

# Dungeness crab fishermen perceptions of injury causation and factors in staying safe

Sabrina Pillai<sup>1</sup>, Viktor E. Bovbjerg<sup>1</sup>, Amelia Vaughan<sup>1</sup>, Kaety R. Jacobson<sup>2</sup>,  
 Laura N. Syron<sup>1</sup>, Laurel D. Kincl<sup>1</sup>

<sup>1</sup>Oregon State University, Corvallis, Oregon, United States

<sup>2</sup>Oregon Sea Grant, Oregon State University Lincoln County Extension, Newport, Oregon, United States

## ABSTRACT

**Background:** Commercial fishing is a hazardous occupation in the United States (US). Injury surveillance data relies heavily on US Coast Guard reports, which capture injuries severe enough to require reporting. The reports do not incorporate the fishermen's perspective on contributing factors to injuries and staying safe while fishing.

**Materials and methods:** We conducted a pre-season survey of Dungeness crab fishermen during 2015 to 2016. Community researchers administered surveys to fishermen. Respondents reported their opinions about factors contributing to injuries and staying safe, which were grouped into similar themes by consensus. Descriptive statistics were calculated to explore the number of injuries, crew position, age, and years of experience. Chi-square tests compared perceptions of injury causation, staying safe, and other factors.

**Results:** Four hundred twenty-six surveys were completed. Injury causation perceptions were sorted into 17 categories, and staying safe perceptions were sorted into 13 categories. The most frequently cited causes of injury were heavy workload (86, 21.9%), poor mental focus (78, 19.9%), and inexperience (56, 14.3%). The most frequently cited factors in staying safe while fishing were awareness (142, 36.1%), good and well-maintained fishing gear/vessel (41, 10.4%), and best marine practices (39, 9.9%). Opinions were not significantly associated with experiencing an injury in the past while fishing, but some opinions were significantly associated with crew position, age, and years of experience.

**Conclusions:** The perceptions of fishermen can be evaluated further and incorporated into training or intervention development. The fishermen-led approach of this project lends itself to developing injury prevention strategies that are effective, realistic and suitable. The resources available at FLIPPresources.org, such as informational sheets for new fishermen, sample crew agreements, and first aid kit resources, supply workers in this fishery with real solutions for issues they identified through their survey responses.

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**Key words:** fisheries, wounds and injuries, occupational health, community-based participatory research

## INTRODUCTION

Commercial fishermen have the second highest fatality rate of all civilian job categories in the United States (US), with a rate of 86 fatal work injuries per 100,000 full-time equivalent workers (FTEs) [1]. Comparatively, it is over 23 times the fatal injury rate for all civilian job categories nationally, 3.6 per 100,000 FTEs [1]. While much published data exists about fatalities and factors relating to fatal incidents, little exists about non-fatal injuries in this industry.

The Dungeness crab fishery is economically important to the US states of Washington, Oregon, and California. In 2015, it produced 22.7 million pounds of crab and generated \$105 million in revenue [2]. It employs approximately 1700 workers each year [3]. This crab fishery has been identified as the second most hazardous fishery in Washington, Oregon, and California, with 114 fatalities per 100,000 FTEs during 2000 to 2014 [4]. An analysis using information abstracted from US Coast Guard (USCG) investigation reports found 28

✉ Sabrina Pillai, Doctoral Student, Oregon State University, 101 Milam Hall, 97331 Corvallis, Oregon, United States, e-mail: sabrina.pillai@oregonstate.edu

fatal and 45 nonfatal injuries in the Dungeness crab fleet over a 12-year period [5], which encompasses only the most severe injuries and is vulnerable to underreporting [5]. A study assessing non-fatal injuries directly with fishermen in this fishery could identify non-fatal injuries that are not consistently captured by USCG systems. Identifying all injuries — not just severe ones — could mean a substantial reduction in worker morbidity and potential cost savings.

