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Work-related mortality in the US fishing industry during 2000-2014: New findings based on improved workforce exposure estimates

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Abstract

Background—Commercial fishing is a global industry that has been frequently classified as high-risk. The use of detailed surveillance data is critical in identifying hazards.

Methods—The purpose of this study was to provide updated statistics for the entire US fishing industry during 2010–2014, generate fleet-specific fatality rates using a revised calculation of full-time equivalent estimates, and examine changes in the patterns of fatalities and in risk over a 15-year period (2000-2014).

Results—During 2010–2014, 188 commercial fishing fatalities occurred in the US. Vessel disasters and falls overboard remain leading contributors to commercial fishing deaths. The Atlantic scallop fleet stands out for achieving substantial declines in the risk of fatalities over the 15-year study period.

Conclusions—This study found fatality rates in fishing fleets during 2010–2014 ranging from 21 to 147 deaths per 100,000 FTEs, many times higher than the rate for all US workers.

Keywords

Fishing; Mortality; Occupational; Surveillance

INTRODUCTION

Commercial fishing is a critical industry for global food security, generating a major source of animal protein for billions of people worldwide.[1] Fishing vessels vary widely in terms of size and configuration, ranging from small undecked vessels with as few as one person onboard to large decked vessels with dozens of crewmembers who catch and process fish into final products in factories onboard the vessels. The fishing industry has been frequently classified as exceptionally high-risk, with workplace fatality rates that are often the highest among all industries in many countries.[2] The life-threatening hazards faced by workers in the fishing industry have been measured and described in many epidemiologic studies for

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decades,[2] yet public concern over the death toll has been mostly lacking, including within social movements such as for sustainable seafood.

Interest in sustainable seafood has been steadily increasing among wholesalers, retailers, restaurants, and consumers.[3] Market research has predicted a growing awareness and preference for seafood that is environmentally, economically, and socially sustainable.[3] Definitions of the term “sustainable seafood” have included specific elements such as locally caught, wild harvested, fresh, whole, and sourced from effectively managed fisheries (e.g., low impact on habitat, not overfished).[3,4] Missing from the sustainable seafood movement is the health and safety of fishing industry workers who harvest the fish and initiate the seafood supply chain.

While several recent studies have examined fatal and nonfatal injuries in specific fishing fleets or regions in the US,[5–8] the most recent epidemiologic profile of work-related mortality for the entire US fishing industry was published in 2010.[9] The study used surveillance data to describe fishing industry fatalities during the decade of 2000–2009. In that study, 504 worker fatalities were identified, an average of 50 work-related deaths per year. The majority of fatalities were caused by vessel disasters (52%) and falls overboard (31%). The Alaska region had the highest number of fatalities (133, 26%), followed by the Northeast (124, 25%) and Gulf of Mexico (116, 23%) regions. The study noted that the annual number of fatalities in the industry had declined gradually since the previous decade of the 1990s. That modest decline was consistent with an international analysis of trends in fatal incidence rates, which found that overall risk in fishing declined in Europe and North America over a three decade period (1980–2010).[10]

Lincoln and Lucas[9] also reported fatality rates for eight large fishing fleets, ranging from 115 to 600 deaths per 100,000 full-time equivalent (FTE) workers, substantially higher than the rate for all US workers. The methodology used in the study for calculating the FTE denominators in fatality rates had been used in several previous studies.[11–13] However, the FTE calculations in those studies were not based on the standard method widely used by other research institutions,[14] making it difficult to compare the rates with others outside of the particular study.

Given the limitations of the previously published FTEs and rates, along with the outdated published national fatality data, the purpose of this study was to: 1) provide updated statistics for the entire US commercial fishing industry by conducting a descriptive analysis of fatalities, with a particular emphasis on those occurring more recently during 2010–2014; 2) generate fleet-specific fatality rates using a revised calculation of FTE estimates; and 3) examine changes in the patterns of fatalities and in risk over a 15-year period.

METHODS

Case Definition

Cases of fatal work-related injuries in the US fishing industry during 2000–2014 were identified and extracted from the Commercial Fishing Incident Database (CFID). This surveillance system, maintained by the National Institute for Occupational Safety and Health

(NIOSH), is a nationwide database containing information on all fatalities in the US commercial fishing industry. NIOSH developed CFID to collect data on commercial fishing fatalities and to identify high-risk fleets (defined by species targeted, type of fishing gear used, and location of fishing grounds).

For inclusion in CFID, fatalities must be the result of a traumatic injury, defined as "any wound or damage to the body resulting from acute exposure to energy… caused by a specific event or incident within a single workday or shift."[15] This definition includes fatal poisonings as well as intentional injuries such as homicide and suicide. Fatalities due to illnesses or chronic conditions are not included in the database and were therefore not in this study. Only cases that met the criteria for an occupational fatality using established guidelines for injury at work were included. The occupation of commercial fisherman was defined by the Standard Occupational Classification (SOC) code 45-3011 "Fishers and Related Fishing Workers." This definition includes captains, mates, and deckhands. CFID also contains data on fatal injuries involving at-sea fish processors and fishery observers if the event occurred onboard or otherwise involved a fishing vessel.

