Injury Risk Reduction Opportunities During Tender Offload: A Case Study of Drift Gillnet Salmon Fishers in Bristol Bay, Alaska

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Abstract

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The Bristol Bay, Alaska drift gillnet fishery is unique due to its intensity and short time frame. Spanning just eight weeks, gillnet fishers participate in the world's largest sockeye salmon run. The days are long and the conditions extremely variable, but fishers return season after season. As an industry, commercial fishing is one of the most dangerous occupations. The Bristol Bay drift gillnet fishery is no exception. Between 2000-2007, 17 deaths occurred in Alaska salmon drift gillnet fisheries (United Fishermen of Alaska, 2008). There is no data on whether these fishers were wearing personal flotation devices. This study was conducted to investigate perception of risk and experiences of Bristol Bay, Alaska drift gillnet fishers while delivering their catch at a tender vessel. Additionally, we investigated the acceptability and potential for the implementation of the hierarchy of hazard controls including engineering, administrative and personal protective equipment (PPE). The study entailed a pre and post season survey of Bristol Bay drift gillnet fishers, open May through August 2021, both online and in person in Naknek, Alaska. The participants were asked to complete the survey electronically. A total of 138 fishers, including 56 vessel captains and 82 deckhands, completed the survey. Most fishers agreed that the lack of sleep affects their awareness and critical thinking. Both captains and deckhands agreed that a personal flotation device (PFD) would help them survive a fall overboard most of the time. Both captains and deckhands also responded that they have never considered wearing a hardhat while delivering. The most favored controls for reducing risk at the tender was the utilization of non-skid on walking surfaces, pre-tied loops in tie-up lines, pre-season training and PFD use. We recommend that additional efforts be made to encourage pre-season training about delivery safety for fishers, boat improvements such as non-skid paint on the deck and PFD use while at the tender.

Table of Contents

List of Appendices

List of Tables

List of Figures

Abbreviations and Acronyms

95%CI: 95% Confidence Interval

ADFG: Alaska Department of Fish and Game

AMSEA: Alaska Marine Safety Education Association

BBRSDA: Bristol Bay Regional Seafood Distribution Association

CDC: Center for Disease Control

CEER: Collaborative on Extreme Event Resilience

CFISA: Commercial Fishing Industry Safety Act

CIB: Current Intelligence Bulletin

DEOHS: Department of Environmental and Occupational Health Sciences

DHHS: Department of health and Human Services

EPIRB: Emergency Position Indicating Radio Beacon

F/V: Fishing vessel

FTE: Full Time Equivalent

IRB: Institutional Review Board

NIOSH: National Institute for Occupational Safety and Health

NTSB: National Transportation Safety Board

PFD: Personal flotation device

PPE: Personal protective equipment

USCG: United States Coast Guard

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Figure 1: The mighty fisherwomen of the F/V Janet Elaine crew taking a much-needed day off up the Cinder River, AK -summer 2021. Left to right: Lillian Saul, Fran Kaul (skipper), Anna Mounsey, Cassidy Butler, Allison Barrett.

Background

Researcher background

This study is led by Anna Mounsey(she/her), a graduate student at the University of Washington. Anna has also been a commercial fisherwoman in the Bristol Bay drift gillnet fishery for six years. This opportunity has allowed her to gather a vast network of fishers. Her previous experience is unique and is instrumental in the gathering of data by utilizing established credibility with deckhands and captains in the Bristol Bay fishery.

Bristol Bay, Ak Drift Gillnet Fishery

The Bristol Bay watershed is home to the largest wild sockeye salmon run in the world and is located in Southwest Alaska. 40,000 acres span across pristine tundra, wetlands, rivers, and lakes. In 2020, 52.6 million sockeye salmon returned to the rivers, lakes, and streams of Bristol Bay. (Ross, 2020). During the month of June, thousands of fishers make their way to Bristol Bay, Alaska for the start of the commercial salmon season. Fishers in Bristol Bay primarily use drift and set gillnet practices to harvest salmon during the commercial season.

There are 5 management districts in the Bristol Bay area open to commercial gillnet fishing - Naknek-Kvichak, Egegik, Ugashik, Nushagak and Togiak, corresponding to the major river drainages. The Alaska Department of Fish and Game (ADFG) manages the fishery with the objective of each river achieving spawning escaping goals while harvesting excess fish (ADFG).

At the beginning of the season in mid-June, salmon begin to swim upstream. Fishers launch their vessels into the water after pre-season preparations and wait until the first opener. During the season, commercial fishing is managed by ADFG through openers and closures. An opener is a set time when fishers can deploy their gillnet or set net. Openers can range from 3 hours to 20+. At first, fishing openers are small windows of time (3-5 hours usually), based on tide patterns and salmon escapement. Escapement is the number of salmon that do not get caught in the nets and escape the fishery to swim upstream and spawn. Fish escapement goals vary between the different river systems in Bristol Bay. For example, the Nushagak River has an escapement goal range 370,000 - 900,000 fish, while the Kvichak River has an escapement goal range of 2,000,000 - 10,000,000 fish (ADFG, 2021). When escapement goals have been met, ADFG extends the fishing hours to 24/7. The season ends when the salmon stop swimming up the rivers to spawn. This happens in late July.

Drift gillnet

In the Bristol Bay fishery, there are two different styles of commercial salmon harvest: set net and drift net. Set net fishing is done from land and set nets “are anchored on both ends of the net, one end on shore above high tide and the opposite end extending perpendicular to the shore and anchored in the water. Set nets must be staked and buoyed” (ADFG). Drift gillnet fishing uses a 32’ vessel that deploys a 150-200 fathom gillnet. Captains decide where nets are set, while deckhands set the net by throwing a buoy overboard attached to the net being deployed (figure 2). The buoy helps hold the net on the water, while the rest of the net spools off the reel situated on the deck of the vessel. Nets lay vertically in the water column allowing passing fish to become entangled. Cork and foam material keeps the net afloat on the surface, while a leaded line holds the rest of the net under water. Figure 2 shows the corks on one side (white foam balls), and the lead line on the other side. Between the two lines are meshes that the fish get

caught in. Depending on the captain's style of fishing, the net will sit in the water for various lengths of time -ranging 30 seconds to 2+ hours.

Figure 2: Anna Mounsey throws the buoy ball into the water to set the net. Photo by Jim Purdum.

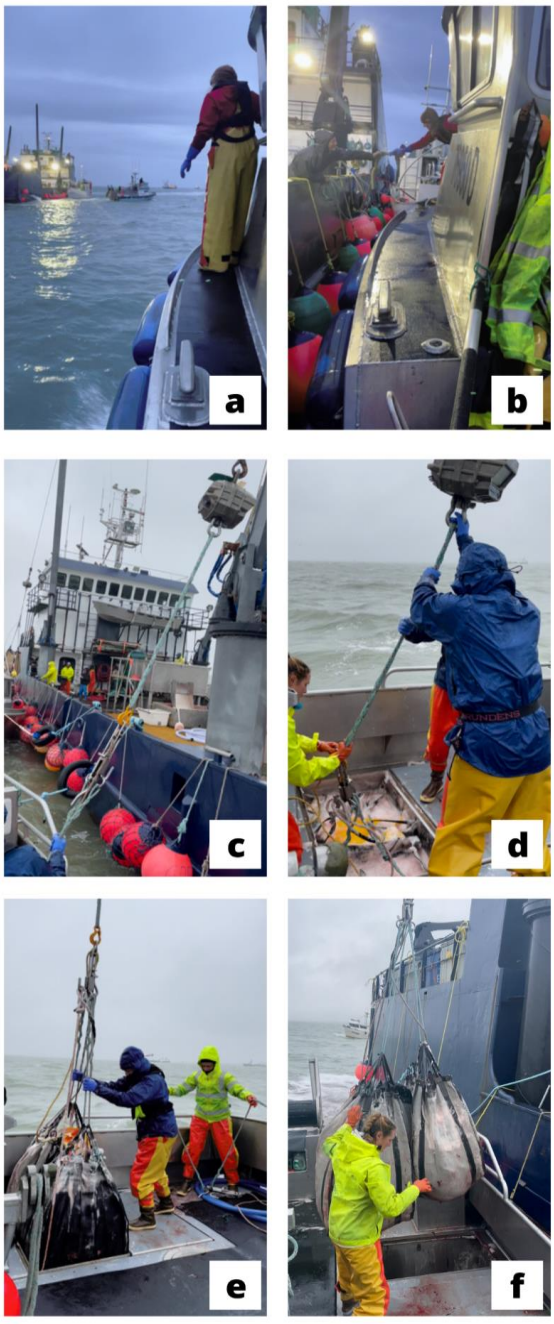
Fishers use hydraulics to bring the net back onto a reel, situated on the deck of the vessel. Fishers pick the salmon out of the net meshes (figure 3) and place them into chilled fish holds. Deckhands place the salmon into brailer bags that are sitting in the chilled water. Brailer bag size depends on the size of each vessel's fish-hold size, but can fit anywhere between 180-250 fish per bag. Fishing crews do not deliver their catch to docks, but instead to vessels called tenders. Deliveries to the tender occur initially when the opener closes and, thereafter, when the fish hold is full.

Figure 3: The net coming aboard the F/V Janet Elaine. Deckhands Anna Mounsey and Cassidy Butler pick the fish out of the net (orange jacket and green jacket). Allison Barrett uses the hydraulic levers to bring the net in (yellow jacket).

