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FISHING



Injuries and Exposure to Time Lobstering in Northeast US Inshore Lobster Fleet

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ABSTRACT

Objectives: The study objective was to estimate a denominator of exposure to inshore lobstering in Full-Time Equivalents (FTEs), to count incident injury data from a sample cohort of this population, to use this count to calculate rates for incident injuries, and to use official counts of fatalities to estimate a fatality rate.

Methods: Captains were randomly selected from those licensed to fish in Maine and Massachusetts. Data on work exposure and injuries that occurred on the boat were collected using a survey that was administered once per season via phone or face-to-face interview with the captain. Data included self-reports of the number of weeks worked during the season, average crew size, number of trips per week, and average trip length in hours. In addition, this survey captured relevant information (body segment affected, type of injury, and whether treatment was received) on all acute injuries occurring during the season. Only data on acute injuries were collected, and defined as having newly occurred within the last 3 months. Counts of fatalities were obtained from an official surveillance database at the National Institute for Occupational Health and Safety.

Results: The total occupational exposure reported for the cohort was over 2 million man-hours over 4 years, resulting in an average annual FTE of 5,847. The fatality rate averaged over 4 years was 21/100,000 FTE. The incidence rates for all injuries (51.0/100 FTE) and injuries receiving treatment (17.5/100 FTE) were much higher than those reported in other studies of fishing that used US Coast Guard data. Lobstermen presented with all categories of injuries, sprains being the most frequent (7.8/100 FTE) and amputations the least (0.2/100 FTE). Wrist/hand injuries on the right side occurred most frequently of all body locations (3.6/100 FTE).

Conclusion: Non-fatal injuries occur at high rates in lobstering. The impact of interventions aimed at exposure to risk for sprains and cuts has potential to affect the most lobstermen. Fatality rate appears to have been unchanging since the year 2000.

KEYWORDS

Non-fatal injury; cohort; commercial fishing

Introduction

Lobsters were one of the top most economically valuable fisheries in the United States in recent years,¹ and are a large contributor to the overall economy in the state of Maine.² While preliminary data from this study were the only data currently published on the rates of injuries among lobstermen, the lobster industry ranks third in numbers of fatalities among commercial fishing in the east coast region.³ Non-fatal injuries have been recognized as a significant occupational health concern of fishermen, as well.^{4,5} Studies on fishermen have shown high prevalence for upper extremity injuries,^{6,7} as well as low back pain,⁸ and in general, more fishermen have experienced injuries at work than have not.⁹

Workers in the lobster harvesting industry, which is commonly referred to as “lobstering” just as commercial fish harvesting is referred to as “fishing,” are predominantly male, and workers who harvest lobsters are referred to as “lobstermen,” regardless of gender.¹⁰

Published reports have described and reviewed occupational health studies of commercial fishing, which is an industry with some unique challenges for research.^{11,12} Surveillance of commercial fishing fatalities has improved, which gave new opportunities for occupational health and safety research in the industry.^{13,14} This study drew on a previous study of lobstering to determine a sampling strategy and on a study of federally licensed commercial fishing to form comparable factors for

determining total occupational exposure.^{15,16} The majority of the lobster landings are harvested from state-regulated waters by state-licensed lobstermen. This single factor excludes this fishery from federal occupational surveillance databases on commercial fishing, as those were constructed around federal landings data from federally licensed boats. States regulate water inshore, up to 3 miles from the coastline, and the US federal government regulates water from there up to 200 miles off the coastline. The two different levels of jurisdiction are managed by respective levels of governing offices.

A prior report from the data presented here has been published for the first 2 years of data collection.¹⁷ This report presents the full 4 years of data collected from 2012 through 2015. The objective for collecting these data was to identify a quantified estimate of the total occupational exposure of the study population and for a quantified estimate of the burden of suffering of acute, non-fatal injuries. The longitudinal characteristic of the quantified estimate and profile of injuries contributes to understanding variation across seasons and geographical locations. With a quantified estimate of the Full-Time Equivalent of the industry, the rates can be compared to reports on other US fisheries.¹⁸

Methods

A survey of lobstermen was conducted to obtain data for estimation of a work-time denominator in the calculation of injury incidence and of fatality rates using publicly available counts of occupationally related deaths of lobstermen. The methods for identifying the study population, sampling frame, sample size, exclusion criteria, recruitment, survey administration, data management, and analysis of the survey data were described in detail in a prior publication on preliminary results of the data.¹⁷

A representative sample was derived from official lists of lobster permit holders from two states, Maine and Massachusetts, whose fleets accounted for about 80% of state-licensed lobstering at the time the study was designed in 2011. One important characteristic of these state-licensed fleets was that their lobstering trips were completed in less

than 24 h. In contrast, a federally licensed lobster boat operating offshore is commonly at sea for 36 h or more. Federally licensed boats were therefore excluded.