The Fishermen Led Injury Prevention Programme (FLIPP) characterised the patterns of non-fatal injuries in the West Coast Dungeness crab fishery to obtain comprehensive estimates of injury burden. It also collected information on safety and injury perceptions of fishermen to inform prevention strategies. This was achieved through the development of a survey instrument in collaboration with the crab fishing fleet. No published research describing injuries to date has surveyed Dungeness crab fishermen directly. This identified the perceived causes of injuries and factors in staying safe as a Dungeness crab commercial fisherman, as assessed by fishermen themselves. It also determined whether perceptions differ by previously experienced injuries, crew position, age, or years of fishing experience. By incorporating the fisherman's perspective, injury prevention strategies can be more closely tailored and more readily adopted.

## MATERIALS AND METHODS

### PARTICIPANTS

Participants included individuals working in commercial fishing who were at least 18 years of age. They were recruited from coastal fishing docks in the US states of California, Oregon, and Washington. All participants consented to participation.

### DATA SOURCE

This analysis utilises data from the FLIPP pre-season survey of Dungeness crab fishermen during the 2015–2016 season. The survey was developed using knowledge gained from focus groups held in seven West Coast crabbing ports. During the focus groups led by trained local fishing community researchers, fishermen and relevant stakeholders gave their input on perceived gaps in the current injury research in the Dungeness crab fleet. The participants gave their feedback on which factors should be assessed to enhance understanding of injury risk. Community researchers pilot-tested the survey in Washington, Oregon, and California. The survey included consent procedures; it did not collect identifying information. The study was approved by the Oregon State University Human Research Protection Program and Institutional Review Board.

The survey included 27 questions, consisting of a combination of free response, multiple choice, multiple an-

swer, and Likert scale questions. Fishermen were asked to self-report all injuries experienced in the past year while commercial fishing. Respondents reported on their commercial fishing activities, injury experience, opinions on safety while engaged in fishing activities, and demographics. In the survey, we asked specifically for injuries that happened in relation to commercial fishing, including shore and/or land-based activities such as working in the gear yard. Per the survey instructions: “By injury we mean a time when your body was damaged and required first aid/medical care at the time of injury or after the injury OR caused time away from fishing or other work OR required you to change how you did your job to accommodate the injury.”

Community researchers administered the paper-based surveys directly to fishermen dockside in the states of Washington, Oregon, and California prior to the 2015–2016 Dungeness crab season. A total of 426 surveys were completed and collected from 21 ports in the three states.

### DATA ELEMENTS

The outcomes of interest, perceived causes of injury, and factors in staying safe, were measured in the survey by two open-ended questions: “What do you think contributes most to commercial fishing injuries?” and “What are two things you think are most important for staying safe while commercial fishing?” Additional survey items included in the analyses were respondent-reported number of injuries in the past year and over the fishing career, crew position (deckhand, captain, owner), age, and number of years of experience as a commercial fisherman.

### ANALYSIS

We asked for one response to the question, “What do you think contributes most to commercial fishing injuries?”, and two responses to the question, “What are two things you think are most important for staying safe while commercial fishing?” First, the individual responses from both questions were condensed into 250 unique responses. Research team members ( $n = 7$ ) independently sorted them into common themes. These independently derived themes were then reviewed by two of the research team to arrive at a consensus. The finalised themes were then assigned by a third member of the research team to each individual response for analysis.

Descriptive statistics characterized the outcomes, number of injuries in the past year, number of injuries over the fishing career, crew position, age, and years of fishing experience. Chi-square tests of independence were used to compare categorical variables by the outcomes. Chi-square tests for equality of medians were used to compare continuous variables by the outcomes. Missing (no response) values were not included in percentage calculations or chi-

**Table 1.** Fishermen demographics

	Range	Mean ± SD
Age (n = 395)	18–80	39.7 ± 14.7
Years of experience (n = 422)	0–60	17.4 ± 14.2
	Frequency	%
At least one injury in past year:		
Yes	77	18.6
No	336	81.4
Missing	13	
Total	426	100
At least one injury in career:		
Yes	203	51.4
No	192	48.6
Missing	31	
Total	426	100
Crew position:		
Deckhand	207	52.0
Owner	140	35.2
Captain	51	12.8
Missing	28	
Total	426	100

SD – standard deviation

square tests. All statistical analyses were completed using R version 3.5.0 [6].