Tender delivery

Tenders are vessels that transport catch from the fishing grounds to the processors on shore where salmon are processed to ship to distributors and the consumer market. Tenders also serve as a "support vehicle", transporting food, water, and fuel to the gillnet vessels. This is essential since the fishing boats stay out on the fishing grounds for up to 6 weeks without returning to shore. During the season, the process of delivering catch to a tender vessel is generally the same for every boat in the fleet. Gillnet vessels drive to where the tenders are anchored up in a predetermined spot - generally outside of the fishing district. Gillnetters then claim their spot in line and wait typically 5-120 minutes to offload their catch. When it is the vessels' turn, the captain maneuvers to the tender and ties up. During this time, one deckhand stands on the bow and one stands on the stern to catch tie-up lines thrown by the tender workers (figure 4 panel a & b). The tender workers then proceed to hand over pelican hooks that attach to brailer bags inside the gillnet vessel fish holds (brailer bag displayed in figure 4e and 4f). When the bags are attached to the pelican hooks, the tender workers operate a crane which brings the scale to the fishing boat. The scale has a J hook that attaches to the pelican (figure 5). Once the brailer bags are hooked up to the pelican hook, which is attached to the J hook and scale, the crane operator on the tender then lifts the bags filled with salmon up and over onto the tender (figure 4 panels c & d). The crane brings the filled bags over to the tender fish holds. Tender workers pull a release on the pelican hooks that dump the fish from the brailer bags into their fish hold.

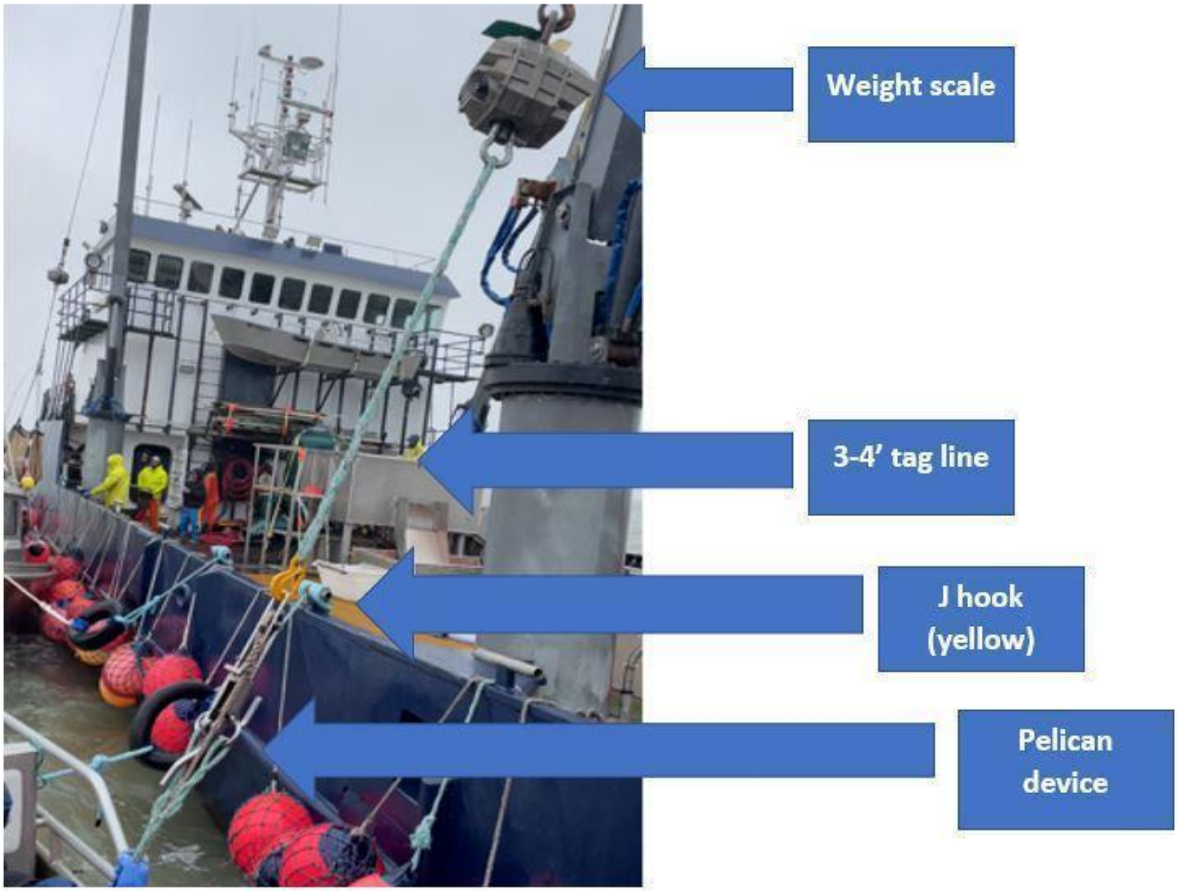
Figure 4: The workflow at the tender. Panels a-f show the process of arriving at the tender, tying up the vessel, hooking up brailer bags filled with fish and craning them over to the tender. Not shown are the empty bags being craned back over onto the gillnet vessel.



There can be anywhere from one to twenty “picks”, until all brailer bags are offloaded from the gillnet vessel (figure 4 panel e-g). The crane operator then returns the brailer bags to the gillnet vessel, where they are cleaned by the deckhands and re-hung in the holds. After the fish ticket has been signed by the gillnet permit holder, the deckhands untie from the tender and throw the lines back to the tender from the bow and stern of their vessel. During this entire process, there

are many hazards that deckhands, captains, and tender workers are exposed to falling off the vessel while tying up the bow, being hit by the scale attached to the crane, and being crushed by the brailer bags as they are lifted from the hold onto the tender. Figure 4 displays the general workflow of approaching a tender and delivering salmon.

Figure 5: Visual description of the weight scale setup.



Occupational Safety in Bristol Bay Drift Gillnet Fishery

Commercial fishing is one of the most dangerous jobs in the world. Since the 1950s, efforts have been made to study occupational safety and health on commercial fishing vessels to reduce injuries and fatalities while at sea (Lucas et al., 2014). In 2019, the fishing and hunting industry's occupational fatal injury rate was 145.0 fatal work injuries per 100,000 full-time equivalent (FTE) workers, compared to the national average rate of 3.5 fatalities per 100,000 FTE workers (National Census of Fatal Occupational Injuries in 2019, 2020). In Alaska specifically, 155 fishers died from falling overboard (2000-2009), representing 37% of work-place fatalities in the state (Lucas et al., 2013). Aside from falls-overboard, fishers can be injured on deck ranging from small injuries to hospitalization. Between 1991-1998, there were 574 hospitalizations in the Alaska fishing industry for injuries. Ninety percent of these injuries occurred on the vessel. Of the injuries, falls accounted for 26% of hospitalizations (Thomas et al., 2001). In Alaska, the injury and illness rate for all occupations was 3.2 per 100 full time workers in 2020. In the

United States, the rate was 3.9 per 100 full-time workers (Bureau of Labor Statistics). The Bureau of Labor Statistics reported the incidence rate of nonfatal occupational injuries and illnesses of all industries in 2020 including private sector, state, and local government to be 2.9 per 100 full-time workers. The incidence of nonfatal occupational injuries and illnesses for fishing was 4.9 per 100 full-time workers, which may be an underestimate due to the challenges of reporting these data (Bureau of Labor Statistics 2020).

Previous studies in Bristol Bay:
There have been efforts to reduce fatal and non-fatal injuries within the commercial fishing industry. In 2013, Lucas et. al., published a study focusing on predictors of personal flotation devices (PFD) use in the Alaskan fishing industry. The researchers found that "gillnetters had the highest perceived susceptibility to falls overboard, with a perceived 41.9% mean chance of falling overboard during their career" (D.L. Lucas et al., 2013). Although PFDs are shown to greatly increase survivability (Jones, C.S., 1999; CDC, 2021; *Current Intelligence Bulletin 58,* 1997), no mandates exist requiring fishers to wear PFDs, even during risky tasks (D.L Lucas et al. 2013). One hundred percent of the 155 fishers who died in the United States from falling overboard during 2000-2009 were not wearing PFDs (*Commercial Fishing Deaths,* CDC, 2010). There is limited safety research that has focused on the Bristol Bay drift gillnet fishery. Lucas et al. observed that "gillnetters were the youngest workers, had the least experience in the fishing industry…, [and] had the lowest rate of formal safety training" (D.L. Lucas et al., 2013). Fishers are exposed to other hazards that result in injury or death other than falling overboard. Between 1991-1998, "the number of deaths not related to vessel loss but occurring on deck of a fishing vessel…has not declined, and the proportion of these deaths among [fishers] is increasing (Thomas et al., 2001). Despite low rates of formal safety training for gillnetters, there are opportunities for captains and deckhands to take drill conductor courses in Bristol Bay and Seattle, WA. Alaska Marine Safety Education Association (AMSEA), a non-profit corporation offers marine safety training for commercial fishermen. Courses are offered year-round and in ports around the country (amsea.org).

Study Aims

The purpose of this research is to describe the presence of risk factors to fishers during the tender delivery process in the Bristol Bay, Alaska drift gillnet fishery. This study hypothesizes that fishing crews have high risk tolerance of the tender delivery process and will not identify safety solutions. Additional questions of interest inquire into the acceptability and implementation of engineering, administrative and personal protective equipment (PPE) controls, which were formulated using the hierarchy of controls as a framework for identifying respective interventions (CDC, 2021). Furthermore, questions will be examined by position (deckhand vs captain) and experience (described in seasons worked).

Aim 1: Describe fishers' risk perception while delivering salmon catch at a tender vessel.

1. How do captains and deckhands perceive sleep deprivation affecting their perception of risk, awareness, coordination, critical thinking, and judgment?
2. What are the differences between how captains think sleep deprivation affects their deckhands vs how deckhands think sleep deprivation affects themselves?
3. What do fishers feel towards their safety while performing tasks during delivery? (Tying up to, maneuvering the weight scale, lifting brailer bags).
4. Do years of experience affect the way that risk is perceived?

Aim 2: Identify safety measures for fishers during tender delivery. Consider the hierarchy of controls including engineering, administrative and PPE interventions.

1. Do fishers think PPE controls will help them survive a fall overboard or prevent serious injury while at the tender?
2. What types of interventions do captains and deckhands prefer?

