

Fatal Falls Overboard on Commercial Fishing Vessels in Alaska

Devin L. Lucas, MS* and Jennifer M. Lincoln, PhD

Background Falls overboard are a major contributor to commercial fishing fatalities in Alaska. The National Institute for Occupational Safety and Health has repeatedly identified falls overboard as a critical issue in commercial fishing safety. This article describes the problem of falls overboard and discusses possible ways to reduce the risk factors.

Methods Data from the Alaska Occupational Injury Surveillance System on fatal falls overboard in Alaska between 1990 and 2005 were used. An in-depth descriptive analysis of these fatalities was performed to identify areas for intervention.

Results There were 71 fatal falls overboard on commercial fishing vessels in Alaska during the 16-year time period. Falls overboard did not decline significantly during those years. The most common circumstances associated with falling overboard were working with fishing gear, being alone on deck, losing balance or slipping, heavy weather, gear entanglement, and alcohol. The level of involvement of those circumstances varied by region and gear type.

Summary Many fatal falls overboard may be prevented by understanding the circumstances involved and targeting interventions at those specific risk factors. Interventions include creating more enclosed work spaces, managing lines, avoiding fishing alone, wearing personal flotation devices and man overboard alarms, and reducing alcohol use. Subsequent research should identify further interventions for each circumstance and evaluate the effectiveness of these interventions with the fishing industry. *Am. J. Ind. Med.* 2007. © 2007 Wiley-Liss, Inc.

KEY WORDS: fishing; fall; overboard; drowning; Alaska

INTRODUCTION

Between 1990 and 2005, 296 commercial fishermen died in Alaskan waters, representing one third of Alaska's occupational fatalities for that time period [NIOSH, 2006]. The occupational fatality rate for fishermen during those

16 years in Alaska was 116/100,000 per year, 23 times higher than the rate for all U.S. workers [NIOSH, 2006].

Falls overboard are a major contributor to commercial fishing fatalities in Alaska. The National Institute for Occupational Safety and Health (NIOSH) reported that from 1990 to 1999, falls overboard represented 23% of the total fishing fatalities [NIOSH, 2002]. The contribution of falls overboard to overall fishing fatalities in Alaska is similar to that in other areas of the United States. The Massachusetts Department of Public Health [2002] reported that from 1991 to 1999, there were 57 commercial fishing fatalities in Massachusetts, of which 23% were due to falls overboard. Nationwide, the United States Coast Guard (USCG) reports that 24% of all commercial fishing fatalities are falls overboard [USCG, 2006].

National Institute for Occupational Safety and Health, Alaska Field Station, Anchorage, Alaska

*Correspondence to: Devin L. Lucas, National Institute for Occupational Safety and Health, Alaska Field Station, 4230 University Drive Suite 310, Anchorage, AK 99508.
E-mail: dluucas@cdc.gov

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The problem of falls overboard is also evident internationally. In a study comparing commercial fishing fatalities among selected northern countries, Abraham [2002] reported that falls overboard in the U.S. represented 25% of all fishing fatalities, compared to 27% in Norway, 30% in Denmark, 20% in Ireland, and 33% in Iceland. A study of Canadian commercial fishing accidents reported that from 1990 to 2000, 24% of fatalities were attributed to falls overboard [MIL Systems, 2002].

While many studies of commercial fishing safety problems identify falls overboard as an important contributor to fatalities, there does not appear to have been any research published that has focused specifically on falls overboard. Several studies of fishing fatalities in Alaska have reported general findings on the causes of falls overboard, but did not review the risk factors and circumstances [Lincoln and Conway, 1999; Thomas et al., 2001; NIOSH, 2002]. Other studies lend only speculation as to what some of the causes of falls overboard might be [Drudi, 1998; MIL Systems, 2002].

NIOSH [1997, 2002] has repeatedly identified falls overboard as a critical issue in commercial fishing safety and as an area where prevention efforts could significantly reduce the number of fatalities. The purpose of this study was to: (1) conduct an in-depth descriptive analysis of the problem of falls overboard on commercial fishing vessels in Alaska; (2) analyze the circumstances involved with falls overboard; and (3) identify possible areas where interventions might help reduce the incidence or increase the survivability of falls overboard.

