoid constricting circulation in the legs

Appendix 8 – Map of Québec Fishing Harbours, from the Department of Fisheries and Oceans Canada

Source: Department of Fisheries and Oceans Canada
http://non-skid.qc.dfo-mpo.gc.ca/ports-harbours/index-eng.asp?p=/ports-harbours/index-eng.html - consulted on February 1, 2013

Appendix 9 – Activity Model in Ergonomics

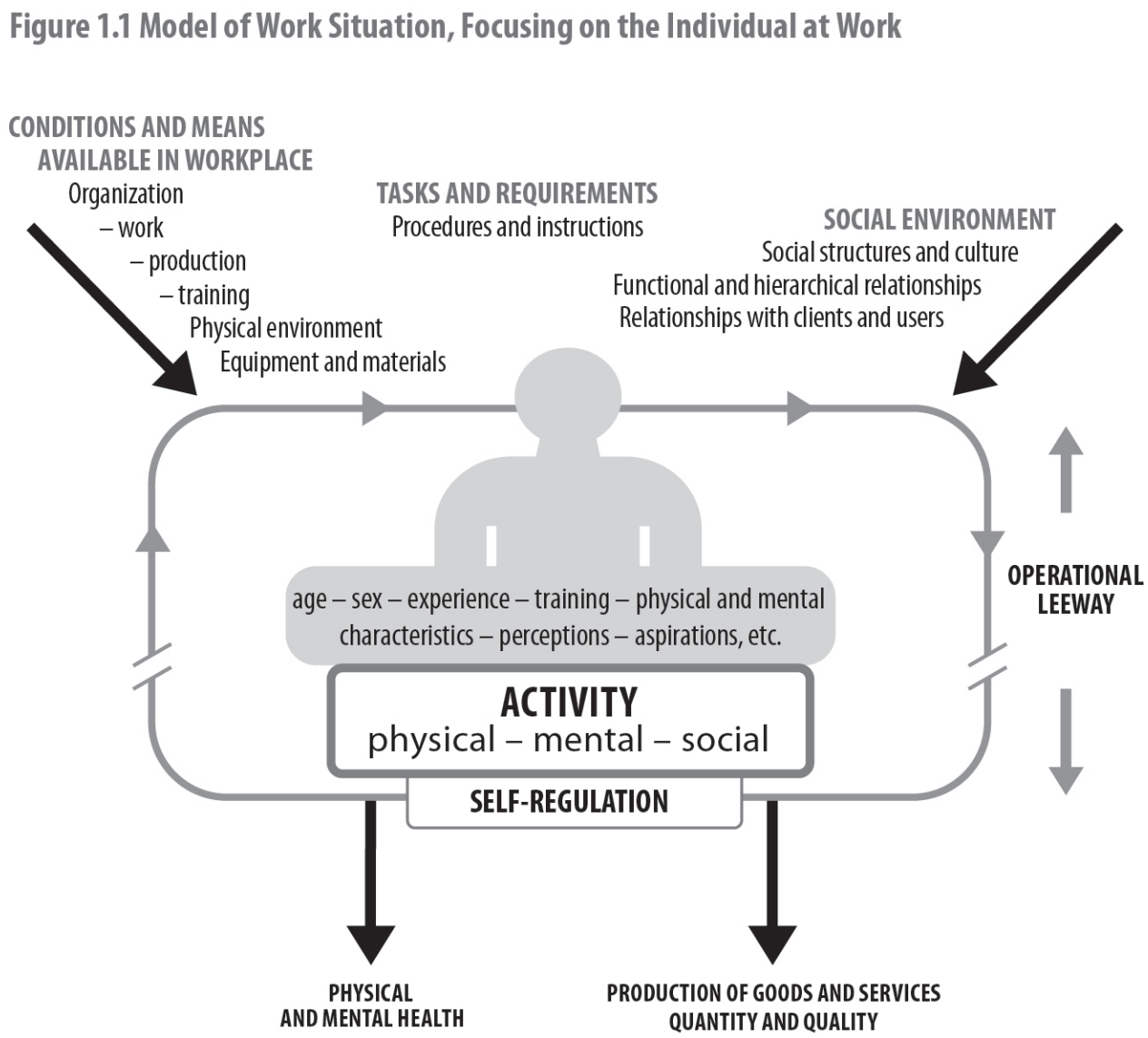


Figure 1.1: Model of Work Situation, Focusing on the Individual at Work (taken from St-Vincent et al., 2011, p. 39, according to Vézina, 2001).
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