Aim 3: Communicate findings to fishers, partner agencies, conferences and to the public

1. What communication medium/mode do captains and deckhands prefer when receiving safety and general information for the Bristol Bay fishery?

The outcomes of the aims will positively impact the field by contributing research on fishing safety and characterizing the occupational hazards and controls associated with a specific process not previously examined in the industry. By addressing tender offload safety, this work contributes to the overall effort of decreasing injuries and fatalities of fishers in Bristol Bay, Alaska.

Aim 1 and 2: Describe perceived risk of fishermen while delivering salmon catch at a tender vessel. Identify safety measures for fishers during delivery considering the Hierarchy of Controls.

Risk Perception and Acceptance of Safety Controls at the Tender in the Bristol Bay, Alaska Drift Gillnet Fishery.

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Abstract

Efficacious injury reduction strategies among fishers working in Bristol Bay, Alaska depend on controls that do not hinder the efficiency of the operation. No current studies address tender offload safety. This study utilized a mixed methods research approach with a survey tool to collect information from captains and deckhands of gillnet vessels operating during 2021 Bristol Bay salmon season. The survey collected risk perception data focused on activities associated with the act of offloading catch at a support vessel (tender). T tests indicate that there are statistically significant differences between mean Likert response to questions addressing sleep deprivation affecting perception of risk and coordination. This study also found that fishers preferred interventions like crew training and non-skid paint or stickers on walking surfaces over harnesses and hard hats. Further research is needed to gather information from the tender worker perspective and the potential for implementation of some discussed safety measures from the study.

Background

In 2010-2014, the Alaska salmon fishery experienced 20 deaths, representing nearly half of the 45 total deaths among the remaining Alaska commercial fishing fleet (CDC, 2021) Among the salmon fishery fatalities, 5 of those were salmon drift gillnet (CDC, 2021). Of the 5 fatalities, the causes of death were: fatal vessel disasters (1) and fatal falls overboard (4). Of the fishers that died after falling overboard, none were wearing a PFD (CDC, 2021). Research indicates that the most common non-fatal injuries occur to fishers while on deck. According to Krenz et al., (2014), the most prevalent accident types are “crushed between objects”, “struck by moving objects”, and “fall onto surface.” Wrists and hands are the most common anatomical sites for injuries (Krenz et al., 2014).

Research on risk perception and attitudes toward onboard vessel safety have not been studied in the Bristol Bay drift gillnet fishery. Other studies address risk perception and safety approaches in other fisheries around the US and the world. Common factors include natural hazards such as high winds and large waves (Bly, 2018), seafarer fatigue (Gander et al., 2008, and capsizing or sinking (Thomas et al., 2001). In 2005, a study conducted by Brooks et al. explored the relationship between occupation culture, workplace social organization and safety management in a lobster fishing industry in a small fishing town in Southern Australia. The study found that captains were aware of the vulnerability that results from lack of health and safety/first aid training for themselves or their deckhands. Additionally, fishers did not believe they were at risk when not wearing PFDS or participating in vessel safety drills. (Brooks et al., 2005).

The International Maritime Organization (IMO) refers to fatigue as a hazard "because it may affect a seafarer's ability to do their job effectively and safely" (IMO, 2019). In a 2014 review of research focusing on fatigue in fishers stated that "reduction of sleep length to 6 or 4 h for 14 days causes cognitive impairments comparable to 2 days of total sleep deprivation" (Høvdanum, A., et al., 2014). Unlike other industries on land, working hours for fishers at sea are not regulated by laws (Høvdanum, A., et al., 2014).

Assessing exposure to hazards is challenging on commercial fishing vessels because there is limited reporting on deck injuries or near misses. The National Institute of Occupational Safety and Health (NIOSH), works within the Occupational Safety and Health Act of 1970 to assure safe and healthful working conditions. Current Intelligence Bulletins (CIBs) are issued by NIOSH to disseminate new information about occupational hazards. CIBs report new data on a known hazard, draw attention to unrecognized hazards, or disseminate information about control. For Alaska commercial fishing, CIBs define problems, describe recent successes, and recommend general approaches to fatal events (CDC, 1997).

The CIB also highlights other regulations for fishers including the Commercial Fishing Industry Safety Act (CFISA) of 1988 which requires each vessel to carry various survival equipment. Additionally, the act required fishers to obtain first aid and participate in emergency drill training. The report states that some controls to reduce death and injury to fishers is a requirement of an immersion suit to be available to all crew members on board vessels operating in Alaskan waters [46 CFR 28.110]. Otherwise, the United States Coast Guard (USCG) recommends fishers wear PFDs while on deck. In 1992, the CFIVSA enabled the USCG to start a program called the Voluntary Dockside Exam Program. This program is voluntary for fishers and permits USCG examiners to board fishing vessels and review the safety equipment on board, including EPIRBs, immersion suits and life rafts (CDC, 1997).

Another recommendation made by the CIB was to license and train skippers. This license requires captains to demonstrate minimum qualifications in vessel safety including rules of the road, firefighting, watertight integrity, and the use of life saving equipment. (NTSB Recommendation M-85-68). (National Transportation Safety Board (NTSB) 1987).
For deckhands, the CIB recommended that consideration should be given to require basic fishing safety training for deckhands before an Alaskan (state) crew license, or a commercial fishing permit is issued (CDC, 1997).

The combined studies and safety acts constitute some of the impactful research done to bring the Alaska fishery safety state to what it is today. To the authors knowledge, there have been no efforts attempted to study perception of risk and acceptability of safety controls specifically during tender offload for the Bristol Bay drift gillnet fishery. To address the lack of research on fisher safety while at the tender, our research team set out to answer some questions regarding perception of risk and the effects of sleep deprivation on captains and deckhands (aim 1), as well as general safety concerns, and the acceptability of current or theorized engineering, administrative and PPE controls (aim 2). Finally, our research team asked fishers about their preferred means of communication for both safety materials and general information about the fisher (aim 3.1).

Methods

Commercial fishers are a challenging population to study. Specifically, in Bristol Bay, fishermen work for a very short period and without a permanent working location on shore. Quantitative questions that focused on interventions were created using the hierarchy of controls framework. Traditionally, this framework is used to determine how to implement feasible and effective control solutions (CDC, 2015). Within the hierarchy, controls can be categorized as: elimination, substitution, engineering controls, administrative controls and PPE, ranked from most to least effective. Quantitative methods represent a limited perspective about the nuances and intricacies of fisher safety during the season. A study conducted on fishers in North Carolina by McDonald and Kucera used qualitative interviews to study fishers. Their research team found that through in-depth ethnographic interviews, fishers related staying safe to work practices and attitudes (McDonland and Kucera, 2007). Qualitative methods enable fishers to share their experiences with the researchers and give invaluable insight into their observations and perceptions while working. Combining mixed methods of both quantitative and qualitative provides a deeper understanding of safety dynamics while fishing and at the tender. Furthermore, open-ended interviews respect the fishers and their experiences. In particular, deckhands feel that their opinions are considered and heard.

Data Source and collection

This study surveyed two distinct worker groups: deckhands and captains working in the Bristol Bay drift gillnet commercial fishery. We utilized two surveys to collect data: one created for deckhands and another for captains. The deckhand survey consisted of 24 questions, while the captain survey consisted of 27 questions. The main differences between the captain and deckhand survey are that we asked captains additional questions about what they thought about their deckhands' safety, or whether captains would implement interventions in their operations. Captain and deckhand surveys included 18 of the same questions.
Surveys for captains and deckhands are in Appendix C. The surveys were created using Google Forms software.

Data was collected from a convenience sample of gillnet vessels originating from the boat yards in Naknek, Alaska. Surveys were open from late May 2021 to mid-August 2021. Deckhands and captains were approached by the researcher during pre, and post season work in the boat yards. Preseason for the Bristol Bay fishery was during the first two weeks of June. Postseason was during the last week in July and the first week in August. Fishers were asked to fill out the survey on iPads or taken on their own phones found with a shareable link. The survey lasted approximately 15 minutes. The researcher then thanked the participants and offered gifts provided by BBRSDA. Gifts for participants consisted of stickers, candy or Koozies. Survey links were posted to Bristol Bay fishermen Facebook pages as well as included in the Bristol Bay Regional Seafood Development Association's June Newsletter. This study included participants over the age of 18 who worked during the 2021 Bristol Bay drift gillnet salmon fishery

Data Analysis

Survey data were downloaded to Microsoft Excel. Data were then coded for ease of manipulation (see Appendix B for coding structure and definitions). Spreadsheets were imported into R Studio version 4.0 for data analysis.

Quantitative analysis

Descriptive statistics were calculated for captain and deckhand demographics and for each of the quantitative survey questions. Differences in responses between job positions were tested using an unequal univariate t test. To explore whether years of experience affected answers, by group, a linear regression model was built using the regress() function with the R rigr package. The general code was:

regress("mean", Response ~ Experience +Group, data)

"Mean" refers to the mean Likert score as the functional. The dependent variable is response, and the independent variable is experience. For this regression, we introduced a third variable, group, to see the results when job position was statistically controlled. The group term acts as an offset term or a shift of means. The data frames were changed for each set of data respective to the question. a multiple testing correction was applied for statistical significance. In the case of this study, alpha/5 = 0.01.

Lastly, boxplots were created to visualize median responses and variation between deckhands and captains, as well as to highlight the differences between the median responses of groups, by years of experience. R Studio software was utilized for statistical analyses and visualization.

Qualitative analysis

Inductive coding and thematic analysis were used to interpret the short answer responses. To do this, we created an inductive codebook to establish representative themes from the responses. Responses were co-coded with a researcher external to the study team. Coded text was compared between the co-coders and discrepancies were discussed and amended. Following co-coding, a single member of the research team (Anna Mounsey) proceeded to code the remainder of the short answers. Emerging themes and ideas from the qualitative data were labeled and defined to better understand fishers' experiences while at the tender.

Appendix B illustrates the parent codes, sub codes and definitions (see Appendix B) used to analyze these data.