MATERIALS AND METHODS

Case Definition

A fatal fall overboard was defined in this study as unintentionally entering the water outside the hull of a commercial fishing vessel resulting in a fatality. This definition included all methods for entering the water, whether it was being pulled over by gear, slipping, losing balance, being knocked overboard by gear, washed over by a wave, or any other means. Incidents were included that occurred from 1990 to 2005 in Alaska waters. Only cases that met the criteria for an occupational fatality as defined by the National Traumatic Occupational Fatality Surveillance System (NTOF) were included [NIOSH, 2001].

Data Sources

The data on fatal falls overboard in Alaska were collected from the Alaska Occupational Injury Surveillance System (AOISS), maintained by the National Institute for Occupational Safety and Health, Alaska Field Station. The data contained in the AOISS database is collected from multiple sources including USCG reports, Alaska State

Trooper reports, medical examiner documents, and death certificates [NIOSH, 2002]. The AOISS database includes information on location, fishery, vessel type, vessel characteristics, circumstances associated with the incident, and demographics of each victim.

There were no incidents that had incomplete information that prevented inclusion in this study. Some incidents had limited data on the circumstances involved when the fall overboard was not witnessed. With some of those cases, the only known circumstance was working alone.

Denominator

The denominator estimate used in this study was full-time equivalent (FTE) fishermen, calculated for each year from 1990 to 2005. Calculating rates using the FTE as the denominator was important in this study because the fishing industry does not operate on a regular full-time schedule. FTEs adjust the worker population to reflect the amount of time working and therefore the exposure to risk.

To calculate the FTEs, data were collected for vessels participating in each fishery, including the number of fishing vessels, average crew size, and length of the fishery (days) during the study period. Multiplying the number of fishing vessels by average crew size resulted in the number of fishermen working in that particular fishery. The product of the number of fishermen and days worked was “fisherman-days.” Fisherman-days were divided by the number of regular work days in a year (260). Fisheries that had seasons less than 15 days were weighted by a factor of three to give credit for longer hours worked and increased time at risk per day. Seasons lasting between 16 and 50 days were weighted by a factor of two, and seasons lasting longer than 50 days were not weighted. The result was the number of FTE fishermen, which was used as the denominator in this study. This method of calculating FTEs for the fishing industry has been utilized and published previously [Thomas et al., 2001; NIOSH, 2002].

Analysis

A descriptive analysis was used to identify the most common circumstances associated with falls overboard incidents. The analysis included general descriptive statistics and Chi-square tests for trend and equal proportions. Rates were calculated using fatal falls overboard as the numerators and FTEs as the denominators. FTEs also served as the controls for the Chi-square test for linear trend.

The circumstances associated with each fall overboard were not mutually exclusive, in order to capture all the circumstances that were related to the event. For example, a victim may have lost his balance and fallen overboard while working with fishing gear in heavy weather. That incident would be coded with all three circumstances of losing

balance, working gear, and heavy weather. When discussing the percentage of fatalities that involved a certain circumstance, the total percentage of all the circumstances will be greater than 100%.

One of the circumstances in several cases was alcohol involvement. An incident was coded in this study as involving alcohol if the USCG and State Trooper investigation reports concluded that it was a factor. The investigator's conclusions were not always based on blood alcohol levels.

The circumstances were not weighted based on an assignment of the sequence or importance of events. All of the circumstances were treated equally in the analysis and only one investigator coded the cases.

RESULTS

From 1990 to 2005, there were 71 fatal falls overboard in Alaska, representing 24% of the total number of commercial fishing fatalities. The number of falls overboard varied from a high of eight in 1992 to a low of one in 1997. For the 16 year time period, there was at least one fatal fall overboard every year, with a mean of 4.4. The percentage of all fishing fatalities that were falls overboard also varied widely over the years, with a low of 17% in 2001 to a high of 63% in 2000. The Chi-square test for linear trend found that the number of fatal falls overboard from 1990 to 2005 did not decline significantly ($P = 0.61$). This test takes the denominators into account, so that changes in the number of fishermen working each year did not influence the results (Table I).