## RESULTS

A total of 426 surveys were completed and collected from 21 ports in three states. The mean age of fishermen was 39.7 years (range: 18–80), and the mean years of experience was 17.4 years (range: 0–60). Approximately 1 in 5 fishermen reported experiencing at least one injury in the past year (77, 18.6%); however, roughly half reported experiencing at least one injury in their fishing career (203, 51.4%). The crew positions of respondents consisted of 207 (52.0%) deckhands, 140 (35.2%) owners, and 51 (12.8%) captains (Table 1). For the outcome “What do you think contributes most to commercial fishing injuries?”, 17 response themes were identified. Respondents cited heavy workload (86, 21.9%), poor mental focus (78, 19.9%), and inexperience (56, 14.3%) as the most frequent causes of commercial fishing injuries (Table 2). For the outcome “What are two things you think are most important for staying safe while commercial fishing?”, 13 response themes were identified. Respondents cited awareness (142, 36.1%), good and well-maintained fishing gear/vessel (41, 10.4%), and best marine practices (39, 9.9%) as the most frequent factors in staying safe while commercial fishing (Table 3).

There were no statistically significant differences in perceived causes of injury opinion or staying safe opinions among those who had and had not experienced at least one injury in the past year, nor among those who had and had not experienced at least one injury in their career.

For perceived causes of injury opinions, poor mental focus, inexperience, drugs/alcohol, unsafe practices, and poor physical condition/self-care differed by crew position. Inexperience and bad luck differed by age. Poor mental focus, inexperience, unsafe vessel and/or gear, unsafe crew, and poor working conditions differed by years of experience. For staying safe opinions, experience differed by crew position and age. Chi<sup>2</sup> results for each opinion are presented in Tables 2 and 3.

## DISCUSSION

Injuries among Dungeness crab fishermen are common. This study helps shed light on the opinions of these fishermen regarding what they believe causes injuries and what factors are important for staying safe while fishing. By requesting free-text responses from fishermen, the research team was able to elicit a wide variety of feedback, without leading or restricting respondents.

Common themes emerged when the individual responses were systematically categorised. Heavy workload, poor mental focus, and inexperience were the top perceived causes of injuries. Awareness, good and well-maintained fishing gear/vessel, and best marine practices were the top perceived factors for staying safe while fishing. Previously experiencing an injury did not influence opinions. Similarly, Eklöf [7] found that previously experiencing an injury did not influence a sample of Swedish fishermen’s reported engagement in safe work practices. Given the common nature of injuries in fisheries, particularly minor injuries, past experiences could have little impact on future opinions and behaviours. A study of North Atlantic fishermen in the US reported a similar finding: workers who experienced more injuries found various types of dangerous fishing conditions less concerning [8].

Some differences were found by crew position, age, and years of experience. In particular, the themes of inexperience (perceived causes of injury) and experience (factors in staying safe) differed by both crew position and age. Generally, deckhands are more likely to experience the harshest working conditions. However, Dungeness crab vessels typically have crews of only 3 to 5. Work roles are often not clearly delineated, with captains and owners commonly engaging in strenuous deckhand tasks as well. Younger workers generally have less experience in commercial fishing than older workers. Focused, standardized training for those new to Dungeness crab fishing should be implemented, given the unique nature of fishing for this particular species.