This study was determined to be human subjects research that qualifies for exempt status (Category 2) by the University of Washington Human Subjects Division. (IRB protocol

Results

This section reviews the results from fisher (captains and deckhands combined) survey responses. Risk perception, sleep impact on risk, controls, interventions, barriers, and facilitators to implementation of controls and communication preferences are discussed (Aims 1, 2 and findings for Aim 3.1).

Demographics

One hundred and thirty-seven fishers, including 55 vessel captains and 82 deckhands completed the survey. Participants were predominantly male (79%) and fell within the 25-44 (50%) year-old age category. The range of experience questions were asked differently for captains and deckhands. Captains: "How many seasons have you operated a gillnet vessel in Bristol Bay?" Deckhands: How many seasons have you worked on a gillnet vessel in Bristol Bay?". It is important to note that captains may have worked as deckhands in Bristol Bay before operating a vessel. If they answered having 1 year of experience as a captain, they may have more years of experience as a deckhand. The seasons of experience in their role ranged from 0 to 21+ years, with 2 captains and 4 deckhands experiencing their first year in their respective roles and 22 captains and 5 deckhands experiencing 21+ years in their roles in the fishery. There were no captains aged 18-24, and there were no deckhands aged 65+ (Table 1).

Table 1: Demographics of Participants

Demographics	**Captain (n=55)**	**Deckhand (n=82)**
	n (%)	n (%)
Age		
18-24	-	29 (35)
25-44	27 (50)	42 (51)
45-64	21 (38)	11 (13)
65+	7 (13)	-
Sex		
Male	49 (90)	59 (72)
Female	4 (7.3)	22 (27)
Queer	-	1 (1)
Prefer not to say	1 (2)	-
Seasons worked in Captain or Deckhand role*		
First season	2 (4)	4 (5)
1-2 seasons	1 (2)	13 (16)
3-5 seasons	5 (9)	28 (34)
6-9 seasons	5 (9)	11 (13)
10-20 seasons	20 (36)	21 (26)
21+ seasons	22 (40)	5 (6)

Additionally, we asked captains about their boat ownership and both captains and deckhands about employment in other commercial fishing besides Bristol Bay. Fifty-two (94%) of captains own the boat they operate, two (3%) were hired skippers, and one captain was an alternate operator. Forty-five (83%) of the captains had worked as deckhands in Bristol Bay before operating a boat. Thirty (54%) of captains have operated boats in other fishing industries besides Bristol Bay where they deliver their catch to a tender, while 39 (47%) of deckhands have worked in other fishing industries where they deliver fish to a tender. During peak season, the majority (60%) of the boats are crewed by four fishers, while the remaining 40% are split between three and five fishers.

Table 2 shows Likert scores for all Likert scale questions from both the captain and deckhand surveys. Results from the question that focused on feeling unsafe while tying up to a tender corresponded with a mean response of "some of the time" for both captains and deckhands, while the mean response to whether a PFD would help them survive a fall overboard was "most of the time". Captains' and deckhand's mean response was "some of the time" to whether or not they wear PFDs while on deck or tying up to a tender. Table 2 also highlights that pre-season training, pre-tied loops on tie up lines from the tender, PFD use and lights on the bow were the more favored controls. The least favored controls were a harness style clip to the bow railing and hard hats.

Table 2: Mean Likert scores for all Likert scale questions in both captain and deckhand surveys.

Captain (n=55)		**Deckhand (n=82)**	
Risk Perceptions		Mean Likert (1= All of the time; 5= Never)	
I feel my crew is unsafe tying up to a tender	4.2	I feel I am unsafe tying up to a tender	4
I feel my crew is unsafe when maneuvering the weight scale or being underneath it	3.9	I feel unsafe when maneuvering the weight scale or being underneath it	3.7
I feel my crew is at risk or being crushed by the brailer bags as they are being lifted from the deck	4.3	I feel at risk or being crushed by the brailer bags as they are being lifted from the deck	4.1
Sleep Impact on Risk		Mean Likert (1=Strongly agree; 5= Strongly disagree)	
Lack of sleep affects my deckhands:		Lack of sleep affects my:	
Perception of risk	2.9	Perception of risk	3.1
awareness	2.5	awareness	2.5
coordination	2.9	coordination	2.7
judgement	2.8	judgement	2.8
critical thinking	2.6	critical thinking	2.5
Captain's perception of sleep deprivation's impact on their own risk:			
Perception of risk	3.5		
awareness	2.9		
coordination	3.2		
judgement	2.9		

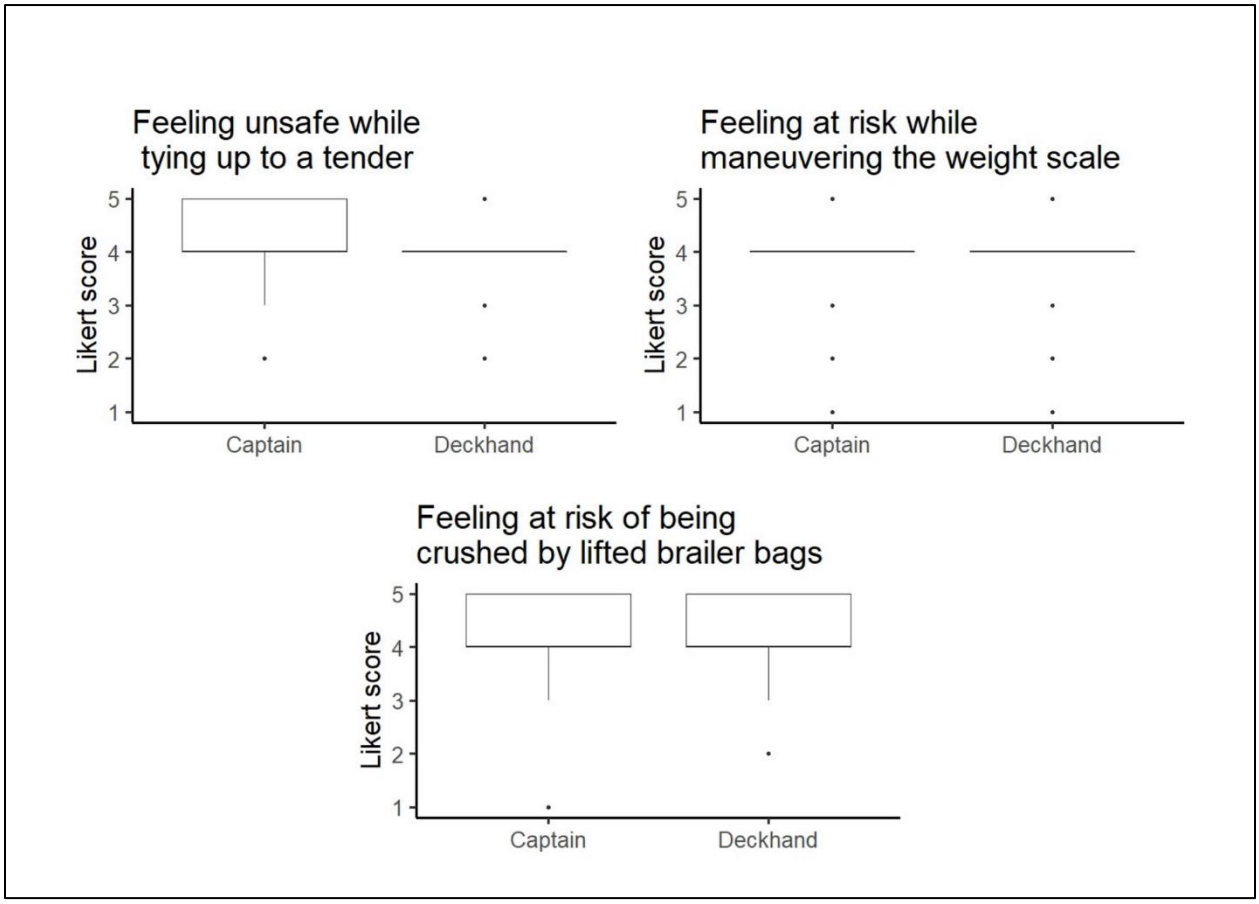
critical thinking	2.8		
Controls		Mean Likert (1=All of the time; 5=Never)	
PFD Use			
My deckhands wear a PFD while tying up to the tender	3.9	I wear a PFD while tying up	4.2
My deckhands wear a PFD while on deck	4.1	I wear a PFD while on deck	4.4
A PFD would help my deckhands survive a fall overboard	2.2	A PFD would help me survive a fall overboard	2.3
Hard Hat Use			
I have considered providing a hard hat to my deckhands when the weight scale is on the gillnet deck	4.4	I have considered wearing a hard hat when the weight scale is on the gillnet deck	4.4
A hard hat would prevent serious injury to my deckhands' head from the weight scale	3.8	A hard hat would prevent serious injury to my head from the weight scale	3.8
Interventions	Mean Likert (1 = Strongly agree, 5 = strongly disagree)		
Implementing non-skid strips or paint on walk surfaces would help reduce risk at the tender	1.7	Participating in non-skid strips or paint on walk surfaces would help reduce risk at the tender	1.6
Implementing PFD use would help reduce risk at the tender	2.4	Participating in PFD use would help reduce risk at the tender	2.4
Implementing pre-season training would help reduce risk at the tender	2.7	Participating in pre-season training would help reduce risk at the tender	2.5
Implementing pre-tied loop on the tie up line from the tender would help reduce risk at the tender	2.4	Participating in pre-tied loop on the tie up line from the tender would help reduce risk at the tender	2.0
Implementing lights on the bow would help reduce risk at the tender	2.7	Participating in using lights on the bow would help reduce risk at the tender	2.3
Implementing Lights along the walkway to the bow would help reduce risk at the tender	3	Participating in lights along the walkway to the bow would help reduce risk at the tender	2.6
Implementing a railing installed along the bow would help reduce risk at the tender	2.9	Participating in the use of a railing installed along the bow would help reduce risk at the tender	2.4
Implementing a harness with a clip to bow railing would help reduce risk at the tender	3.7	Participating in the use of a harness with a clip to bow railing would help reduce risk at the tender	3.1
Implementing use of a hardhat while delivering would help reduce risk at the tender	3.4	Participating in the use of a hardhat while delivering would help reduce risk at the tender	3.7

Risk perception

This study asked questions about how captains and deckhands thought about safety and risk while performing tasks getting to, and while at, the tender. Figure 6 displays boxplots for

responses to perception of risk and safety questions. When asked whether fishers felt unsafe while tying up to the tender or felt at risk while maneuvering the weight scale or being crushed by lifted brailer bags, the median response to all three questions was “some of the time” for both captains and deckhands. Mean responses shown in Table 2 also show the mean response to the questions regarding feeling unsafe tying up to a tender, maneuvering the weight scale and at risk of being crushed by brailer bags as “some of the time”.