TABLE I. Frequency and Rate of Fatal Falls Overboard (N = 71)

Year	Numerator (fatal falls overboard)	Denominator (FTE)	Rate (per 100,000)
1990	6	16,400	36.6
1991	7	16,551	42.3
1992	8	17,055	46.9
1993	4	16,108	24.8
1994	3	16,281	18.4
1995	4	15,448	25.9
1996	7	15,274	45.8
1997	1	14,759	6.8
1998	3	14,704	20.4
1999	3	15,065	19.9
2000	5	13,865	36.1
2001	4	13,325	30.0
2002	5	11,714	42.7
2003	4	11,862	33.7
2004	3	11,688	25.7
2005	4	11,805	33.9

Chi-square test for linear trend $X^2 = 0.3$; $P = 0.61$.

Demographics

All of the victims were male. Sixty-three percent were white, 17% were Alaska Native, and the remaining 20% were other races/ethnicities or their race/ethnicity was unknown. The mean age was 33 years old.

Fishery and Gear Type

The number of falls overboard between 1990 and 2005 differed between fisheries. Twenty-six falls overboard occurred in the shellfish fishery, 25 in the salmon fishery, 19 in the groundfish fishery, and 1 in the herring fishery.

Examining the number of falls overboard that occurred in each fishery does not adequately compare the risk of falling overboard between shellfish, groundfish, and salmon fisheries, because the number of fishermen working in each fishery was different; therefore, rates were calculated to compare the risk between different fisheries (Fig. 1). The rate of falls overboard for shellfishers was three times higher than for salmon fishermen, and five times higher than for groundfishers. Shellfishers had the greatest risk of a fall overboard by a wide margin.

Fatal falls overboard were concentrated on three gear types. Thirty-four percent occurred on vessels fishing with pot gear. Another 28% occurred on gillnet vessels, and 20% on longliners. These three gear types—pot gear, gillnet, and longline—represented 82% of the total falls overboard.

Circumstances

Each falls overboard incident could have more than one circumstance associated with it. For that reason, the number of circumstances exceeded the number of fatalities. None of the victims were wearing a personal flotation device (PFD) when they fell overboard. Most fishermen (61%) were working with fishing gear at the time of the incident (Table II). Thirty-eight percent were alone on deck, with the fall overboard being unobserved. Some of those fishermen were alone on the deck of a vessel with other fishermen

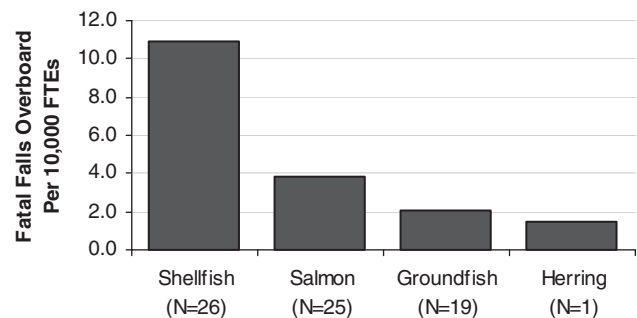


FIGURE 1. Rates of fatal falls overboard by Fishery, 1990–2005 (N = 71).

TABLE II. Circumstances of Fatal Falls Overboard, 1990–2005 (N = 71)

Circumstance (n)	Percent
Working gear (43)	61
Alone (27)	38
Lost balance/slipped (19)	27
Heavy weather (17)	24
Gear entanglement (16)	23
Alcohol involvement (14)	20

Circumstances are not mutually exclusive.
Total is greater than 100%.

inside; however, others were fishermen who work alone on their fishing vessels exclusively.

Losing balance or slipping, heavy weather, gear entanglement, and alcohol were each involved in 20–30% of falls overboard. For the 17 incidents that involved heavy weather, about half (47%) of victims were washed overboard by a wave, and 24% lost their balance or slipped. During these heavy weather incidents, 77% of falls overboard occurred while working gear during fishing operations.

The most common circumstances involved with falling overboard differed by gear type, which is closely related to fishery. Pot gear is used mostly in the shellfish fishery, gillnets are used in the salmon fishery, and longlines are used in a variety of groundfish fisheries. On vessels fishing for shellfish with pot gear, almost all the falls overboard occurred while the victim was working with fishing gear (Table III). Gear entanglement and heavy weather were also common circumstances on pot gear vessels, while being alone on deck was rare. There were no falls overboard that involved alcohol on pot gear vessels.

Gillnet vessels fishing for salmon had 14 unobserved falls overboard, the most of any gear type. Alcohol was also most commonly a circumstance on gillnet vessels, being involved in 35% of those fatalities. Gear entanglement, losing balance or slipping, and heavy weather were not frequent circumstances on gillnet vessels.