In 2014, NIOSH entered into a Memorandum of Agreement with the US Coast Guard (USCG) to facilitate information sharing. This formal partnership allows NIOSH researchers access to Coast Guard investigative reports for CFID data collection. Data in CFID are also obtained by NIOSH staff from other sources in each state, including reports from local law enforcement agencies and local media; death certificates; and state-based occupational fatality surveillance programs. Causes of death were coded using the International Classification of Disease version 10 (ICD-10) obtained from death certificates or determined from investigative reports.

Five types of fatal incidents were identified in CFID: vessel disasters, falls overboard, onboard injuries, onshore injuries, and diving injuries. Vessel disasters involved the fishing vessel being capsized, sunk, or damaged to a degree that the crew abandoned the vessel. This includes both decked and open vessels, such as skiffs. A fall overboard was defined as a worker entering the water outside of the vessel, which included all methods for entering the water: struck by gear, washed over, slipped, jumped, entangled, etc. Onboard fatal injuries occurred on or within the fishing vessel (e.g., struck by gear, entangled in winch). Onshore injuries occurred while on land, including on a dock or float. Falls into water from a dock were coded as onshore injuries, not falls overboard. If a fall into water occurred while boarding or disembarking a fishing vessel, the fatality was coded as a fall overboard if the decedent was in contact with the vessel, or as an onshore injury if the decedent was in contact with the dock. Diving injuries occurred when the worker was intentionally in the water for the purpose of harvesting or other work-related tasks (e.g., diving to untangle a line or net from the propeller).

Fatalities occurred in five fishing regions of the US: East Coast, Gulf of Mexico, West Coast, Alaska, and Hawaii. Fatal injuries that involved US fishing vessels in Canadian waters while in transit to or from Alaska were included in the Alaska region counts.

Workforce Data (Exposure)

Period fatality rates were calculated for fleets with five or more fatalities during the 5-year periods 2000-2004, 2005-2009, and 2010-2014, where workforce data were available. These fleet-specific fatality rates enabled the comparison of risk between fishing fleets that have different levels of exposure as measured by the number of vessels, workers, and days at sea. The rates adjust the number of fatalities in each fleet based on a common denominator of 100,000 FTE workers. In this study, the method for calculating the FTE denominator was revised from earlier NIOSH publications to enhance the validity of the rates and standardize the calculation with the currently accepted method widely used by other agencies and academic institutions. As a result of these changes, the fishing fatality rates published in this study are not comparable to rates published in previous NIOSH studies, such as Lucas and Lincoln,[11] Lincoln and Lucas,[9] and Thomas et al.[13] However, to enable comparisons during 2000–2014 of fleet-specific fatality rates in this study, the previously published rates from 2000–2009 were recalculated using the revised standard method.

The previously published FTEs[9] were calculated by multiplying the number of vessels that made at least one landing in the fishery during the calendar year by the mean operating days for vessels in the fishery, and by the mean crew size for vessels in the fishery. The product, “crew-days,” was then divided by 250 standard eight-hour workdays in one year. Finally, fisheries with short seasons (<15 days duration) were weighted by a factor of three (essentially increasing eight-hour days to 24-hour days), and medium seasons (15 to 49 days) were weighted by a factor of two (increasing eight-hour days to 16-hour days). Seasons lasting longer than 49 days were not weighted.

The methodological justification for weighting the FTEs based on season length was that crewmembers in fisheries with shorter seasons worked longer hours per day than crewmembers in fisheries with longer seasons, and in that way had greater exposure to hazards. This framework implied that workers on fishing vessels were only at risk of injury or death when they were on-duty. However, previous studies of fatalities using that FTE included deaths in the numerator that occurred at any time, including to workers off-duty, creating incongruity between the cases in the numerator and exposure time in the denominator. Because of the unique setting in which commercial fishing takes place (i.e., workers are exposed to work-related hazards even when off-duty), in this study, workers in the fishing industry were considered to be “at work” the entire time they were at sea.

A revised FTE formula was used in this study to account for all exposure time of cases in the denominator. The first part of the calculation was the same as the previous method, and used the same data inputs:[16] the number of vessels that made at least one landing in the fishery during the calendar year were multiplied by the mean operating days for vessels in the fishery, and by the mean crew size for vessels in the fishery. The product, “crew-days,” was the same for both methods, but diverge at the next step. The revised calculation multiplied crew-days by 24 to create “crew-hours.” Crew-hours were divided by 2,000 hours (the standard number of hours in a full-time work year). There was no weighting of FTEs based on season length as was done in the past. All workers in all fleets were considered at-risk the entire time they were onboard the vessels. Because FTEs were not available for 2013 or 2014, the estimates from 2012 were extended for those years.