Prior estimates¹⁶ indicated a sample of 120 license holders per state would result in a margin of error less than 10% for the 95% confidence interval of annual exposure estimates. To allow for 15% attrition, 276 subjects were targeted for recruitment. A pool of potential subjects was randomly identified from the whole lists of license holders. Recruitment was a labor-intensive process including the identification of correct contact information, a mailed invitation, and repeated follow-up phone calls as necessary until the target number agreed to participate.^{19,20} Potential subjects were excluded if they indicated they did not intend to fish in the coming year.

Subjects provided informed consent orally, approved by UMass Lowell's Institutional Review Board. Subjects received \$10 for each interview they completed.

Self-reported acute injury outcomes and factors that account for time at sea were collected through telephone or in-person interviews with each participating lobsterman once each season. Captains were asked to report acute injuries that occurred during the previous season on the boat, whether it was to themselves or their crew. Data on non-acute injuries were not collected by the methods described in this report. For the sake of data collection simplicity and consistency, only the characteristics of the injury were systematically recorded, not the causal or environmental exposures leading to the injury.

The types of injuries were classified according to the US Bureau of Labor Statistics' categories of injury. In addition, the survey captured other relevant information on the injuries (body location, type of injury, whether medical treatment was sought, and whether the injury prevented normal work). "Medical treatment" was a term that was not qualified. However, it can be assumed that treatment must have been first aid at sea or some treatment that had been sought on land, an effort that would have required interruption of routine activities. Both assumptions would have indicated that "medical treatment" could be a proxy for severity of the injury.

Incidence rates were measured using incidence density rather than cumulative incidence, as follow-up time varied between subjects, and a single subject could contribute more than one case to the numerator.

Data management and analysis

For each boat surveyed, as reported by the captain, we calculated “fishermen hours” as the product of the number of weeks worked during the season, average crew size, average number of trips per week, and average length of trip. This estimate of fishermen hours per season was divided by the number of captains surveyed multiplied by 500 (equivalent to assumption of 2000 work hours per year with 2 weeks of vacation) hours to calculate a percentage of available equivalent hours per season. Actual Full-Time Equivalents (FTEs) were then calculated by multiplying these percentages by the total number of licenses in Maine and Massachusetts.

A prior analysis showed that using different methods to calculate time equivalents could introduce some variability in risk estimates.¹⁷ The method described here was chosen because it most closely represented the factors of the formula for hours-based fatality rates described by the United States Bureau of Labor Statistics.²¹ Because federally licensed boats were excluded and all of the trips recorded in the study were less than 24 h, there was no need to adjust FTE calculation to account for fishing time at sea not actively fishing.

Two-way Analysis of Variance (ANOVA) was used to determine differences in FTEs between states and seasons and any interaction effect. Tukey and Ryan, Einot, Gabriel, and Welsch Range (R-E-G-W-R) post-hoc comparisons were employed to further examine the variation in seasons. This analysis was performed using IBM SPSS software (version 23).

Fatality rates were calculated by using the 2012–15 calculations of average FTE per boat multiplied by the average number of licenses in the periods 2012–15 and 2000–09, to determine a denominator for the fatality rate calculations for 2012–15 and 2000–09 deaths, respectively,

on record in Maine and Massachusetts. This was then normalized to 100,000 FTE.

Injury incidence rates were calculated by dividing the total number of injuries by the fishermen hours calculated above for the 4 years of observation, and then multiplied by 200,000 h to normalize to 100 FTEs. For ease in making comparisons within this document, all non-fatal injury rates were normalized to 100 FTEs, regardless of whether they were generated from our original data.

Results

In Maine, 146 subjects agreed to participate, and in Massachusetts, 140 subjects agreed to participate. Among the sampling pool targeted from both states, 11 lobstermen were found to be deceased, 130 ineligible, and 87 had phone numbers that were incorrect or out of service. Of the remaining subjects from both states, 206 did not respond to an exhaustive number of recruitment calls, and 142 declined to participate. By dividing the number of subjects enrolled by the total number who received recruitment calls (excluding those deceased, ineligible, and unable to be contacted because of inaccurate phone numbers), we arrived at an initial participation rate of 46.9% in Maine and 43.3% in Massachusetts.