TABLE III. Frequency of Circumstances Involved With Fatal Falls Overboard by Gear Type, 1990–2005 (N = 71)

Circumstance	Gear type				Total (n = 71)
	Pot (n = 24)	Gillnet (n = 20)	Longline (n = 14)	Other (n = 13)	
Working gear	23	9	8	3	43
Alone	2	14	5	6	27
Lost balance/slipped	7	2	4	6	19
Heavy weather	9	3	4	1	17
Gear entanglement	10	2	4	0	16
Alcohol involvement	0	7	3	4	14

Circumstances are not mutually exclusive.

Location

The commercial fishing industry in Alaska takes place in three large geographic regions. The Southwest region, which includes the Aleutian Islands, Bristol Bay, and the Bering Sea, was the location for 73% of falls overboard in the State (Fig. 2). Seventeen percent occurred in the Southcentral region, which includes Kodiak Island and the Gulf of Alaska. Only 10% of falls overboard took place in the Southeast region.

The difference in the frequency of fatal falls overboard between regions was tested using the Chi-square test for equal proportions and was found to be statistically significant ($P < 0.001$).

The gear types involved with falls overboard varied widely by geographic region and reflected the fisheries that take place in those regions. In Southwest Alaska, 46% of falls overboard occurred on pot gear vessels fishing for crab. Twenty-seven percent were on gillnet vessels fishing for salmon, and 15% were on longline vessels fishing for a variety of groundfish.

In Southcentral Alaska, 84% of falls overboard took place on two vessel types: gillnet (42%) and longline (42%). In Southeast Alaska, where falls overboard were the least common, there was not a single gear type that had a concentration of falls overboard. The seven falls overboard in Southeast Alaska occurred on six different vessel types, from seine vessels to dive fishery vessels.

The circumstances implicated in fatal falls overboard were different depending on the region (Table IV). Being alone on deck and having an unobserved fall overboard occurred less often in Southwest Alaska than in Southcentral or Southeast. Alcohol was a factor most frequently in Southcentral Alaska and least frequently in the Southeast Region.

DISCUSSION

Our analysis revealed that from 1990 to 2005, the number of fatal falls overboard did not show a decreasing

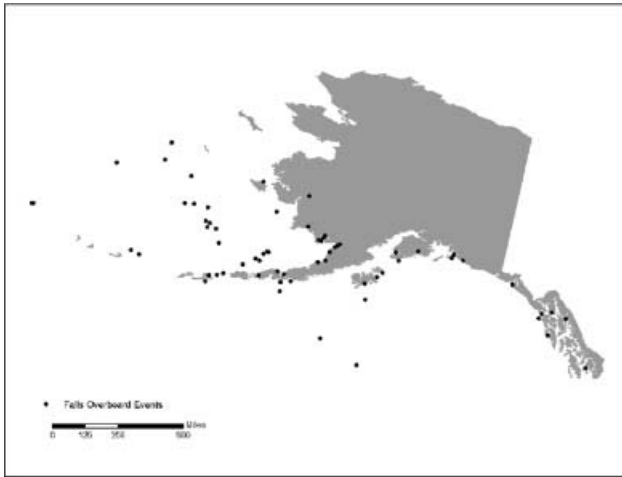


FIGURE 2. Location of Fatal Falls Overboard, 1990–2005 (N = 71).

trend, despite major decreases in other types of fishing fatalities [Lincoln and Conway, 1999; NIOSH, 2002, 2006]. This is similar to a finding in Canada that from 1990 to 2000 the number of falls overboard remained unchanged [MIL Systems, 2002], and another finding of no change in the

TABLE IV. Circumstances Involved With Fatal Falls Overboard by Region, 1990–2005 (N = 71)

Region and circumstance (n)	Percent
Southwest (52)	
Working gear (34)	65
Alone (17)	33
Heavy weather (14)	27
Gear entanglement (12)	23
Lost balance/slipped (13)	25
Alcohol involvement (10)	19
Southcentral (12)	
Working gear (5)	42
Alone (5)	42
Heavy weather (3)	25
Gear entanglement (3)	25
Lost balance/slipped (3)	25
Alcohol involvement (3)	25
Southeast (7)	
Working gear (4)	57
Alone (5)	71
Heavy weather (0)	0
Gear entanglement (1)	14
Lost balance/slipped (3)	43
Alcohol involvement (1)	14

Circumstances are not mutually exclusive.
Total is greater than 100%.