Analysis

A descriptive analysis was completed to explore the patterns and characteristics of work-related fatalities in the US fishing industry during the five-year period 2010–2014. The analysis of this five-year period was completed in a similar style as the previously published analysis of fatalities during 2000–2009.[9] The frequency of fatal injuries was calculated for each year during the study period. Descriptive statistics, including frequency and percent distributions, measures of central tendency and dispersion, and cross-tabulations were calculated for all fatal injuries, both in aggregate for the US and by specific fishing regions. Fatality rates were calculated for certain fleets in each of three 5-year periods (2000-2004, 2005-2009, 2010-2014) using the revised formula for FTE estimates as previously described. Results from the recent five-year analysis (2010-2014) were then compared to the prior time periods (2000–2004 and 2005–2009) to evaluate changes in fatalities and fatality rates over time.

Many cases were missing data for one or more variables. Cases with missing data were excluded from analyses that involved the variables with missing data. Consequently, the total number of cases for each statistic (e.g., percent distribution, correlation, cross-tabulation) reported in the results may be different depending on the amount of missing data in each variable in that particular analysis. This study received a determination of “non-human subjects research” by the NIOSH IRB. All required safeguards for data security and protection were followed by the study team.

RESULTS

Findings from most recent five-year period

During 2010–2014, 188 commercial fishing fatalities occurred in the US, a mean of 38 deaths annually. Decedents were on average 44 years old, predominantly male (185, 98%), and most often deckhands (94, 50%). Drowning was the reported cause of death in the majority of fatalities (139, 75%). Vessel disasters (80, 43%) and falls overboard (57, 30%) were the leading types of fatal incidents. Commercial fishing deaths also resulted from onboard injuries (31, 16%), diving injuries (14, 7%), and onshore injuries (6, 3%). The East Coast had the most commercial fishing deaths (60, 32%) compared to other fishing regions, followed by the Gulf of Mexico (49, 26%), Alaska (45, 24%), and the West Coast (30, 16%). The remaining four fatalities occurred near Hawaii, each due to drowning after falling overboard.

Vessel disasters resulted in the most fatalities during 2010–2014 compared to other types of fatal incidents, with 54 vessel disasters causing 80 deaths (Table I). Severe weather contributed to 37% of fatal vessel disasters. Vessel disasters were most frequently caused by instability (11, 22%), being struck by large waves (10, 20%), and flooding (8, 16%). Overloading was the leading cause of instability in vessel disasters (9, 82%). Flooding events had a variety of causes, with water ingress most commonly the result of hull breaches (3, 38%) or wood rot (2, 25%). The fleets that experienced the highest number of fatal vessel disasters were the Gulf of Mexico shrimp fleet, with six disasters, and the West Coast non-tribal Dungeness crab fleet, with four disasters.

Drowning after falling overboard was the second leading cause of death among commercial fishermen in the US during 2010-2014. None of the falls overboard victims were wearing a personal flotation device when they died. Falls overboard were most frequently caused by loss of balance (13, 36%) and becoming entangled in fishing gear (8, 22%) (Table II). Multiple factors can contribute to a single fatal fall overboard; the most commonly identified factors were working alone (29, 51%) and using alcohol and/or drugs (10, 18%). Among those working alone, 14 were single operators alone on their vessel. The Gulf of Mexico shrimp fleet and the Northeast lobster fleet experienced the highest number of fatal falls overboard, with six and five deaths, respectively.

Sixteen percent of fatalities in the US fishing industry during 2010-2014 were attributed to injuries sustained onboard vessels. The leading causes of these deaths were becoming entangled in fishing gear (7, 23%), poisoning (6, 19%), and being struck by fishing gear or equipment (5, 16%). Over half of the gear entanglement deaths occurred in the Gulf of Mexico shrimp fleet as four fishermen died when they became entangled in deck winches. All fatal poisonings during this period were unintentional drug overdoses.

On the East Coast, vessel disasters and falls overboard were the leading fatal incident types, each resulting in 22 deaths (Table III). The Northeast lobster fleet experienced the most fatalities in the region with 10 crewmember deaths, followed by the Atlantic scallop fleet with six fatalities (Table IV).

Over three-quarters of fatalities in the Gulf of Mexico occurred during vessel disasters (25, 51%) or after falls overboard (13, 27%) (Table III). About half of all fatalities in the region occurred in the shrimp fleet (25, 51%) (Table IV).

Most deaths in Alaska were distributed among vessel disasters (15, 33%), falls overboard (14, 31%) and onboard injuries (12, 27%) (Table III). Ten of the 15 deaths from vessel disasters in Alaska involved crewmembers working in open skiffs that swamped or capsized. The salmon set gillnet fleet experienced the most fatalities in the region, with seven deaths, followed by pot cod (6) and salmon drift gillnet (5) (Table IV).

Thirty fatalities occurred on the West Coast, with the majority from vessel disasters (18, 60%) (Table III). Falls overboard and dive-related injuries caused the same number of deaths, each resulting in four fatalities. The Dungeness crab fleet had the most fatalities with eight deaths, of which five were in the non-tribal sector (Table IV).