After 4 years, 11 subjects from Massachusetts and 4 from Maine elected to drop out. The overall drop-out rate then was 15/286 (5.2% overall; 7.9% in Massachusetts, 2.7% in Maine). Three lobstermen from Massachusetts and one from Maine were substituted for the drop outs as they represented acquaintances or family members of, or were recommended by the subject choosing to drop out. Although these four subjects were not selected at random, they were demographically similar to the other subjects, and it is believed that they did not detract from the representativeness of the sample. Three subjects from Maine died during the exposure period but not during actual lobstering. Some subjects did not complete all 16 interviews in each of the 16 seasons, mainly because subject recruitment occurred over 4 months in Massachusetts, and 5 months in Maine, and therefore extended into the second season of study year one.

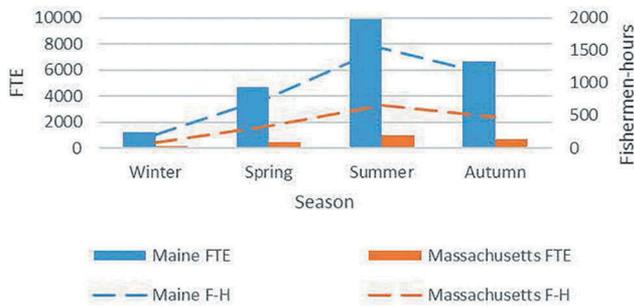


Figure 1. Estimated marginal means of total occupational exposure (2012–2015) of study cohort (Fishermen-Hours) and of general population (FTE) by season and state.

Table 2. Injury incidence rates by type (2012–2015).

Type of Injury	All reported		Injuries that affected work		Injuries receiving treatment	
	N	Rate	N	Rate	N	Rate
Sprains	178	17.8	85	8.5	78	7.9
Cuts	149	14.8	33	3.3	48	4.8
Unidentified pains	95	9.4	23	2.3	20	2.0
Bruises	72	7.2	17	1.7	19	1.9
Fractures	12	1.2	7	0.7	7	0.7
Burns	4	0.4	2	0.2	1	0.1
Amputations	2	0.2	2	0.2	2	0.2
Total	512	51.1	169	16.9	175	17.5

Incidence rate = (N/EH)*200,000; EH = Employee hours; EH = 2,005,525.7 total hours of lobstering in the sample for four years.

Table 3. Acute injury incidence rates by body location.

Body location	Total reported		Affected work		Required treatment	
	N	Rate	N	Rate	N	Rate
Head Face	30	3.0	3	0.3	10	1.0
Neck	6	0.6	1	0.1	0	0.0
Shoulder, Upper Arm						
Right	36	3.6	13	1.3	18	1.8
Left	30	3.0	14	1.4	17	1.7
Both	8	0.8	0	0.0	2	0.2
Elbow, Forearm						
Right	20	2.0	5	0.5	10	1.0
Left	15	1.5	4	0.4	8	0.8
Both	8	0.8	2	0.2	3	0.3
Wrist, Hand						
Right	93	9.2	32	3.2	36	3.6
Left	52	5.2	16	1.6	18	1.8
Both	56	5.6	8	0.8	11	1.1
Back						
Upper Back	16	1.6	5	0.5	8	0.8
Low Back	78	7.8	47	4.7	7	0.7
Lower Extremities						
Hips, Thigh	10	1.0	4	0.4	3	0.3
Knees, Shins	41	4.1	10	1.0	20	2.0
Ankles, Feet	13	1.3	5	0.5	4	0.4

Incidence rate = (N/EH)*200,000; EH = Employee hours = 2,005,525.7 total hours of lobstering in the sample for four years.

periods.¹⁸ We used the average available FTE worked per license (95.8%; Table 1) estimated in this study for the years 2012–2015 multiplied by

the average number of licenses in 2000–2009 as a denominator for the 14 fatalities in the decade between 2000 and 2009 and found an average fatality rate of 20.5/100,000 FTE. Our method excluded the federally licensed offshore fleet, which would have increased the denominator and thus lowered the rate, if none of the fatalities was from the offshore fleet. Conversely, if the recorded fatalities of this period were from the offshore fleet, then our method would have overestimated the fatality rate for inshore lobstermen. This estimated lobster industry fatality rate for 2000–09 appears to be lower than almost all other US fisheries on record, calculated with comparable methods to this study,¹⁸ even if the rate itself is much higher than general industry. The result also indicates that the trend of the rate has remained flat since 2000.

