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Predictors of personal flotation device (PFD) use among workers in the Alaska commercial fishing industry

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ABSTRACT

Introduction

The purpose of this study was to identify the predictors of personal flotation device (PFD) use among workers in the Alaska commercial fishing industry.

Methods

This study analyzed data from a questionnaire administered to fishing industry workers on four types of commercial fishing vessels in Alaska. Workers' risk perceptions of falling overboard, attitudes regarding PFDs, and other factors were compared using Chi-square tests. A forward stepwise procedure was used to fit multivariate logistic regression models predicting PFD use.

Results

PFD usage ranged from 0% reporting always using a PFD among longliners to 51% among trawlers. Among the statistically significant predictors of PFD use identified in multivariate models, the belief that PFDs were an entanglement hazard was inversely associated with any use of PFDs among longliners (OR 0.38; 95% CI: 0.20, 0.73) and gillnetters (OR 0.38; 95% CI: 0.19, 0.76). The belief that PFDs interfered with work was inversely associated with high use of PFDs among crabbers (OR 0.16; 95% CI: 0.06, 0.45) and with always using PFDs among trawlers (OR 0.35; 95% CI: 0.16, 0.78). Other significant predictors were specific to each vessel type.

Conclusions

Interventions to increase PFD use in the fishing industry should be tailored to each vessel type and focus on addressing the significant barriers to PFD use. Workers may increase PFD usage if they are familiarized with newer PFDs that have been tested and accepted by their peers.

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1. Introduction

Commercial fishing is the most hazardous occupation in the US, with a fatality rate of 116 deaths per 100,000 workers during 2010 (Bureau of Labor Statistics, 2011). During 2000–2009, 155 workers in the US fishing industry (crewmembers on commercial fishing vessels) drowned after falling overboard (Lincoln and Lucas, 2010). None of the victims were wearing a personal flotation device (PFD). These fatal falls overboard were the second largest cause of work-related fatalities, accounting for 31% of all fatalities in the US fishing industry for those years (Lincoln and Lucas, 2010), with only vessel disasters accounting for more.

Fatal falls overboard are a persistent problem. During 1990–2005, an average of 4.4 workers died each year after falling overboard in Alaska, and the rate of fatal falls overboard during that time period did not decline (Lucas and Lincoln, 2007). During 2000–2009, 76% of fatal falls overboard occurred on four types of fishing vessels: drift gillnetters (14, 37%), longliners (9, 24%), crabbers (4, 11%), and trawlers (2, 5%) (National Institute for Occupational Safety and Health, 2011). During 2009, approximately 6700 workers were employed on gillnetters (vessels towing gillnets, primarily to catch salmon), 10,600 on longliners (vessels anchoring strings of baited hooks on the ocean floor to catch a variety of bottom fish), 1100 on crabbers (vessels dropping baited pots to catch crab on the ocean floor), and 4300 on trawlers (vessels towing large trawl nets to catch groundfish and some pelagic fish) (NIOSH, 2011).

The National Institute for Occupational Safety and Health (NIOSH) has repeatedly identified falling overboard as a critical

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hazard in the commercial fishing industry and as an area where prevention efforts could significantly reduce the number of fatalities (NIOSH, 1997, 2002). Primary prevention of falling overboard through engineering and administrative controls would likely be the most effective way to prevent these fatalities, but given the operational nature of commercial fishing, this may not always be possible. For example, on most vessels the deck area must be open to allow fishing gear to be set and retrieved, making an engineering intervention such as enclosing the deck unfeasible. When falls overboard do occur, proper PFD use can greatly increase survivability (Jones, 1999; NIOSH, 1994; National Transportation Safety Board, 1993).

The physiologic response to cold water immersion involves three phases that are important for understanding PFD efficacy and necessity. The first phase involves initial immersion and the cold shock response which causes victims to experience an immediate inspiratory gasp response, subsequent hyperventilation, and an inability to breath-hold. The second phase involves short-term immersion and a loss of physical performance which erodes coordinated swimming motions and the ability to assist with rescue efforts. The third phase involves long term immersion and the onset of hypothermia as the core temperature in the victim cools below 35 °C (Giesbrecht and Steinman, 2012). Without flotation and thermal protection, death from cold water immersion may occur during all three phases.

An average person requires at least seven pounds of extra buoyancy to stay afloat with the mouth and nose out of the water (Brooks, 2003). PFD use can provide this necessary buoyancy, yet there are currently no mandates by regulatory agencies in the United States for fishing industry workers to wear PFDs.

There is a lack of published literature examining the predictors of PFD use among fishing industry workers. However, in a project to develop safer work clothing for fishing workers, Geving et al. (2006) surveyed 306 workers and found that 45.8% requested flotation to be integrated into their normal work clothes, suggesting that they recognized the benefit of flotation and had an interest in new PFD designs to increase comfort and convenience. PFDs are a form of personal protective equipment (PPE), and many studies have examined the barriers to PPE use in a variety of industries. One study on the use of anti-slipping boots in the Denmark fishing industry found that the boots effectively reduced slips, trips and falls, and that workers were generally satisfied with the comfort of the boots (Jensen and Laursen, 2011).

Barriers to PFD use among workers in the fishing industry may be similar to barriers to wearing respirators, helmets, fall protection and other types of PPE experienced by other workers. Studies of PPE use in other industries have reported fairly consistent results (Akbar-Khanzadeh, 1998; Edelson et al., 2009; Forst et al., 2004; Lombardi et al., 2009; Salazar et al., 2001; Schenker et al., 2002). Common reasons for non-use include discomfort, misperceptions of risk, and negative attitudes about PPE efficacy. Findings regarding other factors, such as training and age, have been mixed (Blanco-Munoz and Lacasana, 2011; Nicol and Kennedy, 2008).