Figure 6: Questions that addressed perception of risk and safety while at the tender



Sleep deprivation effects on fishers

To gather more information about sleep habits, fishers were asked about patterns of sleep and operational logistics during delivery. The study results found that during peak season, 52% of captains and 36% of deckhands reported getting 4-5 hours of sleep in a 24-hour period. Thirty percent of captains and 50% of deckhands reported getting 2-3 hours of sleep. During that same 24-hour period, 85% of captains and 80% of deckhands reported delivering fish to a tender 1-2 times. Often, crew will take bunk rotations especially during delivery, leaving one less worker able to help with delivering. One question asked captains and deckhands how many people are typically awake and helping during delivery. Fifty four percent of captains and 41% of

deckhands reported 4 people awake and helping during delivery. Bunk rotations are explained in the discussion portion of this paper.

This study explored the perceived effects that lack of sleep has on perception of risk, awareness, coordination, judgment, critical thinking for both captains' and deckhands' personal experiences. Table 3 displays Likert scores for captains and deckhands as well as results from an unequal, univariate t-test comparing the difference in means between the two groups and assessing significance. Both the perception of risk (95% CI: -0.40, 0.20) and coordination (95% CI: 0.13-0.85) show the strongest association with job position (captain vs deckhand) and response. We also asked the captains their perspective on how sleep impacted their deckhands' perception of risk, awareness, coordination, judgment, critical thinking. Although tests showed that coordination had statically significant differences in means between captains and deckhands, t-tests showed that there are no statistically significant differences in means for how captains think sleep impacts their deckhands' perception of risk, awareness, coordination, judgment and critical thinking. Table 3 also displays mean responses, t-test scores and p-values for the comparison of how captains think sleep affects their deckhands to how deckhands think sleep affects them.

Table 3: Mean Likert scores for captains and deckhands.

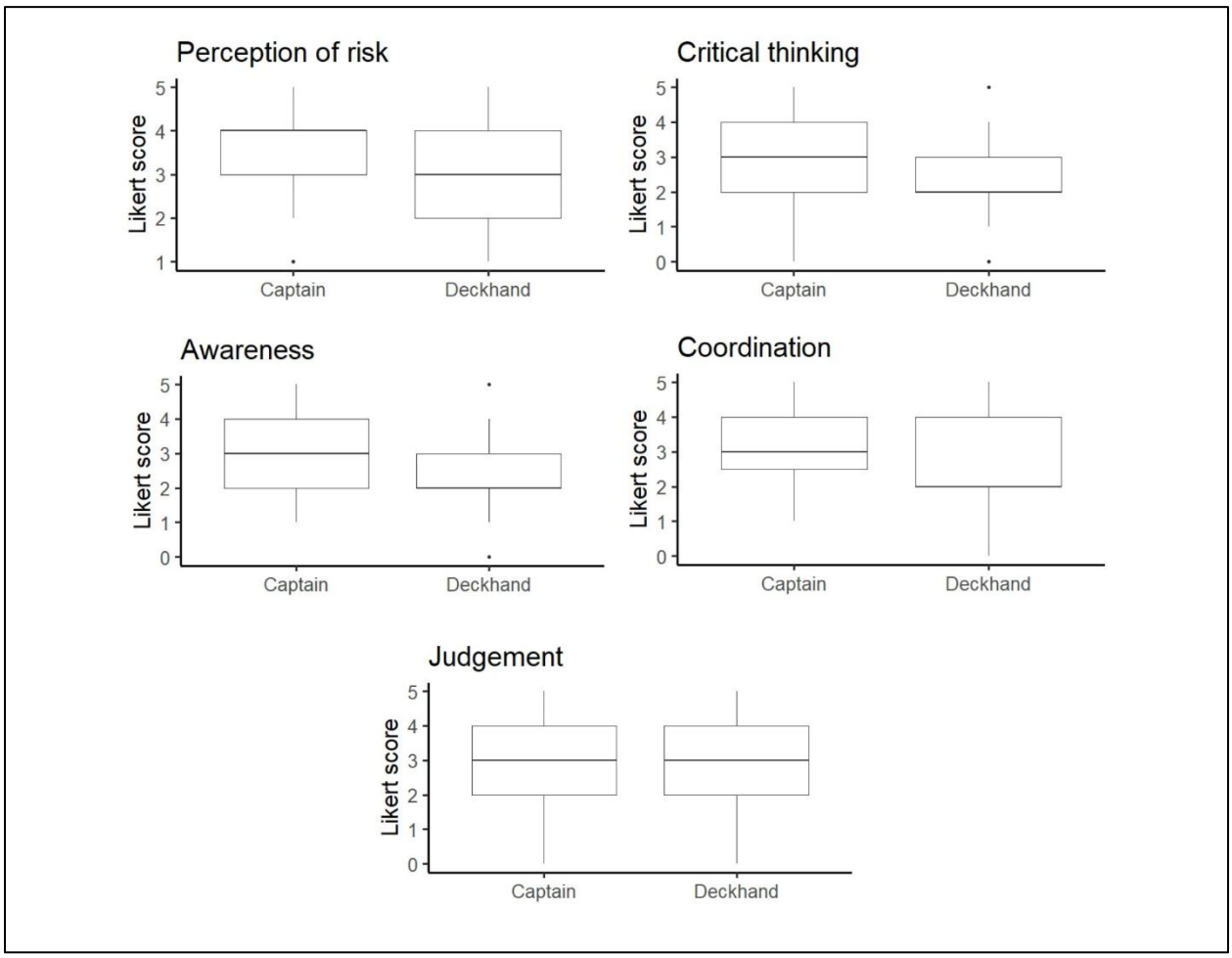
Mean Likert score	**Captain** (n=56)	**Deckhand** (n=82)	**95% CI**	**T statistic**	**P-value**
I feel that lack of sleep affects my:					
Perception of risk	3.5	3.1	[-0.40, 0.20]	-2.03	0.04
Awareness	2.9	2.5	[-0.05, 0.77]	1.7	0.08
Coordination	**3.2**	**2.7**	[0.13, 0.85]	2.7	0.007
Judgment	2.9	2.8	[-0.30, 0.55]	0.58	0.55
Critical thinking	2.8	2.5	[-0.15, 0.68]	1.3	0.21
I feel that lack of sleep affects my deckhand's:					
Perception of risk	2.9	3.1	[-0.5, 0.2]	-0.8	0.4
Awareness	2.5	2.5	[-0.4, 0.4]	-0.06	0.9
Coordination	2.9	2.7	[-0.2, 0.6]	1.0	0.3
Judgment	2.8	2.8	[-0.4, 0.4]	-0.2	0.8
Critical thinking	2.6	2.5	[-0.3, 0.5]	0.5	0.7

*Bolded results indicate statistically significant differences between the groups' mean Likert scores.

Figure 7 displays the median Likert score from the question "I feel that lack of sleep affects my….". Likert scale descriptors include perception of risk, critical thinking, awareness,

coordination, and judgment. For all plots except judgment, the median score for captains was higher than the median score for deckhands by 1 point. Captains' median response on the Likert scale for all descriptors except perception of risk was "neutral", except for perception of risk which was "disagree". Deckhands' median response was "agree" on the Likert scale for all descriptors except perception of risk and judgment, which was "neutral".

Figure 7: Boxplots showing Likert score values for the question "I feel that lack of sleep affects my..."