Fleet-specific fatality rates using the revised, improved FTE calculations are shown for each five-year period in Table IV, sorted in descending order in each region based on the 15-year total number of fatalities. In the most recent five-year period 2010-2014, fleet-specific rates were largely not calculated due to small frequencies of fatalities in that period. Among the five fleets that had at least five fatalities during 2010-2014 and FTE data available, rates ranged from 21 fatalities per 100,000 FTEs in the Gulf of Mexico shrimp fleet to 147 deaths per 100,000 FTEs in the Alaska salmon set gillnet fleet.

Trends during 2000–2014

Over the 15-year period 2000–2014, there were 693 commercial fishing fatalities, a mean of 46 deaths per year. The annual number of deaths varied from a high of 61 in 2001 to a low of 29 in 2014. The mean number of fatalities was highest in the first five-year period (2000–2004) with 53 deaths per year and has since decreased, with an average of 48 deaths per year during 2005–2009, and finally, an average of 38 deaths per year during 2010–2014.

The most recent five-year period saw a substantial decrease in the number of deaths that occurred during vessel disasters. Vessel disaster fatalities were at a high during 2000–2004 with 133 deaths, followed by 131 deaths in the next five-year period, and contributed to about half of all fatalities in both periods. During 2010–2014, the number decreased to 80 deaths (43% of fatalities). While flooding was the leading initiating event in fatal vessel disasters during the first two periods, these events became slightly less common during 2010–2014 (Table I).

The number of fatalities due to falls overboard steadily decreased in each five-year period, starting with 85 deaths during 2000–2004, 68 deaths in 2005–2009, and 57 deaths in 2010–2014. Fatal falls overboard represented about the same proportion (30%) of all fishing deaths in each of the five year time periods. The causes of these events have also changed over time. While tripping or slipping was the leading cause of falls overboard during 2000–2004, it became less frequent in the periods that followed (Table II). Of note, alcohol and/or drug use contributing to fatal falls overboard decreased over the 15 years.

No clear trend was observed in the remaining fatal incident types nationally, with onboard, onshore, and diving fatalities each experiencing fluctuations in the number of deaths attributed to them among the three time periods; however, a higher number of onboard and diving fatalities occurred during 2010–2014 compared to the preceding five-year period.

On the East Coast, the distribution of fatalities among incident types, especially vessel disasters and falls overboard, were fairly consistent between 2000–2004 and 2005–2009 (Table III). However, in the last five-year period, the proportion of fatalities due to vessel disasters had decreased and those to falls overboard increased, both representing 37% of fatalities in the region. Over the three five-year periods, a decline in fatality rate occurred in the scallop fleet, with the most notable decrease observed in 2010—2014 (Table IV).

In Alaska, the number and percentage of deaths due to each incident type were fairly similar between the first two time periods, although an increase in fatal onboard injuries was observed during 2010—2014 (Table III). Overall, vessel disaster fatalities decreased in the last time period, but the number and proportion of deaths among fishermen working in skiffs increased considerably in 2010—2014 compared to the previous periods. Among Alaska fleets, the fatality rate in the groundfish freezer trawl fleet decreased during 2005—2009 from the preceding period. Although the rate was not calculated for the 2010—2014 period, this trend appears to continue (Table IV). The Bering Sea crab and halibut/sablefish longline fleets experienced no fatalities during 2010-2014, a clear contrast to the previous five-year time periods.

During 2000–2004 in the Gulf of Mexico, nearly half (47%) of all fatalities in the region were due to falls overboard (Table III). These fatalities decreased in the following periods, while fatalities attributed to vessel disaster increased, accounting for 51% of all fatalities in the region during 2010–2014. The only fatality rates available for the Gulf of Mexico were for the shrimp fleet in 2005–2009 and 2010–2014, and the rates were not considerably different between the two periods (Table IV).

Vessel disasters have consistently been the leading cause of fatalities on the West Coast, resulting in 60% or more of commercial fishing fatalities in each five-year period (Table III). The proportion of deaths due to falls overboard decreased during 2010–2014, while diving fatalities increased in both frequency and proportion in this period. The most recent five-year period also had a decrease in the non-tribal Dungeness crab fleet fatality rate compared to the preceding periods (Table IV).

DISCUSSION

The analysis of more recent fatality data in this study (2010–2014) revealed that vessel disasters and falls overboard remain leading contributors to commercial fishing deaths. NIOSH has recommended that vessel owners and operators review their vessel's stability and watertight integrity, and take action to improve and maintain those key conditions.[12,17,18] In situations where primary prevention of vessel disasters is not successful, and crewmembers are forced to abandon ship, it is imperative that well-maintained and fully functional safety equipment is onboard, including life-rafts and immersion suits, to protect fishermen from the effects of cold water immersion. Additionally, crewmembers must know how to use the equipment correctly while under extreme psychological stress. Marine safety training and monthly emergency drills are designed to provide crewmembers with the knowledge and skills they need to respond to vessel sinkings and other vessel emergencies.[19] All crewmembers should take marine safety training as recommended by NIOSH[18] and participate in monthly drills as required by federal regulations.[20] Further, personal flotation device use is recommended to those working in skiffs to keep crewmembers afloat in the event of a rapid skiff swamping or capsizing.