Among fishing industry workers, perceptions of risk and attitudes regarding PFDs may be similar to those of workers in other industries regarding PPE. Fishing industry workers who do not wear PFDs may under estimate the risk of falling overboard. They may feel that a PFD will be uncomfortable and impede their ability to work. There may also be the belief that a PFD not designed for their working conditions could endanger them by restricting their movements, or by creating an entanglement hazard. Some workers may also believe that wearing a PFD will not improve their survival in cold water because they misunderstand the physiology of cold water immersion. For instance, it is generally a widespread misperception that hypothermia will cause death within several minutes of cold water immersion regardless of PFD usage.

The purpose of this study was to examine the associations between risk perceptions of falling overboard, history of falling overboard, attitudes regarding PFDs, and the actual use of PFDs in order to identify the predictors of PFD use.

2. Material and methods

2.1. Data source

This study used data collected during 2008–2009 by research staff at the NIOSH Alaska Pacific Regional Office. The data were self-reported and collected with an anonymous questionnaire distributed to fishing industry workers on four types of commercial fishing vessels: longliners, gillnetters, crabbers and trawlers. These vessels were operating in the Southwest and Southcentral regions of Alaska, which include the Alaska Peninsula, Bristol Bay, the Bering Sea, and the Gulf of Alaska. They were selected for inclusion in this study because of their contribution to the majority of fatal falls overboard in Alaska (NIOSH, 2011).

The questionnaire included 32 closed-ended questions designed to measure workers' current perceptions of the risk of falling overboard, history of falling overboard, attitudes about PFD efficacy and comfort, and demographic and vessel information. The questionnaire was pilot tested with a focus group of fishing industry workers, and revised using their feedback. The study protocol and survey instrument were reviewed and approved by the National Institute for Occupational Safety and Health Human Subjects Review Board as well as the Office of Management and Budget.

Several days prior to the start of a fishing season, research teams traveled to five fishing ports to survey workers. Crabbers were surveyed in October 2008, trawlers in January 2009, longliners during March–April 2009, and gillnetters in June 2009. The research teams walked the docks and boat yards, contacted workers onboard vessels, and distributed the questionnaire until 100 workers had completed it on each of the four vessel types. The sampling was stratified by vessel type to ensure that a sufficient sample size would be obtained within each vessel type to allow for analysis of each vessel type separately. Refusals to participate were recorded for response rate calculations. The response rate for the survey was 97%, with 409 completed surveys.

2.2. Data elements

The outcome of interest, PFD usage, was measured in the survey by the question "How often do you wear a PFD on deck?" Response categories were: Never, Sometimes, Frequently, or Always. Three categories of predictors of PFD use were examined:

(1) *Risk perceptions* included perceived seriousness of falling overboard and perceived susceptibility to falling overboard. These two types of risk perception are major constructs of the Health Belief Model (Strecher and Rosenstock, 1997).
(2) *Attitudes about wearing PFDs* included perceived efficacy, discomfort, interference with work, and creation of new hazards.
(3) *Demographic and personal characteristics* included age, history of falling overboard, job position onboard, completion of formal safety training, months spent per year fishing, self-efficacy, and years of experience fishing.

2.3. Statistical analysis

Descriptive statistics were calculated for all variables. The distributions of all variables in the analysis were compared across the four vessel types. Chi-square tests for independence were used

to compare categorical variables by vessel type. Chi-square tests for equality of medians were used to test the difference in medians of continuous variables by vessel type.

Based on this study team's prior research experience with fisheries in Alaska, it was expected a priori that there would be large differences in PFD usage between the four vessel types, which would necessitate analyzing each vessel type separately. Indeed, preliminary examination of the PFD usage variable found large differences in the response distributions for each vessel type. Within each vessel type, at least one of the four response categories had too few cases for statistical analysis; hence, the following vessel-specific binary outcome variables were created for use in logistic regression models: (1) longliners and gillnetters – sometimes/frequently/always use a PFD vs. never use a PFD; (2) crabbers – frequently/always use a PFD vs. sometimes/never use a PFD; and (3) trawlers – always use a PFD vs. never/sometimes/frequently use a PFD.

Unadjusted associations between PFD use and each potential predictor were examined separately for each vessel type using logistic regression. Each odds ratio was interpreted as the change in the odds of PFD use for each one unit increase of the predictor. These crude associations assisted the exploration of the data and informed the procedure for fitting the subsequent multivariate models. Ordered categorical variables were treated as continuous in the analysis when the logit-transformed predicted probabilities of the outcome were linear and the Hosmer–Lemeshow test for goodness-of-fit was not statistically significant.

A forward stepwise procedure with a criterion for entry of $P < 0.05$ was used to fit multivariate logistic regression models with the same vessel-specific PFD use outcome as in the unadjusted models. All of the variables included in the unadjusted models were eligible for inclusion in the final multivariate model. The final model contained only the variables which had $P < 0.05$ while holding other variables in the model constant.

The likelihood ratio test was the primary determinant of association for all regression models. The Hosmer–Lemeshow test was used to assess overall model fit. The Pregibon Delta–Beta influence statistic (dbeta) was used to identify influential subjects and potential outliers. All statistical analyses were completed using Stata version 11.2 (StataCorp, 2009).