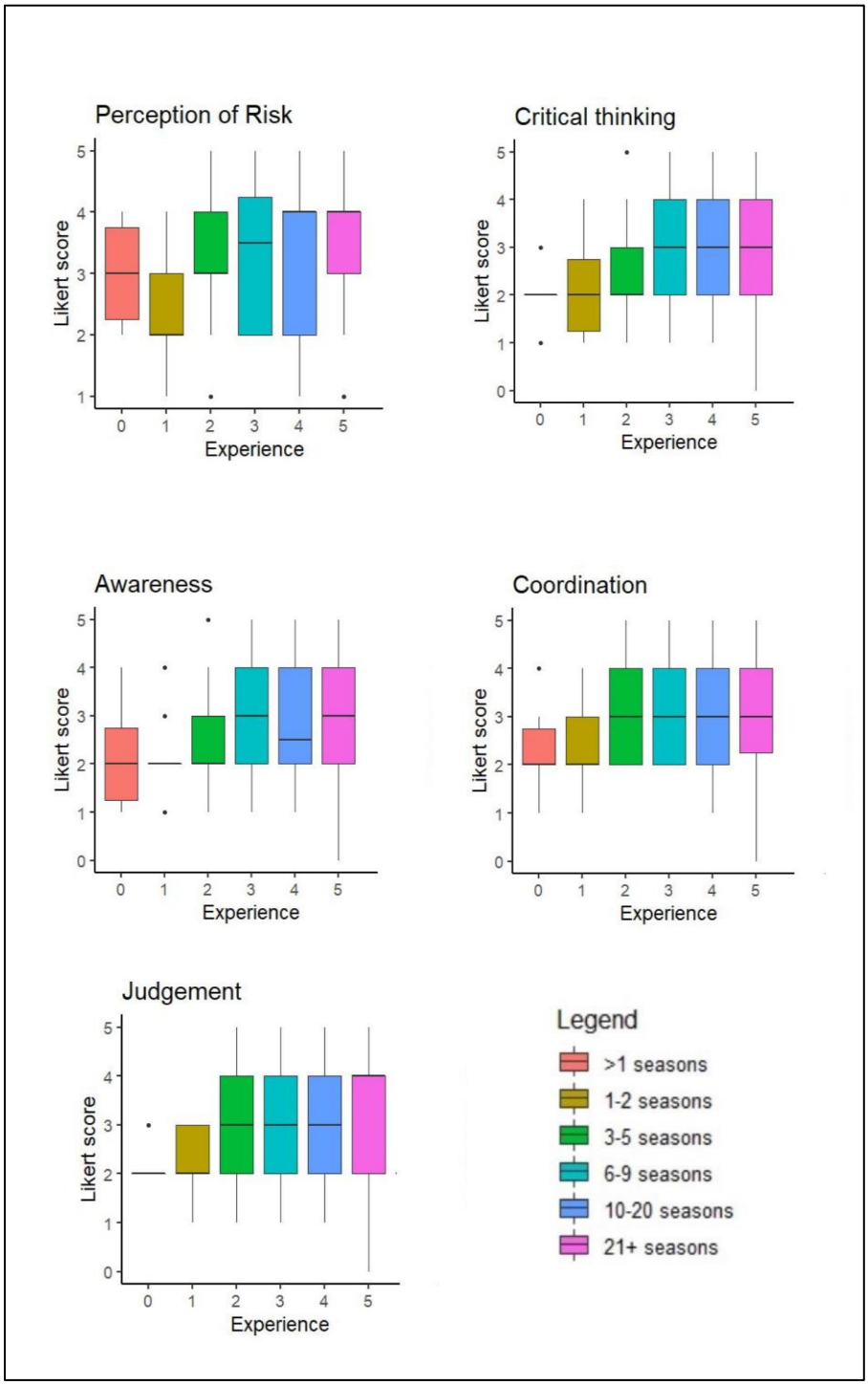


(1 – "Strongly agree, 2= "agree", 3= "neutral", 4=" disagree", 5=" strongly disagree").

In the fishing industry, years of experience affects almost every aspect of how the job is performed. While creating this study, the research team was interested in how experience affected the responses of answers to the survey questions. Figure 8 displays boxplots of the response to the sleep deprivation question broken into categories of experience. The boxplots display a pattern: experience groups above 6 years responded higher and more towards the "neutral" or "disagree" option. The experience groups between >1 year and 5 years chose options closer to the "neutral" or "agree" option. This shows that fishers with more years of

experience were either “neutral” or “disagreed” that lack of sleep affects their perception of risk, critical thinking, awareness, coordination, and judgment compared to fishers with less years of experience.

Figure 8: Box plots showing median response to sleep deprivation broken into years of experience on the x-axis



(1 – “Strongly agree, 2= “agree”, 3= “neutral”, 4=” disagree”, 5=” strongly disagree”).

After visualizing how experience affected the responses to the sleep deprivation questions, the research team wanted to see if the differences in responses were statistically significantly associated with experience. Table 4 displays F statistics and p-values for the linear regression model performed on the sleep deprivation data. F statistics ranged from 2 to 4.3. P-values for descriptors show that the association between experience and mean Likert responses were statistically significantly different except for critical thinking and perception of risk.

Table 4: F Statistics and P-values for regression model for sleep deprivation.

Descriptor	F statistic	P-value
Awareness	**2.9**	**0.01**
Coordination	**3.4**	**0.004**
Critical thinking	2.1	0.06
Judgment	**4.3**	**0.0005**
Perception of risk	2.6	0.02

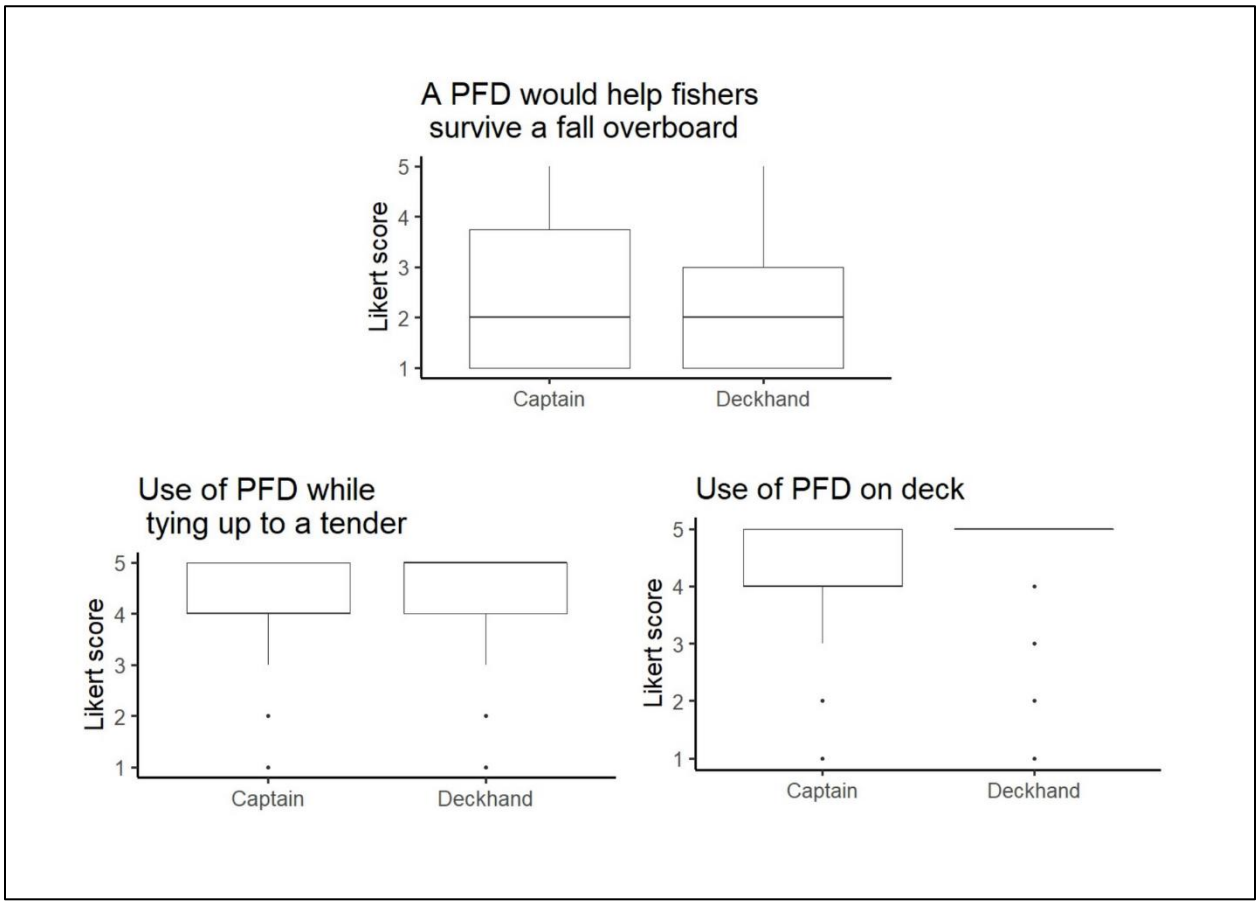
*Bolded results indicate statistically significant differences between the groups' mean Likert scores.

Personal Protective Equipment as a Controls

For this study, the research team was interested in investigating current acceptability of PPE. The research team also investigated attitudes towards PPE, asking whether they thought a PFD would help them survive a fall overboard, or if a hardhat would prevent serious injury.

When asked if fishers "have…personally experienced or know someone who has fallen overboard while tying up to or untying from a tender during delivery", 17 captains and 23 deckhands reported yes, while 37 captains and 57 deckhands reported no. For total fishers (captain and deckhand), 30% of fishers from this study have either personally experienced or know someone who has fallen overboard. Figure 9 illustrates the difference in PFD use between work groups. The fishers were asked if "a PFD would help fishers survive a fall overboard" (captains were asked these questions regarding their crew). Captains and deckhands had the same median Likert score, responding "most of the time". When asked if fishers wear PFDs on deck or tying up, median scores for deckhands were "some of the time", while deckhands' were "never".