U.K. from 1989 to 1995 [Loughran et al., 2002]. The finding that the number of falls overboard has not been declining emphasizes the need to target prevention efforts at this type of fishing fatality.

The frequency and circumstances of falls overboard was different in each region, fishery, and gear type. Since the circumstances implicated in falls overboard are different among fisheries and gear types, prevention strategies need to be tailored in order to be most effective.

Proven methods of injury control are available to help target prevention efforts. Some of these methods are engineering controls, administrative controls, and personal protective equipment (PPE) [Olishifski, 1988]. Engineering controls are interventions that engineer out the hazard by physically separating the worker from the hazard. Administrative controls are rules and management policies that reduce exposure to risks. PPE is used when it is not possible to make the environment completely safe through the use of engineering controls [Olishifski, 1988]. The following sections discuss possible interventions for preventing falls overboard from occurring, and increasing the survivability of the incident when it does occur.

Engineering Controls

Engineering controls are the most desirable type of intervention, because they separate the worker from the hazard and decrease the possibility of an incident occurring. In the case of falls overboard, engineering controls are physical changes to the vessel and equipment to prevent a fisherman from falling overboard. One area of intervention that has been mentioned in the literature is creating more enclosed workspaces and raising the gunnels [Thomas et al., 2001]. Raising gunnels and creating more enclosed workspaces would only be possible in certain areas of the deck that are not required to be open for the operation of fishing gear, but in areas of the deck that do not need to be open for the operation of fishing gear, raising the gunnels could help prevent falls overboard in those areas.

The extent to which the gunnels could be raised and the deck enclosed depends on the type of fishing gear. Also, adding weight on the deck has implications for stability and allowable deck load [Jensen Maritime, 2002]. However, if those considerations were addressed, then certain areas of the deck of all vessels could be more enclosed.

Creating more enclosed workspaces is a general intervention that would help prevent fishermen from falling overboard. Other engineering controls can be implemented to address specific circumstances like gear entanglement, a circumstance in 23% of falls overboard. Although gear entanglement is much more common on pot gear vessels than on gillnet or longline vessels, engineering controls designed to prevent entanglement would be applicable on all vessels.

Gear entanglement is an issue that has been addressed fairly extensively before, with several publications available for fishermen that give ideas and instructions on how to prevent entanglement situations [Harvard, 2000; Jensen Maritime, 2002; AMSEA, 2006].

Line bins and line lockers keep lines off the deck to prevent entanglement around feet and legs. Those and other forms of line management are controls for entanglement that can be applied on any vessel type. Having an engine kill switch located on deck in a location where an entangled fisherman could reach it may be especially useful for fishermen who work alone on their vessels. Shutting off the engine could allow the fisherman to lessen the stress on the line and rescue themselves from the entanglement. There are also new devices on the market that can detect when a fisherman has gone overboard and automatically kill the engine, giving the single operator the possibility of reboarding the vessel.

Engineering controls can also help reduce the circumstance of losing balance or slipping. Installing non-slip deck surfaces would help prevent some of the falls overboard that involved losing balance or slipping. It would also help prevent non-fatal injuries that are caused by falling on the deck of a fishing vessel [Thomas et al., 2001]. Several ideas for different types of non-slip surfaces are available to fishermen in the publication *Deck Safety for Crab Fishermen* and can be applied to any vessel [Jensen Maritime, 2002]. These include placing fiber mats or non-skid gratings in work areas.

Administrative Controls

The current federal safety regulations for fishing vessels do not contain any requirements that would help prevent falls overboard. There are only two requirements aimed at increasing the survivability of a fall overboard, which are monthly falls overboard drills and the presence of throwable flotation devices [USCG, 2004]. While those two requirements are important elements of surviving a fall overboard, they have not been shown to be sufficient for reducing the numbers of fatal falls overboard.

Since administrative controls are not currently provided by federal safety regulations, responsibility falls on individual vessel skippers to set and enforce additional rules to protect themselves and their crew from this type of fatality.