3. Results

The descriptive analysis revealed statistically significant differences in characteristics of workers on the four vessel types (Tables 1–3). Gillnetters were the youngest workers (median 30.5 years) with the least experience (median 7.0 years), while trawlers were the oldest workers (median 45.0 years) with the most experience (median 22.0 years). Gillnetters typically fished two months per year, while trawlers, crabbers and longliners all worked approximately seven months per year. Trawlers had the highest completion of formal safety training (94.0%), while gillnetters had the lowest (51.4%).

Use of PFDs differed by vessel type (Table 1). None of the longliners and only 4.7% of the gillnetters reported always wearing a PFD, as opposed to 22.3% of crabbers and 51.0% of trawlers. The majority of longliners and gillnetters never wore a PFD (64.3% and 55.1% respectively), compared to 12.0% of trawlers and 15.5% of crabbers.

Workers on each vessel type had differing risk perceptions and experiences with falling overboard (Table 2). Longliners had the highest percentage of workers having fallen overboard in the past (48.0%), followed by crabbers (31.7%), gillnetters (27.1%), and trawlers (21.0%). Gillnetters had the highest perceived susceptibility to falls overboard, with a perceived 41.9% mean chance of falling overboard during their career; trawlers had the lowest (27.8%).

Workers' attitudes about PFDs varied across vessel types. Almost 57% of gillnetters believed that PFDs were very effective, compared to 36.5% for longliners (Table 3). Trawlers had the most positive beliefs about PFD comfort, interference with work, and threat of the PFD becoming an entanglement hazard. Longliners and gillnetters had the least positive beliefs on those items (Table 3).

3.1. Predictors of any use of PFDs among longliners

The outcome for the regression models for longliners was defined as any use of PFDs. The distribution of this variable was 64% never use PFDs and 36% any use of PFDs. In unadjusted logistic regression models, six predictors were statistically significant at $P < 0.05$ (Table 4).

Table 1
Characteristics of sample by vessel type.

Continuous variables	Longliners				Gillnetters				Crabbers				Trawlers				Chi[2a]	*P*-value
	n	Mean	Med	SD	*n*	Mean	Med	SD	*n*	Mean	Med	SD	*n*	Mean	Med	SD		
Age (years)	98	38.2	38.5	11.3	107	35.1	30.5	14.3	104	37.7	38.0	10.0	100	42.3	45.0	9.6	21.8	<0.001
Experience (years)	98	20.2	20.0	11.0	106	14.5	7.0	14.4	104	18.1	19.0	9.9	100	20.8	22.0	9.3	21.2	<0.001
Season (months)	98	7.4	7.5	2.0	107	3.7	2.0	2.9	104	6.7	7.0	1.9	100	6.8	7.0	1.3	50.2	<0.001
Vessel length (ft)	98	56.8	58.0	13.0	107	31.9	32.0	1.4	104	121.9	125.0	13.5	100	148.8	148.5	28.1	402.0	<0.001
Crew size (# workers)	98	4.3	5.0	0.9	107	3.6	4.0	0.7	104	6.6	6.0	1.5	100	5.9	6.0	1.2	183.4	<0.001
Categorical variables	Freq	%			Freq	%			Freq	%			Freq	%			Chi[2b]	
Sex (male)	96	98.0			100	94.3			104	100.0			100	100.0			11.6	0.009
Position																	46.5	<0.001
Captain	41	41.8			36	34.0			22	21.2			17	17.0				
Deckhand	55	56.1			69	65.1			76	73.0			64	64.0				
Other	2	2.0			1	0.9			6	5.8			19	19.0				
Safety training (yes)	65	67.0			55	51.4			79	76.7			94	94.0			48.8	<0.001
PFD Usage																	186.3	<0.001
Never	63	64.3			59	55.1			16	15.5			12	12.0				
Sometimes	30	30.6			32	29.9			52	50.5			11	11.0				
Frequently	5	5.1			11	10.3			12	11.7			26	26.0				
Always	0	0.0			5	4.7			23	22.3			51	51.0				

[a] Pearson Chi[2] test for equality of medians.
[b] Pearson Chi[2] test for independence.

Table 2
Falls overboard risk perceptions and experiences by vessel type.

Continuous variables	Longliners				Gillnetters				Crabbers				Trawlers				Chi[2a]	*P*-value
	n	Mean	Med	SD	*n*	Mean	Med	SD	*n*	Mean	Med	SD	*n*	Mean	Med	SD		
Chance of fall over (%)	98	38.7	25.0	35.1	107	41.9	30.0	34.1	104	35.0	25.0	32.2	100	27.8	15.0	27.5	5.4	0.144
Chance survival																		
Summer with PFD (%)	98	75.1	80.0	24.5	107	82.0	90.0	20.4	104	80.2	90.0	21.1	100	72.0	80.0	26.1	13.9	0.003
Summer no PFD (%)	98	47.4	50.0	25.3	107	47.9	50.0	28.7	104	47.7	50.0	26.2	100	32.8	30.0	23.9	16.0	0.001
Winter with PFD (%)	98	57.2	50.0	28.9	107	57.1	60.0	24.0	104	65.2	70.0	24.4	100	54.5	50.0	25.6	6.3	0.097
Winter no PFD (%)	98	24.8	20.0	24.1	107	17.5	10.0	21.8	104	21.8	12.5	21.6	100	16.2	10.0	22.0	8.1	0.044
Categorical variables	Freq	%			Freq	%			Freq	%			Freq	%			Chi[2b]	
Worry abt. fall over																	11.9	0.222
Not at all	5	5.1			5	4.7			2	2.0			7	7.0				
Very little	35	35.7			30	28.0			27	26.5			34	34.0				
Somewhat	43	43.9			46	43.0			40	39.2			37	37.0				
Very much	15	15.3			26	24.3			33	32.4			22	22.0				
Avoid fall overboard																	6.3	0.393
Not very much	7	7.1			2	1.9			5	4.8			3	3.0				
Some	36	36.7			31	29.0			33	31.7			34	34.0				
A lot	55	56.1			74	69.2			66	63.5			63	63.0				
Fallen overboard (yes)	47	48.0			29	27.1			33	31.7			21	21.0			18.3	<0.001
Know a survivor (yes)	87	88.8			79	73.8			94	90.4			86	86.0			13.7	0.003
Know a fatality (yes)	41	41.8			28	26.4			54	51.9			34	34.0			15.8	0.001