Falls overboard have been consistently identified as a major hazard in commercial fishing[9,11,12,17] and remain a leading cause of death among fishermen in the US. In previous studies on the barriers to personal flotation device use, fishermen have expressed various concerns about personal flotation devices, including discomfort, cost, and possibility for increased chances of entanglement.[21–22] The lack of personal flotation device use in all man overboard fatalities since 2000 highlights the need for more research to understand fleet-specific barriers and develop innovative, wearable personal flotation devices to voluntarily increase use, as there are currently no regulatory mandates for fishermen to wear personal flotation devices. Because of the many fishermen who died after falling overboard as single operators or while working alone on deck, man overboard systems should be considered to alert others of a fall overboard and potentially shut off the engine.[11] The use of re-boarding ladders may also be useful in enabling self-rescue should a fall occur.

Winch entanglements have been associated with both fatal and nonfatal traumatic injuries in the Gulf of Mexico shrimp fleet,[23,9] and the findings from this study show that deaths due to these entanglements continue to occur in the fleet. Expanding on previous engineering solutions to prevent winch entanglements,[24] prototype testing of stationary guards and auxiliary stops is currently underway with fishermen to inform development of devices that would prevent or reduce the severity of entanglements.[25] If proven to be effective and widely adopted, these mechanisms could greatly reduce the incidence of injuries due to entanglement in drum and try-net winches on commercial shrimp vessels.

One issue that this study identified was the prevalence of unintentional drug overdoses onboard commercial fishing vessels, in addition to other types of fatalities where drug or alcohol use may have contributed. While this is generally an issue that requires attention outside of a traditional marine safety solution, vessel owners and operators should consider creating and enforcing policies prohibiting the use of drugs and/or alcohol on board.

The revised FTE formula presented in this study has improved the validity of fatality rates by including all exposure time of cases in the denominator. The new formula also improved the comparability of rates to other industries by using a standard, widely accepted method. The average annual occupational fatality rate for all US workers during 2010–2014 was 3.4 deaths per 100,000 FTEs.[14] Using the same FTE calculation method, this study found period rates in fishing fleets during 2010–2014 ranging from 21 to 147 deaths per 100,000 FTEs, many times higher than the rate for all US workers. The extreme variability in risk among fishing fleets suggests that hazardous conditions differ greatly, and preventive measures have been more successfully applied in certain fleets than in others.

Because the new FTEs were used in this study to calculate revised fatality rates for fleets retrospectively to the year 2000, observations of trends during 2000–2014 were also possible. The fatality rate of the Alaska dive harvest fleet was among the highest nationally over the 15-year period. The continued incidence of fatalities among sea cucumber harvesters in Alaska reinforces the conclusion that adequate training and the use of experienced tenders are necessary to improve dive safety.[26]

There have been several fleet-specific successes in improving commercial fishing safety since 2000. The Alaska groundfish freezer trawl and cod freezer longline fleets experienced a decline in the number and rate of fatalities over 15 years. This is due, at least in part, to their compliance with the Alternate Compliance and Safety Agreement (ACSA). This program was developed to allow certain vessels to continue processing activities as an alternative to meeting class standards, and included provisions related to watertight integrity and material condition of the hull. Previous research[27] demonstrated a significant decrease in the rate of reported serious vessel casualties among vessels in compliance with ACSA requirements.

The Bering Sea and Aleutian Islands crab fleet has also experienced substantial improvements in vessel and crewmember safety. In the 1990s, an average of eight fishermen died in the fleet annually, primarily due to vessels capsizing and sinking or to falls overboard.[28] The US Coast Guard implemented dockside stability checks in 1999 to prevent

vessels from going out to sea while overloaded with crab pots. Because of these stability checks, changes in fishery management, and industry initiatives, the number and rate of fatalities has declined substantially in the fleet from the 1990s to 2000-2014.[28]

In the East Coast region, the Atlantic scallop fleet stands out for achieving substantial declines in the risk of fatalities over the 15-year study period. The fatality rate in the fleet during 2010–2014 was approximately four times lower than the rates in the two previous periods (2000–2004 and 2005–2009). Similarly in the West Coast region, the non-tribal Dungeness crab fleet had a fatality rate during 2010–2014 that was more than two times lower than the rates observed during the previous five-year periods. The factors that have promoted risk reductions in the Atlantic scallop and West Coast Dungeness crab fleets are unknown. No studies of hazards or interventions in these specific fleets have been published that would explain the declines in fatality rates. Further research is needed to understand the safety improvements in Atlantic scallop and West Coast Dungeness crab fleets, and to monitor the trends moving forward.