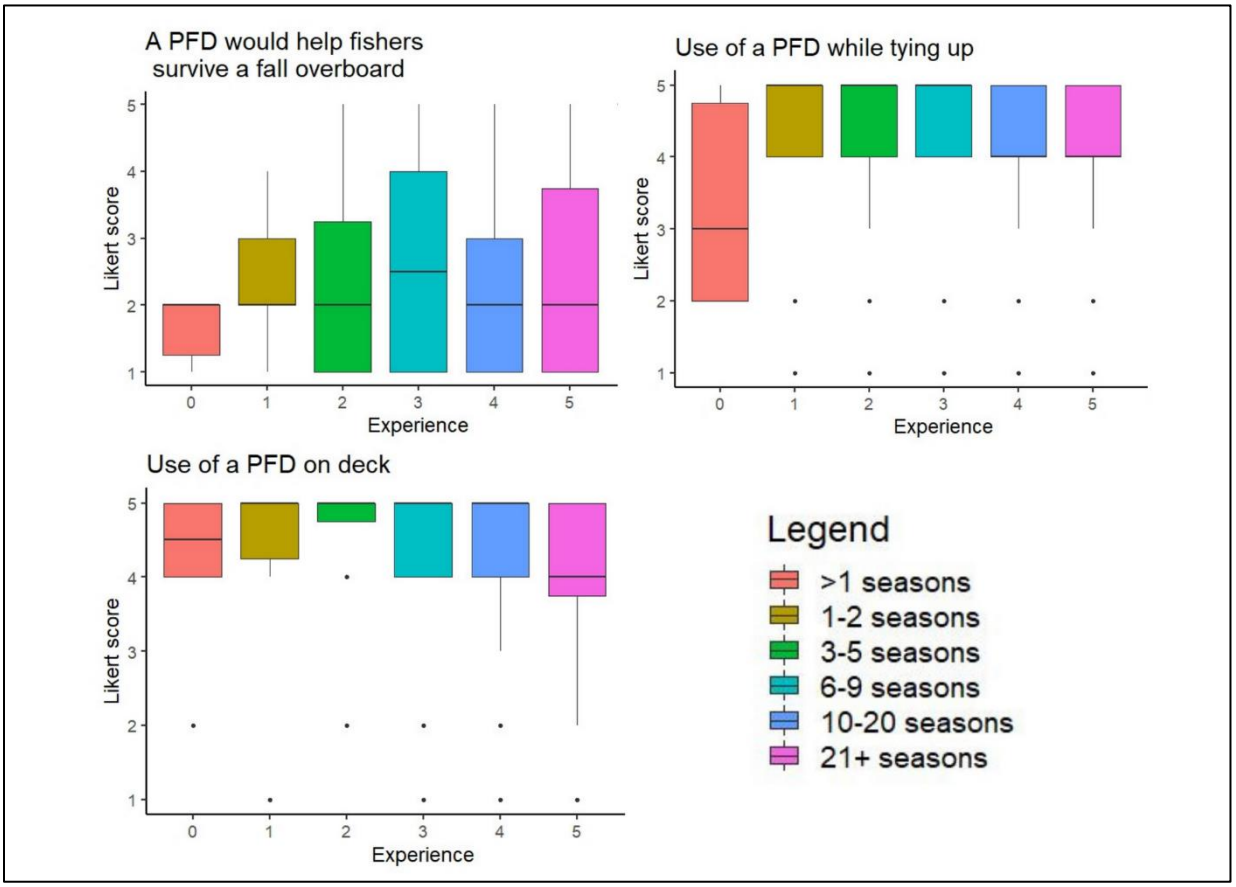
Figure 9: Boxplots showing Likert score values for the questions regarding attitudes and actions while tying up.



(1 – “all of the time", 2= “most of the time”, 3= “neutral”, 4=” some of the time”, 5=” never”).

We explored whether years of experience affected study participant’s answer to the same questions around PFD and found stark contrasts between new workers and use of a PFD compared to those with experience. Figure 10 displays boxplots of the response to the questions asking about fishers’ attitudes towards safety while tying up and PFD use, broken into categories of experience. The captains were asked these questions regarding their crew. When asked whether fishers feel unsafe while tying up to a tender, the medians for all experience categories responded with “some of the time”. When asked if a PFD would help fishers survive a fall overboard, most experienced groups responded, “most of the time”. However, experience groups 1-20 years’ median Likert response was “never” when asked if they use a PFD on deck while delivering. The experience group of >1 year responded “neutral” to whether they use a PFD to tie up or not, while the 1-9 years’ experience groups’ median response was “never”. However, the 10-21+ experience group responses were “some of the time”.

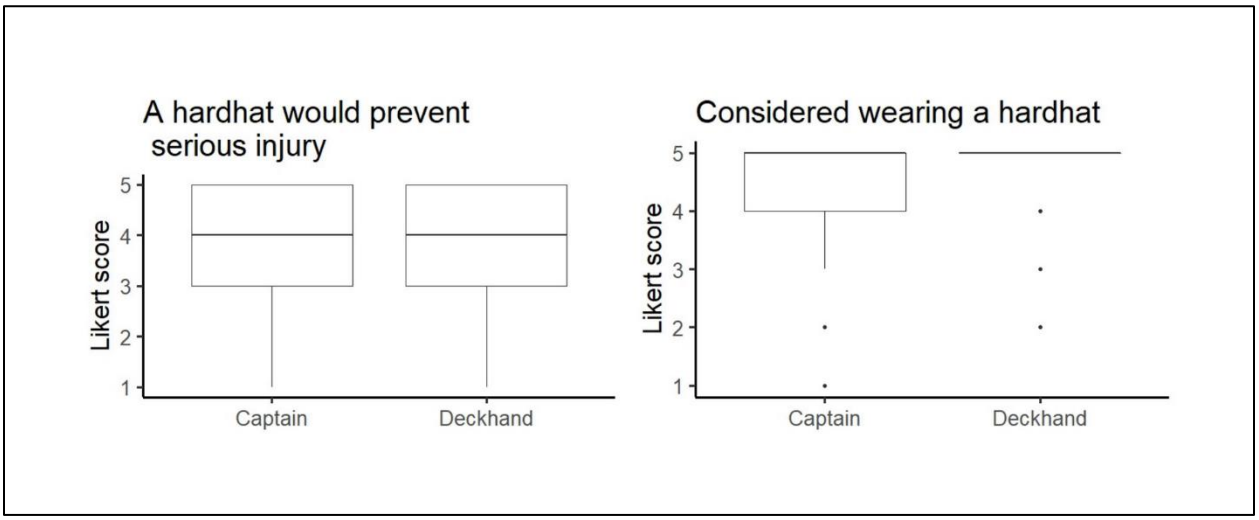
Figure 10: Boxplots showing responses by experience to questions about tying up and PFD use.



(1 – "all of the time", 2= "most of the time", 3= "neutral", 4=" some of the time", 5=" never").

This study asked fishers if they "have…personally experienced or know someone who has been hit in the head by a weight scale during delivery". Twenty-eight captains and 27 deckhands reported yes, while 27 captains and 54 deckhands reported no. For total fishers (captain and deckhand), 40% of fishers from this study have either personally experienced or know someone who has been hit in the head by a weight scale during delivery. Figure 11 displays boxplots of the response to the questions asking about fishers' attitudes towards safety while on deck and hardhat use. While the captains' and deckhands' median responses show that they think a hardhat would prevent a serious injury "some of the time", both groups' median responses show that they have "never" considered wearing a hardhat.

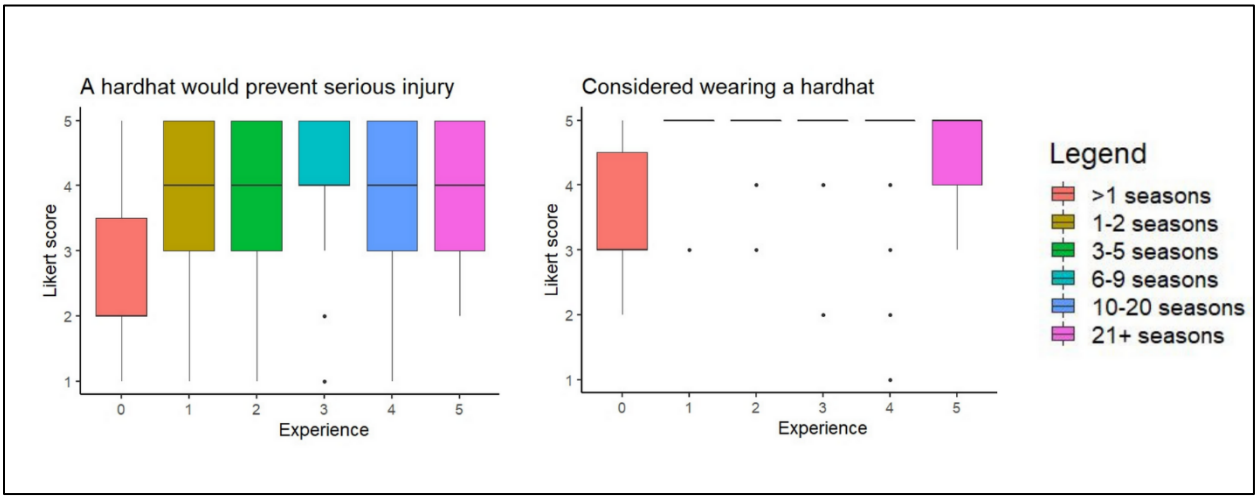
Figure 11: Boxplots showing Likert score values for the questions regarding hard hat use while on deck during delivery.



(1 – "all of the time", 2= "most of the time", 3= "neutral", 4=" some of the time", 5=" never").

Like the PFD use questions, the research team was curious about the differences between years of experience and responses to whether fishers think a hardhat would prevent serious injury, or if they have considered wearing a hardhat. Figure 12 shows median responses from questions asking about hard hat use, broken into categories of experience. The >1 season category fell between "neutral" and "some of the time". Median scores for whether fishers would consider a hardhat had a median response of "never" for experience groups 1-21+ seasons. The >1 years of experience group also responded that a hardhat would prevent serious injury "most of the time", while the other experience groups responded with "some of the time".

Figure 12: Boxplots showing responses by experience to questions about hazards hard hat use on deck during delivery.



(1 – "all of the time", 2= "most of the time", 3= "neutral", 4=" some of the time", 5=" never").

Like the linear regression performed on the sleep deprivation data, the research team was curious about the associations between years of experience and response to the general safety questions. Table 5 displays F statistics and P-values from linear regression models.