[a] Pearson Chi[2] test for equality of medians.
[b] Pearson Chi[2] test for independence.

Table 3
Attitudes regarding personal flotation devices (PFDs) by vessel type.

Variables	Longliners		Gillnetters		Crabbers		Trawlers		Chi[2a]	*P*-value
	Freq	%	Freq	%	Freq	%	Freq	%		
PFD effectiveness									18.1	0.006
Not at all	0	0.0	0	0.0	0	0.0	0	0.0		
Somewhat effective	21	21.9	15	14.2	13	12.8	7	7.0		
Fairly effective	40	41.7	31	29.3	32	31.4	45	45.0		
Very effective	35	36.5	60	56.6	57	55.9	48	48.0		
PFD comfort									41.9	<0.001
Very uncomfortable	30	32.3	24	22.9	15	15.3	4	4.0		
Somewhat uncomfortable	40	43.0	47	44.8	50	51.0	38	38.0		
Somewhat comfortable	19	20.4	29	27.6	26	26.5	50	50.0		
Very comfortable	4	4.3	5	4.8	7	7.1	8	8.0		
PFD Interference									21.4	0.011
Not at all	2	2.1	2	1.9	2	2.0	2	2.0		
Very little	17	18.1	13	12.4	18	18.0	25	25.0		
Somewhat	46	48.9	62	59.1	62	62.0	65	65.0		
very much	29	30.9	28	26.7	18	18.0	8	8.0		
PFD entangle hazard									35.7	<0.001
Not at all	11	11.6	5	4.7	6	5.9	2	2.0		
Very little	30	31.6	24	22.6	44	43.6	45	45.0		
Somewhat	42	44.2	51	48.1	39	38.6	49	49.0		
very much	12	12.6	26	24.5	12	11.9	4	4.0		
Wearing a PFD…										
Is a smart thing to do	74	75.5	80	74.8	88	84.6	98	98.0	25.3	<0.001
Is not necessary	19	19.4	20	18.7	4	3.9	1	1.0	29.7	<0.001
Gets in the way	47	48.0	56	52.3	32	30.8	9	9.0	51.8	<0.001
Can save your life	82	83.7	95	88.8	88	84.6	93	93.0	5.0	0.169
Shows intelligence	35	35.7	41	38.3	52	50.0	75	75.0	38.8	<0.001
Creates new hazards	27	27.6	42	39.3	19	18.3	15	15.0	19.7	<0.001
Is a way to be safer	68	69.4	79	73.8	77	74.0	92	92.0	17.2	0.001
Is uncomfortable	51	52.0	57	53.3	45	43.3	30	30.0	14.1	0.003
Should be required	9	9.2	9	8.4	21	20.2	61	61.0	100.6	<0.001

[a] Pearson Chi[2] test for independence.

The multivariate logistic regression model (Table 4) indicated that for longliners, the belief that PFDs are an entanglement hazard was inversely associated with any use of PFDs (OR 0.38; 95% CI: 0.20, 0.73). The belief that wearing a PFD demonstrates intelligence was positively associated with any use of PFDs (OR 5.66; 95% CI: 2.02, 15.85).

3.2. Predictors of any use of PFDs among gillnetters

The distribution of PFD use among gillnetters was similar to that of longliners, and the same outcome variable, any use of PFDs, was used in the regression models. When considered individually (unadjusted), there were 11 statistically significant predictors (Table 5).

Table 4
Predictors of any use of PFDs among longliners.[a]

Predictors	Unadjusted models			Multivariate model[b]		
	n	OR	95% CI	*n*	OR	95% CI
Age (years)	98	1.03	0.99, 1.07			
Experience (years)	98	**1.06**	**1.02**, **1.10**			
Season (months)	97	1.14	0.92, 1.41			
Position						
Captain	96	1.21	0.52, 2.80			
Deckhand (ref)	–	–	–			
Safety training (y/n)[c]	97	1.60	0.64, 4.00			
Chance of fall over (%)	98	1.00	0.99, 1.01			
Chance survival						
Summer with PFD (%)	95	1.01	0.99, 1.03			
Summer no PFD (%)	95	1.00	0.98, 1.01			
Winter with PFD (%)	95	1.01	1.00, 1.03			
Winter no PFD (%)	95	1.00	0.98, 1.02			
Worry abt. fall over (1–4)	98	1.52	0.88, 2.61			
Avoid fall overboard (1–3)	98	1.24	0.63, 2.43			
Ever fallen overboard (y/n)	98	1.04	0.45, 2.38			
Know a survivor (y/n)	98	2.75	0.56, 13.52			
Know a fatality (y/n)	98	1.28	0.56, 2.95			
PFD Effectiveness (1–4)	96	1.49	0.84, 2.64			
PFD Comfort (1–4)	93	1.60	0.96, 2.68			
PFD interference (1–4)	94	**0.43**	**0.23**, **0.79**			
PFD Entangle hazard (1–4)	95	**0.48**	**0.28**, **0.81**	86	**0.38**	**0.20**, **0.73**
Wearing a PFD…						
Is a smart thing to do (y/n)	98	**3.60**	**1.12**, **11.60**			
Is not necessary (y/n)	98	0.80	0.27, 2.32			
Gets in the way (y/n)	98	0.50	0.22, 1.17			
Can save your life (y/n)	98	**10.63**	**1.34**, **84.32**			
Shows intelligence (y/n)	98	**4.27**	**1.76**, **10.34**	86	**5.66**	**2.02**, **15.85**
Creates new hazards (y/n)	98	0.54	0.20, 1.44			
Is a way to be safer (y/n)	98	1.81	0.70, 4.65			
Is uncomfortable (y/n)	98	0.47	0.20, 1.09			
Should be required (y/n)	98	4.14	0.97, 17.73			