**Table 2.** Perceived causes of injury among Dungeness crab fishermen

Theme	Frequency	%	Injury past year		Injury career		Crew position		Age		Years of experience	
			Chi <sup>2a</sup>	p	Chi <sup>2a</sup>	p	Chi <sup>2a</sup>	p	Chi <sup>2b</sup>	p	Chi <sup>2b</sup>	p
Heavy workload	86	21.9	0.37	0.829	0.19	0.909	6.84	0.144	4.82	0.090	4.86	0.088
Poor mental focus	78	19.9	0.19	0.909	0.06	0.971	<b>10.21</b>	<b>0.037</b>	8.14	0.017	<b>7.12</b>	<b>0.028</b>
Inexperience	56	14.3	0.70	0.706	0.20	0.903	<b>10.07</b>	<b>0.039</b>	<b>9.45</b>	<b>0.009</b>	<b>10.41</b>	<b>0.005</b>
Weather and/or sea conditions	38	9.7	4.98	0.083	0.59	0.744	6.58	0.160	4.40	0.111	5.47	0.065
Stupidity	29	7.4	1.34	0.512	0.06	0.973	6.62	0.157	4.91	0.086	5.51	0.063
Unsafe vessel and/or gear	26	6.6	0.17	0.919	0.64	0.726	8.23	0.083	4.24	0.120	<b>6.38</b>	<b>0.041</b>
Unsafe attitude	18	4.6	2.00	0.368	3.45	0.178	7.20	0.126	4.28	0.118	4.89	0.087
Drugs/alcohol	16	4.1	1.79	0.409	1.54	0.463	<b>10.47</b>	<b>0.033</b>	4.84	0.089	4.89	0.087
Bad luck	11	2.8	5.61	0.060	1.50	0.473	6.96	0.138	<b>7.94</b>	<b>0.019</b>	5.46	0.065
Rushing	10	2.6	0.17	0.917	0.12	0.943	5.83	0.212	4.42	0.110	5.12	0.077
Lack of training/ /safe procedures	6	1.5	0.16	0.921	0.31	0.859	8.43	0.077	5.20	0.074	4.87	0.088
Unsafe crew	5	1.3	1.71	0.425	0.20	0.903	7.38	0.117	5.69	0.058	<b>9.51</b>	<b>0.009</b>
Unsafe practices	4	1.0	0.27	0.873	0.05	0.975	<b>14.00</b>	<b>0.007</b>	4.25	0.119	4.86	0.088
Bad attitude	3	0.8	0.83	0.660	0.44	0.804	6.28	0.179	4.24	0.120	5.12	0.078
Poor physical condition/self-care	3	0.8	0.83	0.660	0.34	0.845	<b>14.44</b>	<b>0.006</b>	4.71	0.095	5.28	0.071
Ego	2	0.5	1.48	0.478	0.05	0.975	8.70	0.069	3.38	0.066	4.86	0.088
Poor working conditions	1	0.3	0.38	0.827	1.10	0.576	7.73	0.102	3.48	0.062	<b>4.04</b>	<b>0.044</b>
No response	34											
Total	426	100										

<sup>a</sup>Pearson Chi<sup>2</sup> test of independence; <sup>b</sup>Pearson Chi<sup>2</sup> test for equality of medians

The ideas presented by the fishermen can have an impact on realistic intervention development. Several of the themes appear related and can be grouped together when planning prevention strategies. For example, inexperience, “stupidity,” unsafe crew, unsafe practices, and lack of training/safe procedures can all be addressed with appropriate training and training requirements. Revising the current make-up of training for new crew, ongoing training practices for continuing crew, and the mechanisms for training delivery can all help to improve crew safety. Rushing and heavy workload could be addressed with work organisation and practices that pace and allow for appropriate rest, while not affecting productivity. Health promotion resources that are tailored for and readily accessible to fishermen can address poor physical condition/self-care and drugs/alcohol. Outreach to fishermen by fisheries management and regulatory bodies in the US is not always seen as successful [9]. All of the potential interventions mentioned above would be bolstered by collaborative relationships between fishermen and management.