The primary limitation of this study relates to the calculation of FTEs and fatality rates. FTE estimates were not available for all fleets with fatalities, particularly for those outside of Alaska. Data needed to calculate FTEs are difficult to obtain, especially for state-managed fisheries. The Northeast inshore lobster fleet, for example, is one fleet that was missing FTE data for this study. However, fatality rates in that fleet were recently calculated by Fulmer et al.[6] Using the same standardized method for calculating FTEs that this study used, the overall fatality rate in the Northeast inshore lobster fleet was 47.7 deaths per 100,000 FTEs during 2000–2009. Future research is needed to assess and compare the risk of fatalities in other fleets.

This study provided an updated epidemiologic profile of work-related fatalities in the US fishing industry during 2010–2014 and a comparison of fatality rates over 15 years. The findings show that while the number of fatalities among commercial fishermen in the US has generally declined since 2000, commercial fishing continues to have one of the highest occupational fatality rates in the US. Workers are exposed to fatal hazards related to the marine environment in which they work, as well as work-related hazards associated with fishing gear and deck equipment. The use of detailed surveillance data is critical in identifying priority hazards to be addressed in order to reduce the number and rate of work-related deaths. As noted by the Occupational Safety and Health Administration,[29] “Employers are only sustainable when they ensure the safety, health, and welfare of their workers.” The sustainable seafood movement could assist in improving the health and safety of fishing industry workers if the issue was integrated into the definition of sustainable seafood. This market-driven approach, along with updating safety regulations, could be a successful path for reducing hazards and preventing deaths.

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TABLE I

Initiating Events and Causes Involved with Fatal Vessel Disaster Events, United States, 2000-2014

	2000-2004 (n=75)		2005-2009 (n=75)		2010-2014 (n=54)		Total (n=204)	
Events and Causes	**n***	**%****	**n**	**%**	**n**	**%**	**n**	**%**
Initiating Events								
Flooding	20	29.9	17	26.2	8	16.3	45	24.9
Instability	10	14.9	14	21.5	11	22.4	35	19.3
Struck by Large Wave	13	19.4	11	16.9	10	20.4	34	18.8
Collision/Allision	8	11.9	6	9.2	7	14.3	21	11.6
Prop Entanglement	4	6.0	2	3.1	3	6.1	9	5.0
Fire/Explosion	3	4.5	3	4.6	2	4.1	8	4.4
Struck Rocks/Bottom	3	4.5	0	0.0	4	8.2	7	3.9
Struck by Wind Gust	2	3.0	3	4.6	1	2.0	6	3.3
Crossing Hazardous Bar	0	0.0	3	4.6	2	4.1	5	2.8
Gear Caught on Bottom	1	1.5	3	4.6	1	2.0	5	2.8
Engine Failure	2	3.0	2	3.1	0	0.0	4	2.2
Steering Failure	0	0.0	1	1.5	0	0.0	1	0.6
Listing	1	1.5	0	0.0	0	0.0	1	0.6
Unknown Events	8	–	10	–	5	–	23	–
Causes of Flooding								
Down-Flooding (Foundering)	7	50.0	7	53.8	1	12.5	15	42.9
Swamping (Open Skiff)	3	21.4	5	38.5	1	12.5	9	25.7
Through-Hull Fitting Break	4	28.6	0	0.0	0	0.0	4	11.4
Hull Breach (Unspecified)	0	0.0	0	0.0	3	37.5	3	8.6
Wood Rot	0	0.0	0	0.0	2	25.0	2	5.7
Hull Corrosion	0	0.0	1	7.7	0	0.0	1	2.9
Hull-Seam Break	0	0.0	0	0.0	1	12.5	1	2.9
Unknown Cause	6	–	4	–	0	–	10	–
Causes of Instability								
Overloading	5	50.0	5	38.5	9	81.8	19	55.9
Hauling up Heavy Net	3	30.0	3	23.1	0	0.0	6	17.6

	2000-2004 (n=75)		2005-2009 (n=75)		2010-2014 (n=54)		Total (n=204)	
Events and Causes	**n***	**%****	**n**	**%**	**n**	**%**	**n**	**%**
Shifting Load	1	10.0	2	15.4	1	9.1	4	11.8
Icing	0	0.0	2	15.4	0	0.0	2	5.9
Structural Modifications	1	10.0	0	0.0	1	9.1	2	5.9
Slack Tank (Free Surface Effect)	0	0.0	1	7.7	0	0.0	1	2.9
Unknown	0	–	1	–	0	–	1	–

*All numbers in this table are the number of events, not number of deaths. One or more deaths can occur during a single vessel disaster event.