[a] 0 = Never use PFD; 1 = any use of PFD (combined sometimes, frequently, and always).
[b] Forward stepwise method with criterion to enter and be retained $p < 0.05$.
[c] All yes/no responses compared yes to no (no was the reference group).

The multivariate logistic regression model indicated that experience in the fishing industry (OR 1.04; 95% CI: 1.01, 1.08) and worry about falls overboard (OR 1.97; 95% CI: 1.02, 3.81) were positively associated with any use of PFDs. The belief that PFDs are an entanglement hazard (OR 0.38; 95% CI: 0.19, 0.76) and the belief that PFDs are uncomfortable (OR 0.37; 95% CI: 0.14, 0.99) were inversely associated with any use of PFDs among gillnetters (Table 5).

3.3. Predictors of high PFD use among crabbers

The distribution of the outcome variable for crabbers (never/sometimes use PFDs vs. frequently/always use PFDs) was 66% low PFD use and 34% high PFD use. Five individual (unadjusted) predictors of high PFD use were statistically significant (Table 6).

The multivariate logistic regression model evaluating all potential predictors simultaneously determined that months worked per year (OR 1.49; 95% CI: 1.11, 1.99), perceived chance of survival in the winter with a PFD (OR 1.03; 95% CI: 1.01, 1.06), and the belief that wearing a PFD demonstrates intelligence (OR 3.07; 95% CI: 1.04, 9.04) were positively associated with high PFD use. Perceived chance of survival in the summer without a PFD (OR 0.98; 95% CI: 0.95, 0.99) and the belief that wearing a PFD interferes with work (OR 0.16; 95% CI: 0.06, 0.45) were inversely associated with high PFD use among crabbers (Table 6).

3.4. Predictors of always use PFDs among trawlers

Among trawlers, the distribution of the outcome (always use PFDs vs. never/sometimes/frequently use PFDs) was 51% always use PFDs, and 49% not always use PFDs (Table 1). Five individual (unadjusted) predictors of always use PFDs were statistically significant (Table 7).

The multivariate logistic regression model for trawlers (Table 7) contained three statistically significant predictors. Experience in the fishing industry (OR 0.94; 95% CI: 0.89, 0.99) and the belief that wearing a PFD interferes with work (OR 0.35; 95% CI: 0.16, 0.78) were inversely associated with always using PFDs. Months worked per year (OR 1.94; 95% CI: 1.24, 3.05) had a positive association.

4. Discussion

Workers on the four vessel types included in this study had different risk perceptions of falling overboard, attitudes and beliefs about PFDs, frequencies of PFD usage, and demographic characteristics. Accordingly, interventions to increase PFD usage should be focused on specific types of fishing vessels to be effective. The following discussion is organized by vessel type.

4.1. Longliners

Longliners had the lowest use of PFDs among workers in this study, yet reported the highest frequency of falling overboard in the past (48% had fallen overboard). Longliners in Alaska had the second highest frequency of fatal falls overboard during 2000–2009 (NIOSH, 2011), underscoring the need to increase PFD usage among these workers.

The descriptive analysis found that longliners had some of the most negative attitudes and beliefs about PFD efficacy, comfort, and interference with work. Attitudes and beliefs about PFDs

Table 5
Predictors of any use of PFDs among gillnetters.[a]