The incidence rate for all reported non-fatal injuries in this investigation was high (Table 4), but caveats are warranted for comparisons to other studies. The injury rates presented here are much higher than injury rates derived from data reported to the US Coast Guard (USCG) through their passive surveillance system.^{22,23} Our method of active data collection through quarterly (one per season) surveys versus the passive system employed by the USCG would explain most of the discrepancy in the estimates of injury rates. The level of severity of an injury may be an underlying factor that could produce a systematic difference between active and passive surveillance. The definition of injury in this study met the same criteria as reports on USCG non-fatal injury data. The data on level of severity were far less sensitive in this study, even if minor injuries may have been systematically more likely to be captured by the

Table 4. Injury and fatality events and rates per year, Maine and Massachusetts lobstermen, 2012–2015.

Year	Population estimate		Self-reported by cohort (N = 286)			
	FTE	Fatalities	Fatality rate (per 100K FTE)	Injuries	Fishing Hours	Incidence density (per 100 FTE)
2012	5987	1	17	138	481,318	57.3
2013	5830	0	0	116	520,066	44.6
2014	6097	4	66	118	513,760	45.9
2015	5946	0	0	140	490,382	57.1
4 yrs	5847	5	21	512	2,005,526	51.1

active surveillance. In comparison to injury rates based on data reportable to the Bureau of Labor Statistics (BLS), it should be noted that the BLS does not collect data from the self-employed, whereas most lobstermen are in fact self-employed. Nevertheless, the rate of injuries receiving treatment (17.5/100 FTE) was much higher than the overall rate (2.1/100 FTE) of reportable injuries in all of fishing and hunting.²⁴

The body location of the injuries reported here is consistent with reports about pain in other commercial fisheries,²⁵ and with exposure assessments in lobstering.²⁶ There were more injuries that affected work reported to have occurred to the low back and the wrist/hand areas than injuries at other body segments. All the wrist/hand injuries affecting work received treatment, in contrast to only some of the low back injuries. This may have indicated that the wrist/hand injuries tended to be too severe to work with, while the low back injuries were not as debilitating. It seems likely, however, the hand/wrist injuries received treatment more consistently than the back injuries, because the hand/wrist injuries were more easily treatable, or perhaps, some qualitative aspect of the respective treatments was more important to receiving treatment than simply that an injury was severe enough to affect work. Another possible underlying factor is the relative importance of the implications of the pain location to the function of the work, such that, given a hypothetical equivalence of severity, the effect of an injury to the hand/wrist is less easily endured than to the low back. Regardless of the reason, it is remarkable that 12 more reports of unique hand/wrist injuries received treatment ($N = 76$) than affected work ($N = 64$), whereas only 7 low back injuries were reported to have received treatment of 47 that affected work.

All self-reported data carry the inherent problem of subject recall, so our data were limited in this way. However, data collection was employed to minimize recall bias to the extent possible. Possibly, also, injuries suffered by crew were under-reported by captains, who were the only sources of data in this study. Still, these data must be recognized as part of an active data collection method in contrast to a less sensitive, passive system of surveillance for BLS rates. This

report did not generate data on duration of injury, and that should be considered a limitation.

In our determination of the denominator of occupational exposure, “time lobstering”, the estimated potential of FTE per boat, calculated from data collected in the survey, was multiplied by the total number of licenses, obtained from each state’s official licensing database, to produce the FTE for the industry. We assumed that within our cohort, the number of lobstermen who did not fish in a season would represent a proportion generalizable to the general industry. However, we do not know whether the proportion of lobstermen originally excluded during recruitment for the survey because they had no intention to fish was generalizable to the whole population. In any case, because the cohort only included lobstermen who were licensed and considered to be actively lobstering, our calculation of FTE would have overestimated the denominator in the calculation of the fatality rate for the industry, and thus, underestimated the rate itself.

Many of the reported cuts, punctures, and bruises were considered routine in unsolicited comments by the subjects of this study. This did not mean they were insignificant. Injuries affecting work and injuries requiring treatment are fair threshold qualifications of severity. Reports on these variables should be used to inform occupational health intervention. Compared to other industries, the observed rate of injuries affecting work was very high, at 16.9/100FTE, as was the 17.5/100FTE found for injuries that received treatment. Noted in prior reports,^{17,27} the non-routine approach to working at sea, and the fact that the lobstermen cannot generate income without days at sea, might affect how lobstermen think about a “day off” from work to treat an injury.

Conclusion

Studies examining commercial fishing health and safety are developing a quantitative understanding of an industry long qualitatively understood to expose fishermen to high risk. This study advances that understanding through primary data collected from a representative sample of lobstermen in the northeast United States that characterized and tracked the rate of injuries that occurred at a rate

of 17.5 injuries and that required treatment per 100 FTE of lobstering time. Research and dissemination of possible means to effectively reduce these rates is needed.

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Disclosure statement

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