One rule that could be enforced by skippers is a zero tolerance for alcohol on board their vessel. The results of this study showed that 20% of fatal falls overboard involved alcohol. The data also suggest that a zero tolerance policy may already be enforced by skippers of crab vessels, as there were no fatal falls overboard involving alcohol in that fleet. On gillnet vessels however, 35% of falls overboard involved alcohol. None of the findings of this study offered an explanation of the difference in alcohol involvement among

gear types, but there is clearly a need for intervention on gillnetters to reduce the involvement of alcohol in these fatalities.

Thirty-eight percent of falls overboard happened while fishermen were alone on deck. Skippers could reduce the risk of these unobserved falls overboard by making policies that discourage crewmembers from going out on deck alone. For skippers who routinely fish on their vessels alone, they might consider always taking along at least one other person who could come to their assistance in the event of a fall overboard.

Personal Protective Equipment

Another method of control is PPE. Engineering and administrative controls have the potential to prevent many falls overboard from occurring, and efforts should be made to develop and implement such controls on fishing vessels. Controls can help reduce the risk of falling overboard, but they may not be able to completely eliminate the hazard. When falls overboard do occur despite prevention efforts, PPE can increase the survivability of the event and further decrease the number of fatalities.

There is a requirement for fishing vessels in Alaska to carry an immersion suit for each person on board, but they are not designed to be worn during normal fishing operations, and so would not prevent fatalities from falls overboard. The results of this study showed that none of the fishermen who died from a fall overboard were wearing a PFD. Even though it is not a requirement, all fishermen should consider wearing a PFD while on deck. There are more types and styles of PFDs available now than ever before, with several styles that would probably meet the needs of commercial fishermen. Some of these newer PFDs are compact, unrestricted inflatable types that automatically inflate when a person falls into the water. While inflatable PFDs do not offer any thermal protection, they would give a fisherman in the water better chances of survival than if the fisherman had no flotation, especially if the fall overboard was witnessed.

Being alone on deck was a circumstance in 38% of falls overboard. Because those victims were alone when the falls overboard occurred, the incidents were unobserved. Unobserved falls overboard are a problem because when a fall goes unnoticed, there is a delay in search and rescue efforts which can cost a fisherman his life.

“Man overboard” alarms are devices that sound an alarm when a person falls overboard, alerting crewmembers instantly to the emergency. Each crewmember wears a small transmitter that is activated when submerged in water. The receiver is installed in the pilot house. Man overboard alarms have recently become small, lightweight, and relatively inexpensive. If incorporated into commercial fishing, these alarms could represent a significant safety improvement.

Reducing the risk of being alone on deck needs to address not only the problem of fishermen going out on deck alone, but also fishermen who operate on their vessel alone. Some of the man overboard alarms available have additional features, like stopping the engine of a vessel when a person falls overboard. The auto-engine kill devices would be particularly useful for fishermen working alone on their vessel.

One additional item of PPE that this study recommends is based on the finding that 23% of falls overboard involved gear entanglement. Fishermen should consider wearing an accessible knife that can be used to cut lines and other gear if entangled and pulled overboard. This suggestion was emphasized in a Harvard [2000] publication for lobstermen in Maine to prevent entanglements.

CONCLUSION

Falls overboard are a major contributor to commercial fishing fatalities in Alaska, and unlike other types of fatalities, the problem has not been declining. This study revealed where these falls overboard occurred in Alaska, which fisheries and gear types were most susceptible to falls overboard, and most importantly, what circumstances were implicated in those incidents. By using proven methods of injury control, the circumstances involved with falls overboard can be reduced. Many falls overboard can be prevented by employing engineering and administrative controls, and when an incident does occur, PPE can increase the chances of survival for the fisherman in the water.

Analyzing only fatal falls overboard with no comparison group was a limitation of this study. The nature of falls overboard makes it difficult to identify survivors, because there are usually no medical problems requiring treatment subsequent to being rescued from a fall overboard. This means that there are no reports and no records of fishermen who fell overboard and were saved. In future research, it would be helpful to examine the differences between fatal and non-fatal falls overboard. Additionally, this study only analyzed falls overboard in Alaska. The circumstances involved with falls overboard and the related recommendations may be different in other areas of the U.S. Further research is needed to describe the problem of falls overboard in other areas of the country so that recommendations can be tailored to each region and fishery.

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