Predictors	Unadjusted models			Multivariate model[b]		
	n	OR	95% CI	*n*	OR	95% CI
Age (years)	106	**1.04**	**1.01, 1.07**			
Experience (years)	106	**1.05**	**1.02, 1.08**	100	**1.04**	**1.01, 1.08**
Season (months)	106	1.06	0.93, 1.21			
Position						
Captain	105	**2.46**	**1.08, 5.62**			
Deckhand (ref)	–	–	–			
Safety training (y/n)[c]	107	1.66	0.77, 3.58			
Chance of fall over (%)	106	1.01	1.00, 1.02			
Chance survival						
Summer with PFD (%)	107	1.00	0.98, 1.01			
Summer no PFD (%)	107	1.00	0.98, 1.01			
Winter with PFD (%)	107	1.01	0.99, 1.02			
Winter no PFD (%)	107	1.00	0.98, 1.01			
Worry abt. fall over (1–4)	107	**2.19**	**1.31, 3.67**	100	**1.97**	**1.02, 3.81**
Avoid fall overboard (1–3)	107	1.50	0.69, 3.25			
Ever fallen overboard (y/n)	107	1.77	0.75, 4.18			
Know a survivor (y/n)	107	**3.24**	**1.24, 8.48**			
Know a fatality (y/n)	106	1.66	0.70, 3.96			
PFD Effectiveness (1–4)	106	1.30	0.76, 2.23			
PFD Comfort (1–4)	105	**2.41**	**1.41, 4.11**			
PFD Interferance (1–4)	105	**0.44**	**0.23, 0.83**			
PFD Entangle Hazard (1–4)	106	**0.43**	**0.25, 0.74**	100	**0.38**	**0.19, 0.76**
Wearing a PFD…						
Is a smart thing to do (y/n)	107	1.54	0.63, 3.77			
Is not necessary (y/n)	107	0.46	0.16, 1.31			
Gets in the way (y/n)	107	**0.28**	**0.13, 0.63**			
Can save your life (y/n)	107	0.36	0.10, 1.29			
Shows intelligence (y/n)	107	2.10	0.95, 4.63			
Creates new hazards (y/n)	107	**0.22**	**0.09, 0.53**	100	**0.37**	**0.14, 0.99**
Is a way to be safer (y/n)	107	1.36	0.57, 3.28			
Is uncomfortable (y/n)	107	**0.26**	**0.12, 0.58**	100	**0.37**	**0.14, 0.99**
Should be required (y/n)	107	1.60	0.40, 6.32			

[a] 0 = Never use PFD; 1 = any use of PFD (combined sometimes, frequently, and always).
[b] Forward stepwise method with criterion to enter and be retained $p < 0.05$.
[c] All yes/no responses compared yes to no (no was the reference group).

among longliners are most likely pre-conceptions; that is, they may not be based on actual experiences since most workers reportedly never wear PFDs. Longliners may have these pre-conceptions of PFDs because they are unfamiliar with newer models which have been designed specifically for the fishing industry.

The results of the multivariate logistic regression model for longliners identified beliefs about entanglement hazards as a predictor for any use of PFDs. For each one unit increase (on a four-point scale) in the belief that PFDs were an entanglement hazard, the odds of any use of PFDs decreased 62%. Longliners have a legitimate reason to be concerned about entanglement hazards, especially on vessels with less automated systems for setting and retrieving fishing gear. Workers on longliners are exposed to fast moving fishing gear containing sharp hooks and lines that have the potential to snag them. A PFD not designed for their work environment could introduce a real hazard.

In a companion study on PFD comfort and satisfaction among longliners, gillnetters, crabbers and trawlers, workers wore and evaluated six different types of PFDs during their fishing seasons (Lucas et al., 2012). The study found that on each vessel type, workers rated at least one of the six PFDs with high marks for comfort and satisfaction. Based on the findings from that study, it is clear that there are PFDs available which can address workers' concerns and specific work-setting needs.

Longliners who believed that wearing a PFD showed intelligence had a higher probability of wearing a PFD than those who did not agree with that belief. In the unadjusted logistic regression models, a similar belief statement, that wearing a PFD is a smart thing to do, was also a significant predictor of PFD use for longliners. It is possible that for longliners, appearing "smart" or "intelligent" to their peers may be an important factor in wearing a PFD. A precise explanation of this finding is not possible using the data collected in this study. Additional research may be required to fully understand its meaning and importance.

4.2. Gillnetters

Gillnetters were the youngest workers and had the least experience in the fishing industry. They worked on the smallest vessels and for the shortest fishing season, only two months per year. Gillnetters had the lowest rate of formal safety training, and along with longliners had the lowest use of PFDs. Only 15% of gillnetters frequently or always used a PFD. Gillnetters contribute the most to fatal falls overboard in Alaska. During 2000–2009, 37% of unintentional fatal falls overboard occurred on gillnetters (NIOSH, 2011). Prevention of fatal falls overboard among these workers is a priority.

In the multivariate model predicting any use of PFDs among gillnetters, experience in the industry was predictive of PFD use. For each additional year of experience in the fishing industry, the odds of any use of PFDs increased 4%. This is not a modifiable factor, but it does provide information which could help develop effective interventions. For example, interventions to increase PFD use among gillnetters may focus on younger workers with little experience in the industry, since they were the least likely to use a PFD. Interventions could incorporate peer to peer recommendations about PFD use, using the more experienced gillnetters to "train" the younger workers.

Other predictors of PFD use among gillnetters may be more directly modifiable and potentially lead to higher use of PFDs. One

Table 6
Predictors of high PFD use among crabbers.[a]