**Valid percent

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TABLE II

Causes and Contributing Factors of Fatal Falls Overboard, United States, 2000-2014 (n=210)

	2000-2004 (n=85)		2005-2009 (n=68)		2010-2014 (n=57)		Total (n=210)	
Causes & Contributing Factors	**n***	**%****	**n**	**%**	**n**	**%**	**n**	**%**
Causes								
Trip/Slip	24	30.8	19	37.3	4	11.1	47	28.5
Lost Balance	22	28.2	11	21.6	13	36.1	46	27.9
Gear Entanglement	14	17.9	7	13.7	8	22.2	29	17.6
Jumped	7	9.0	8	15.7	6	16.7	21	12.7
Knocked by Gear/Object	6	7.7	4	7.8	4	11.1	14	8.5
Washed Over	5	6.4	2	3.9	1	2.8	8	4.8
Unknown	7	–	17	–	21	–	45	–
*Contributing Factors***								
Alone	43	50.6	38	55.9	29	50.9	110	52.4
Alcohol/Drugs	24	28.2	13	19.1	10	17.5	47	22.4
Vessel Motion	8	9.4	7	10.3	3	5.3	18	8.6
Deck Obstacles	12	14.1	4	5.9	1	1.8	17	8.1
Leaning Over Side	6	7.1	3	4.4	5	8.8	14	6.7
Struck by Large Wave	6	7.1	3	4.4	2	3.5	11	5.2
Fatigue	4	4.7	1	1.5	4	7.0	9	4.3
Lost Balance	1	1.2	1	1.5	6	10.5	8	3.8
Other	0	0.0	0	0.0	4	7.0	4	1.9

*All numbers in this table are the number of deaths

**Valid percent

***Not mutually exclusive; percent totals exceed 100%

TABLE III

Types of Fatal Incidents in Fishing Regions, United States, 2000-2014 (n=693)

	2000-2004		2005-2009		2010-2014		Total	
Region and Incident Type	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
East Coast Region								
Vessel Disaster Fatalities	47	60.3	51	58.6	22	36.7	120	53.3
Falls Overboard Fatalities	18	23.1	18	20.7	22	36.7	58	25.8
Onboard Fatalities	9	11.5	9	10.3	7	11.7	25	11.1
Onshore Fatalities	2	2.6	6	6.9	4	6.7	12	5.3
Diving Fatalities	2	2.6	3	3.4	5	8.3	10	4.4
Total	78	100.0	87	100.0	60	100.0	225	100.0
Alaska Region								
Vessel Disaster Fatalities (Decked)	26	38.8	32	47.8	5	11.1	63	35.2
Vessel Disaster Fatalities (Skiff)	6	9.0	3	4.5	10	22.2	19	10.6
Falls Overboard Fatalities	23	34.3	19	28.4	14	31.1	56	31.3
Onboard Fatalities	7	10.4	5	7.5	12	26.7	24	13.4
Onshore Fatalities	2	3.0	7	10.4	1	2.2	10	5.6
Diving Fatalities	3	4.5	1	1.5	3	6.7	7	3.9
Total	67	100.0	67	100.0	45	100.0	179	100.0
Gulf of Mexico Region								
Vessel Disaster Fatalities	24	33.3	16	37.2	25	51.0	65	39.6
Falls Overboard Fatalities	34	47.2	18	41.9	13	26.5	65	39.6
Onboard Fatalities	9	12.5	6	14.0	9	18.4	24	14.6
Onshore Fatalities	0	0.0	0	0.0	0	0.0	0	0.0
Diving Fatalities	5	6.9	3	7.0	2	4.1	10	6.1
Total	72	100.0	43	100.0	49	100.0	164	100.0
West Coast Region								
Vessel Disaster Fatalities	30	69.8	28	66.7	18	60.0	76	66.1
Falls Overboard Fatalities	10	23.3	11	26.2	4	13.3	25	21.7
Onboard Fatalities	2	4.7	1	2.4	3	10.0	6	5.2
Onshore Fatalities	0	0.0	1	2.4	1	3.3	2	1.7

Region and Incident Type	**2000-2004**		**2005-2009**		**2010-2014**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Diving Fatalities	1	2.3	1	2.4	4	13.3	6	5.2
Total	43	100.0	42	100.0	30	100.0	115	100.0
Hawaii Region								
Vessel Disaster Fatalities	0	0.0	1	33.3	0	0.0	1	10.0
Falls Overboard Fatalities	0	0.0	2	66.7	4	100.0	6	60.0
Onboard Fatalities	2	66.7	0	0.0	0	0.0	2	20.0
Onshore Fatalities	0	0.0	0	0.0	0	0.0	0	0.0
Diving Fatalities	1	33.3	0	0.0	0	0.0	1	10.0
Total	3	100.0	3	100.0	4	100.0	10	100.0

TABLE IV

Commercial fishing fatality frequencies and rates* per 100,000 by fleet, US fishing industry, 2000-2014