Captains must be responsible for best marine practices, good and well-maintained fishing gear/vessel, and emergency drills and preparation. Captains and owners should promote safety culture, while all crew members have a role in communication on board. In a study by Poggie et al. [10], an owner-operator on board the vessel was strongly correlated with the perception that human error and carelessness contributed to accidents. Having a good crew agreement and identifying resources to help captains should be explored. Also, educating new potential fishermen on how to assess these issues is key in keeping captains accountable. Crew agreements and informational sheets to be distributed to new fishermen have been developed by this research team and are publicly available online at the project website [11]

#### LIMITATIONS OF THE STUDY

This study was the only to date to directly survey Dungeness crab fishermen for the purposes of describing injuries. One limitation was reliance on self-reported data. Fishermen

**Table 3.** Perceived factors in staying safe among Dungeness crab fishermen

Theme	Frequency	%	Injury past year		Injury career		Crew position		Age		Years of experience	
			Chi <sup>2a</sup>	p	Chi <sup>2a</sup>	p	Chi <sup>2a</sup>	p	Chi <sup>2b</sup>	p	Chi <sup>2b</sup>	p
Awareness	142	36.1	0.03	0.984	4.60	0.100	5.27	0.261	0.27	0.873	0.14	0.930
Good/well-maintained fishing gear/vessel	41	10.4	2.37	0.305	1.27	0.529	3.89	0.421	2.14	0.343	0.89	0.641
Best marine practices	39	9.9	0.03	0.985	1.65	0.438	5.74	0.219	0.10	0.950	0.24	0.888
Crew/skipper	35	8.9	1.54	0.463	1.37	0.504	6.19	0.186	2.45	0.294	5.00	0.082
Self-care	35	8.9	0.48	0.786	1.33	0.515	1.51	0.825	0.32	0.853	3.76	0.153
Wisdom	26	6.6	1.99	0.370	1.64	0.439	8.42	0.077	0.40	0.821	2.92	0.232
Experience	20	5.1	0.19	0.909	1.29	0.524	<b>19.50</b>	<b>0.001</b>	<b>6.21</b>	<b>0.045</b>	5.60	0.061
Physicality	14	3.6	0.97	0.617	3.41	0.181	2.47	0.650	0.05	0.97	0.30	0.860
Communication	13	3.3	1.33	0.515	2.82	0.244	8.73	0.068	1.63	0.442	3.77	0.152
Drills and preparation	11	2.8	0.51	0.775	2.96	0.228	1.86	0.761	0.64	0.724	0.18	0.915
Drug/alcohol free	6	1.5	0.89	0.642	2.83	0.243	4.53	0.339	0.89	0.642	0.06	0.972
Understand fatigue management	6	1.5	0.89	0.642	2.12	0.346	1.57	0.814	0.33	0.850	0.79	0.675
Personal	5	1.3	1.54	0.462	5.90	0.052	2.00	0.736	0.46	0.796	0.23	0.890
No response	33											
Total	426	100										

<sup>a</sup>Pearson Chi<sup>2</sup> test of independence; <sup>b</sup>Pearson Chi<sup>2</sup> test for equality of medians

might be unwilling or unable to accurately report their injury experiences, particularly for non-severe injuries. Typically, recalling severe injury experiences from memory results in more accurate information than recalling minor injury experiences. The vast majority of injuries reported were not treated by medical professionals, so there is no practicable alternative to self-report. Primary data collection of injuries, even with limited reliability, can provide some insight for injury prevention strategies especially when worker perceptions of what causes injuries and what works to stay safe are included. Another limitation is the use of only the first response to the question “What are two things you think are most important for staying safe while commercial fishing?” The second response to this question was excluded because of the low response rate and to avoid non-independent responses.

## CONCLUSIONS

The fishermen-led approach of this project lends itself to developing interventions that are feasible and suitable to the Dungeness crab fishing community. Fishermen may be more likely to take part in future interventions if they are incorporated into the decision-making process, and, in addition, if the interventions reflect their priorities and experience. The FLIPP study included perceptions of injury cause and of factors relating to staying safe based on

fishermen recommendations during survey development. Injury control measures may be more likely to be successful if informed both by epidemiologic data and the perceptions of the workforce who will be implementing those measures.

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