Predictors	Unadjusted models			Multivariate model[b]		
	n	OR	95% CI	*n*	OR	95% CI
Age (years)	103	0.98	0.94, 1.02			
Experience (years)	103	0.98	0.94, 1.02			
Season (months)	102	1.23	0.98, 1.55	92	**1.49**	**1.11**, **1.99**
Position						
Captain	103	0.73	0.25, 2.09			
Deckhand (ref)	–	–	–			
Other position	103	0.91	0.16, 5.28			
Safety training (y/n)[c]	102	0.79	0.30, 2.04			
Chance of fall over (%)	102	1.00	0.99, 1.01			
Chance survival						
Summer with PFD (%)	103	1.02	1.00, 1.04			
Summer no PFD (%)	101	0.99	0.98, 1.01	92	**0.98**	**0.95**, **0.99**
Winter with PFD (%)	103	**1.02**	**1.01**, **1.04**	92	**1.03**	**1.01**, **1.06**
Winter no PFD (%)	101	1.00	0.98, 1.02			
Worry abt. fall over (1–4)	101	0.92	0.55, 1.51			
Avoid fall overboard (1–3)	103	1.63	0.77, 3.47			
Ever fallen overboard (y/n)	103	0.96	0.40, 2.30			
Know a survivor (y/n)	103	1.22	0.30, 5.06			
Know a fatality (y/n)	103	0.71	0.31, 1.60			
PFD effectiveness (1–4)	101	1.78	0.94, 3.37			
PFD comfort (1–4)	98	**1.88**	**1.08**, **3.26**			
PFD interferance (1–4)	100	**0.35**	**0.17**, **0.71**	92	**0.16**	**0.06**, **0.45**
PFD entangle Hazard (1–4)	100	**0.49**	**0.27**, **0.88**			
Wearing a PFD…						
Is a smart thing to do (y/n)	103	2.52	0.67, 9.52			
Is not necessary (y/n)	103	0.64	0.06, 6.36			
Gets in the way (y/n)	103	0.46	0.17, 1.20			
Can save your life (y/n)	103	1.16	0.37, 3.64			
Shows intelligence (y/n)	103	2.28	0.99, 5.26	92	**3.07**	**1.04**, **9,04**
Creates new hazards (y/n)	103	0.71	0.23, 2.17			
Is a way to be safer (y/n)	103	2.16	0.78, 5.98			
Is uncomfortable (y/n)	103	0.55	0.24, 1.29			
Should be required (y/n)	103	**3.42**	**1.27**, **9.20**			

[a] 0 = Low PFD Use (combined never and sometimes); 1 = high PFD Use (combined frequently and always).
[b] Forward stepwise method with criterion to enter and be retained $p < 0.05$.
[c] All yes/no responses compared yes to no (no was the reference group).

such predictor was worrying about falling overboard, a measure of risk perceptions. For every one unit increase in worry on a four-point scale, the odds of any use of PFDs increased 97%. This finding is consistent with previous research in other industries, such as construction and agriculture (Edelson et al., 2009; Forst et al., 2004; Schenker et al., 2002). Interventions focused on raising the concern of falling overboard may be effective for increasing PFD use among gillnetters.

Gillnetters had one predictor of PFD use in common with longliners: beliefs about entanglement hazards. Gillnetters may have this belief because they are in frequent contact with gillnet mesh as fishing gear is being set and retrieved. As the moving mesh comes in contact with the worker, it can snag on parts of clothing and other items worn by the worker. This shared concern among gillnetters and longliners over entanglement hazards stresses the importance of addressing this particular issue with workers, and investigating best work practices as well as PFD design. The belief that PPE can create new hazards has been identified in previous research as a predictor of non-use among workers in a metal refining plant (Akbar-Khanzadeh, 1998). As with the longliners, interventions should focus on familiarizing workers with newer PFDs that have been tested and accepted by their peers (Lucas et al., 2012).

The final significant predictor of PFD use among gillnetters was their attitude regarding PFD comfort. The probability of wearing a PFD for gillnetters who believed that wearing a PFD was uncomfortable was lower than for gillnetters who did not share that belief. Interventions focused on improving PFD attitudes may be effective for increasing PFD use among gillnetters.

4.3. Crabbers

Crabbers reported moderate use of PFDs, with 51% sometimes using a PFD. Their use of PFDs was higher than longliners and gillnetters, but lower than trawlers. Owners and operators of crab vessels typically have PFD policies that require PFD use during certain work tasks, such as climbing the stack of crab pots on the deck (M. Gleason, personal communication, February 28, 2012). This may explain the high frequency of responses in the "sometimes wear a PFD" category. Along with moderate use of PFDs, crabbers had seemingly moderate attitudes and beliefs regarding PFDs. On almost every measure, crabbers had more positive responses than longliners and gillnetters, but less positive responses than trawlers.

The objective for increasing PFD use among crabbers is advancing them from low or moderate use of PFDs to high use of PFDs. The multivariate regression model predicting high use of PFDs among crabbers identified five significant predictors which may guide interventions, especially perceived seriousness of falling overboard in different conditions. Interventions aimed at increasing crabbers perceived seriousness of falling overboard may lead to increased use.

The belief that wearing a PFD interferes with work was a strong negative predictor of high use of PFDs. For each one unit increase (on a four-point scale) in the belief that PFDs interfered with work, the odds of high use of PFDs decreased 84%. Just as longliners and gillnetters require a PFD that will not create an entanglement hazard, crabbers require a PFD that does not interfere with their fast paced and labor intensive work on deck. For instance, the task of

Table 7
Predictors of always use PFDs among trawlers.[a]