	2000-2004			2005-2009			2010-2014			15-Year Total		
Fleet	**Fatalities**	**FTE****	**Rate**	**Fatalities**	**FTE**	**Rate**	**Fatalities**	**FTE**	**Rate**	**Fatalities**	**FTE**	**Rate**
East Coast Region												
Atlantic Scallop	21	12091	174	23	13643	169	6	13907	43	50	39641	126
Northeast Multi-Species												
Groundfish Trawl	11	5858	188	14	3565	393	4	2496	NC	29	11919	243
Northeast Lobster	8	–	–	11	–	–	10	–	–	29	–	–
Atlantic Clam/Quahog Dredge	6	1449	414	4	1312	NC	2	1325	NC	12	4086	294
Atlantic Summer												
Flounder/Scup/Black Sea Bass	5	3870	129	4	3357	NC	3	3330	NC	12	10557	114
Atlantic Snapper/Grouper	2	3118	NC	4	2682	NC	3	2355	NC	9	8155	110
Atlantic Shrimp	3	–	–	3	–	–	2	–	–	8	–	–
Atlantic Clam/Quahog Other												
Gear Types	1	–	–	3	–	–	4	–	–	8	–	–
Atlantic Blue Crab	3	–	–	4	–	–	0	–	–	7	–	–
Atlantic Oyster	2	–	–	0	–	–	5	–	–	7	–	–
Atlantic Herring Trawl	3	430	NC	1	449	NC	3	396	NC	7	1275	549
Atlantic Tuna	5	–	–	1	–	–	0	–	–	6	–	–
Atlantic Urchin	0	–	–	5	–	–	0	–	–	5	–	–
Atlantic Squid	0	2547	NC	2	2366	NC	3	2369	NC	5	7282	69
Atlantic Other Fleets (w/<5 fatalities 15 years)	8	–	–	8	–	–	15	–	–	31	–	–
Alaska Region												
Alaska Groundfish Freezer												
Trawl (AM80)	15	12135	124	8	12571	64	2	12503	NC	25	37209	67
Alaska Salmon Drift Gillnet	8	17412	46	10	17469	57	5	18506	27	23	53387	43
Alaska Pot Cod	2	–	—	10	–	—	6	–	—	18	–	–
Alaska Salmon Set Gillnet	6	4516	133	4	4603	NC	7	4751	147	17	13870	123
Alaska Halibut/Sablefish												
Longline	4	6308	NC	10	6125	163	0	5384	NC	14	17817	79

Fleet	2000-2004			2005-2009			2010-2014			15-Year Total		
	Fatalities	FTE**	Rate	Fatalities	FTE	Rate	Fatalities	FTE	Rate	Fatalities	FTE	Rate
Alaska Cod Freezer Longline	6	12375	48	1	10822	NC	2	12054	NC	9	35251	26
Alaska Bering Sea Crab	2	5238	NC	7	3997	175	0	2768	NC	9	12003	75
Alaska Dive Harvest	4	589	NC	1	483	NC	3	468	NC	8	1540	519
Alaska Salmon Tender	2	3840	NC	1	3720	NC	4	3600	NC	7	11160	63
Alaska Salmon Troll	3	4267	NC	2	5129	NC	1	4970	NC	6	14366	42
Alaska Salmon Seine	2	14729	NC	0	12396	NC	3	14408	NC	5	41533	12
Alaska Other Fleets (w/<5 fatalities 15 years)	13	–	–	13	–	–	12	–	–	38	–	–
Gulf of Mexico Region												
GOM Shrimp	35	–	–	23	129768	18	25	121782	21	83	–	–
GOM Snapper/Grouper	7	–	–	3	–	–	9	–	–	19	–	–
GOM Oyster	8	–	–	3	–	–	4	–	–	15	–	–
GOM Crab	6	–	–	2	–	–	2	–	–	10	–	–
GOM Menhaden	0	–	–	4	–	–	3	–	–	7	–	–
GOM Other Fleets (w/<5 fatalities 15 years)	16	–	–	8	–	–	6	–	–	30	–	–
West Coast Region												
West Coast Non-Tribal												
Dungeness Crab	9	7097	127	16	10147	158	5	9042	55	30	26286	114
West Coast Tribal Salmon	4	–	–	6	–	–	4	–	–	14	–	–
West Coast Multi-Species												
Groundfish Trawl	6	2928	205	1	2104	NC	4	1517	NC	11	6549	168
West Coast Dive Harvest	1	–	–	1	–	–	4	–	–	6	–	–
West Coast Tribal Dungeness												
Crab	1	–	–	1	–	–	3	–	–	5	–	–
West Coast Other Fleets (w/<5 fatalities 15 years)	22	–	–	17	–	–	10	–	–	49	–	–
Hawaii Region												
Hawaii Groundfish	3	–	–	1	–	–	1	–	–	5	–	–
Hawaii Other Fleets (w/<5 fatalities 15 years)	0	–	—	2	–	—	3	–	—	5	–	–

*All rates in this table were calculated using the revised formula for FTEs described in the Methods section

**Full-time equivalent

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NC = Rate not calculated when frequency is less than 5 fatalities in a 5-year period

-- = Missing FTE data for fleet