Predictors	Unadjusted models			Multivariate model[b]		
	n	OR	95% CI	*n*	OR	95% CI
Age (years)	100	**0.96**	**0.92**, **0.99**			
Experience (years)	100	**0.94**	**0.89**, **0.98**	99	**0.94**	**0.89**, **0.99**
Season (months)	100	**1.81**	**1.21**, **2.71**	99	**1.94**	**1.24**, **3.05**
Position						
Captain	100	**0.29**	**0.09**, **0.91**			
Deckhand (ref)	–	–	–			
Other position	100	0.50	0.18, 1.41			
Safety training (y/n)[c]	100	1.04	0.20, 5.44			
Chance of fall over (%)	100	1.01	0.99, 1.02			
Chance survival						
Summer with PFD (%)	100	0.99	0.98, 1.01			
Summer no PFD (%)	100	1.00	0.98, 1.02			
Winter with PFD (%)	100	0.99	0.97, 1.01			
Winter no PFD (%)	99	1.00	0.98, 1.01			
Worry abt. fall over (1–4)	100	0.91	0.58, 1.43			
Avoid fall overboard (1–3)	100	1.21	0.59, 2.47			
Ever fallen overboard (y/n)	100	0.52	0.19, 1.38			
Know a survivor (y/n)	100	0.53	0.16, 1.71			
Know a fatality (y/n)	100	1.35	0.59, 3.09			
PFD Effectiveness (1–4)	100	1.39	0.73, 2.63			
PFD Comfort (1–4)	100	1.33	0.75, 2.37			
PFD Interferance (1–4)	100	**0.42**	**0.21**, **0.87**	99	**0.35**	**0.16**, **0.78**
PFD Entangle Hazard (1–4)	100	0.99	0.52, 1.90			
Wearing a PFD…						
Is a smart thing to do (y/n)	100	1.04	0.06, 17.13			
Gets in the way (y/n)	100	0.75	0.19, 2.97			
Can save your life (y/n)	100	0.77	0.16, 3.61			
Shows intelligence (y/n)	100	1.81	0.72, 4.54			
Creates new hazards (y/n)	100	1.12	0.37, 3.35			
Is a way to be safer (y/n)	100	1.82	0.41, 8.06			
Is uncomfortable (y/n)	100	0.43	0.18, 1.05			
Should be required (y/n)	100	1.63	0.73, 3.66			

[a] 0 = Not always use PFD (combined never, sometimes, and frequently); 1 = always use a PFD.
[b] Forward stepwise method with criterion to enter and be retained $p < 0.05$.
[c] All yes/no responses compared yes to no (no was the reference group).

setting and retrieving crab pots requires workers to move quickly and constantly around the deck of the vessel. Efforts should be made to educate crabbers about modern PFDs which are designed to meet the demands of their work.

4.4. Trawlers

Trawlers were the oldest workers and had the most experience in the fishing industry compared to workers on other vessel types. Nearly all trawlers reported having received formal safety training, the highest level among vessel types. Trawlers also had the highest use of PFDs, with 51% reporting always wearing a PFD on deck. Trawl vessels that operate in the Bering Sea are generally owned and operated by large firms which have safety programs and policies for their vessels, including requirements for deckhands to wear PFDs on deck (A. Davis, personal communication, November 18, 2011). These corporate policies most likely explain the high use of PFDs among trawlers, as well as the high rate of formal safety training.

Trawlers had the most positive attitudes about PFDs among workers on the four vessel types. The majority of trawlers reported that PFDs were comfortable to work in, and had the least concern over PFDs interfering with work or causing entanglement hazards. Trawlers almost unanimously believed that wearing a PFD is a smart thing to do, can save their lives, and is a way to be safer.

While trawlers' use of PFDs was highest among workers in this study, the rate of always wearing a PFD has substantial room to increase. Ideally, trawlers who sometimes or frequently wear a PFD on deck would progress into the "always use a PFD" category. The multivariate regression model identified three significant predictors of always using a PFD. For each additional year of experience in the fishing industry, the odds of always using a PFD decreased 6%.

As with crabbers, months worked per year and the belief that wearing a PFD interferes with work were predictive of PFD use among trawlers. For each additional month worked per year, the odds of always using a PFD increased 94%. A one unit increase (on a four-point scale) in the belief that wearing a PFD interferes with work was associated with a 65% decrease in the odds of always using a PFD. Like other fishing industry workers in this study, trawlers may benefit from educational efforts to improve their knowledge of newer PFDs which have been evaluated by other trawlers in actual working conditions.

4.5. Limitations

This study addressed a gap in the literature on fishing industry workers' use of PFDs by surveying a large sample of workers in high risk fleets in Alaska. One limitation of this study was the use of a convenience sample to collect data from fishing industry workers. This methodology was unavoidable, given the difficulties of sampling from this population of workers. However, it requires a degree of caution in generalizing the results. Another limitation may have been the reliance on self-report. Although self-report is appropriate for data on risk perceptions and attitudes, it may lead to inaccuracy in regard to other items such as frequency of PFD use. As with all cross-sectional data, time order of the predictors and outcome could not be established. Finally, it is possible that responses of workers on the same fishing vessel may be correlated, which would violate the independence assumption of the logistic

regression models employed in this study. It was not possible to adjust for these correlations because no data were collected which linked workers to particular vessels.

5. Conclusions

Fatal falls overboard are a persistent problem in the commercial fishing industry and the use of PFDs can save lives. Understanding the barriers that fishing industry workers have to wearing PFDs is an important first step in increasing PFD usage. Findings in the published literature regarding risk perceptions of PPE, the importance of PPE comfort, and the belief that PPE can create new hazards were also found in this study of PFD use. Interventions to increase PFD use in the fishing industry should be tailored to each vessel type and focus on modifying the significant barriers identified. Workers may increase their PFD usage if their perceptions of risk and beliefs about PFDs are improved. Familiarizing workers with newer PFDs that have been tested and accepted by their peers may be a helpful step in modifying beliefs and increasing PFD use.

Although most longliners, gillnetters and crabbers in this study did not believe that PFD use should be required, the majority of trawlers did support mandatory PFD use. This support for mandatory PFD use among trawlers may be related to their current high use of PFDs and largely positive attitudes about PFDs. As stated previously, trawlers may have this high use of PFDs because of the current PFD policies of their companies. Based on the successful and positive experience of trawlers with required PFD use, it seems reasonable that all fishing vessel owners and operators should consider providing appropriate PFDs for their workers and creating policies for their use.

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