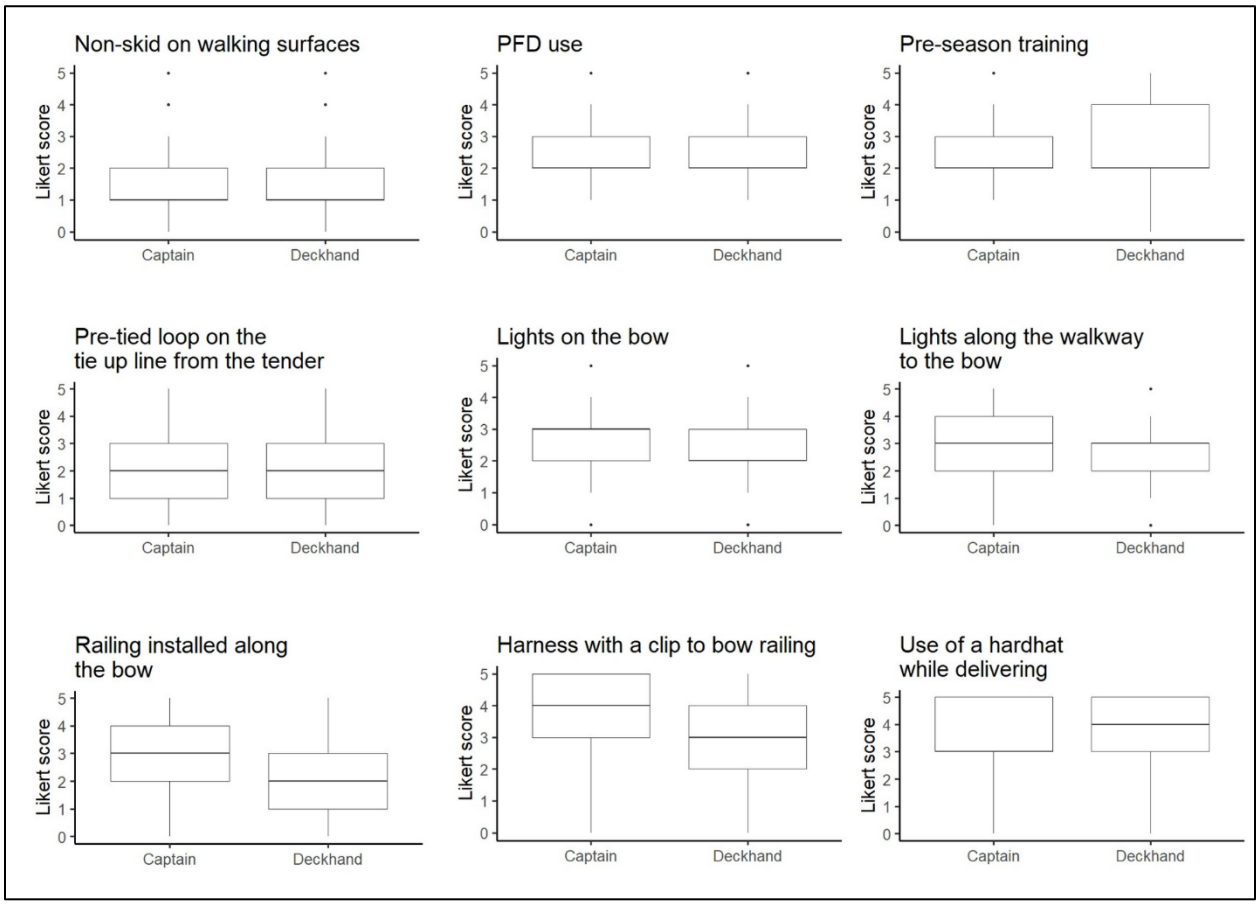
Table 5: F Statistics and P-values for attitude and call to action regression models. Bolded results indicate statistically significant linear association between response and experience.

Question	F statistic	P-value
Feeling unsafe while maneuvering the weight scale	0.8	0.6
Feeling unsafe while tying up to the tender	2.3	0.04
Feeling at risk of being crushed by brailer bags	0.7	0.6
Use of a PFD tying up	0.1	0.4
Use of a PFD on deck	1.9	0.1
A PFD would help fishers survive a fall overboard	1.6	0.1
Considered wearing a hardhat	2.7	0.01
A hard hat would prevent serious injury	1	0.4

Interventions

For this study, it was essential to ask fishers about the potential for implementation of these safety controls. How possible is it that fishers will use these safety measures? What types of controls are favored within the gillnet community? Questions for the implementation section began with asking fishers, "*participating* in the following control measures would help reduce risk while at the tender" for deckhands and "*implementing* the following control measures would help reduce risk while at the tender:" for captains. Results for mean Likert response for captains and deckhands are displayed in Table 2. Figure 13 shows box plots displaying responses for captains and deckhands. Captains and deckhands had the same median Likert scores for pre-season training ("agree"), PFD use ("agree"), pre-tied loops on the tie up line from the tender ("agree"), lights along the walkway to the bow (neutral"), and the use of non-skid on walking surfaces ("strongly agree"). Captains' median response to implementing hardhats was "neutral", while deckhands' median response was "disagree" to using hardhats. Captains' median response to implementing a harness with a clip to the bow railing was "disagree", with deckhands' median response being "neutral". Finally, captains' median response to bow lights was "neutral", while the deckhands' was "agree". Among all controls included in the questions, non-skid was the most agreeable option. Other agreeable control measures were pre-season training, PFD use and pre-tied loops on the tie up lines from the tender.

Figure 13: Boxplot displaying median Likert score responses to questions asking about safety control implementation.



(1 – "all of the time", 2= "most of the time", 3= "neutral", 4=" some of the time", 5=" never").

Barriers and facilitators

Following up on previous research done to investigate why fishers wear PFDs, why they don't, and what would encourage them to wear PFDs, three questions included in the surveys asked captains and deckhands about facilitators and barriers to PFD use while delivering. Table 6 displays results from a question asking about what types of conditions prompt deckhands to wear a PFD, and what conditions result in captains encouraging deckhands to wear a PFD. The question was formatted as a "check all that apply " question with an "other" option for short answer responses. The most common conditions where a PFD would be worn was bad weather (30% for captains and 18% for deckhands), delivering at night in bad weather (30% and 20%). For "other", 4 captains and 1 deckhand responded that anchoring at night and anchoring during rough weather prompts the use of a PFD. Additionally, Table 6 asks captains and deckhands what encourages the use of a PFD. The most common answer was if the PFD was small and compact, and that it does not get in the way (25% for captains and 23% for deckhands). Another common answer was if the PFD was comfortable (24% and 22%). Furthermore, the survey asked if requiring a PFD would encourage use. Fourteen percent of captains and 23% of deckhands

responded that this requirement would encourage them to wear a PFD. Table 6 displays barriers to PFD use. The most common barrier to PFD use was that it was uncomfortable to wear for both captains (27%) and deckhands (26%). Other barriers were space to store the PFDs and time to locate one and put it on. Other responses noted that it is bulky, inconvenient and can affect mobility. Two deckhands and one captain responded that PFDs are a snag hazard.

Table 6: Table highlighting barriers and facilitators to PFD use, Likert scale responses to interventions, and responses to questions regarding communication.

	Captain (n=55)	**Deckhand (n=82)**
What conditions prompt you to wear/encourage deckhands to wear a PFD when tying up to the tender and delivering? Check all that apply	n(%)	n(%)
I always wear a PFD	7(6)	11(8)
Bad weather (seas over 4')	32(30)	25(18)
Night delivery	17(15)	16(11)
Night delivery and bad weather	34(30)	29(20)
My captain requires I wear a PFD while delivering	5(5)	13(9)
I never wear a PFD while delivering	7(6)	42(30)
Other	8(7)	6(4)
What are some potential barriers to wearing a PFD when tying up and delivering? Check all that apply	n(%)	n(%)
Time to locate and put it on		
Time to locate and put it on	23(20)	33(22)
Space to store on the vessel	23(20)	26(17)
Uncomfortable to wear	31(27)	40(26)
It is not required	10(9)	27(18)
It is not provided	6(5)	18(12)
Cost	8(7)	-
Other	18(15)	9(6)
What would encourage you/deckhands to wear a PFD when tying up and delivering at the tender? Check all that apply:	n(%)	n(%)

	Captain (n=55)	Deckhand (n=82)
Hung up in an obvious and reachable spot	18(15)	31(14)
Small and compact -does not get in the way	30(25)	52(23)
Comfortable	28(24)	50(22)
If the PFD is provided	11(9)	33(15)
If it is required	17(14)	53(23)
If it is affordable	6(6)	-
Other	8(7)	7(3)
Implementing/Participating in the following control measures would help reduce risk while at the tender:	Mean Likert Score (1=Strongly agree – 5= Strongly disagree)	Mean Likert Score (1=Strongly agree – 5= Strongly disagree)
Non-skid	1.7	1.6
PFD use	2.4	2.4
Preseason training	2.7	2.5
Pre-tied loop on the tie up line from tender (do not have to cinch to cleat)	2.4	2
Lights on the bow	2.7	2.3
Lights on the walkway to the bow	3	2.6
Railing installed along the bow	2.9	2.4
Harness style clip to bow railing	3.7	3.1
Use of a hard hat while delivering	3.4	3.7
My preferred way to receive and or deliver safety training materials is: Check all that apply	n(%) marked	n(%) marked
Pre-season drills	42(34)	35(27)
Safety brochures	16(13)	13(10)
Safety posters	8(7)	9(7)
Pre-season video trainings	11(9)	12(9)
Drill instructor course	33(27)	19(15)
I do not receive training	6(5)	31(23)
Other	6(5)	11(8)
What are the ways in which you get information for the Bristol Bay fishery? Check all that apply	n(%) marked	n(%) marked

	Captain (n=55)	Deckhand (n=82)
From my captain	14(10)	76(38)
Emails from processor	41(30)	18(9)
Bristol Bay Regional Seafood Development Association Newsletter	40(29)	31(16)
Facebook	7(19)	59(30)
Posters	7(5)	7(3)
Other	7(5)	7(3)

Communication

Table 6 displays responses to the question asking about the preferred ways in which captains receive and deliver safety training materials and the preferred ways in which deckhands receive training materials. The most popular way to receive and deliver these materials was pre-season drills (34% for captains and 27% for deckhands). Another popular medium was drill instructor courses (27% and 15%). Table 6 also displays responses to the question asking about the preferred ways in which captains and deckhands receive information for the Bristol Bay fishery. The most common communications medium for captains was emails from the processor or BBRSDA (30% and 29%). For deckhands, the most common medium was from their captains and Facebook (38% and 30%).

Qualitative

Another important piece of this study was the inclusion of short-answer questions that gave the researchers a deeper understanding into the thoughts of fishers on subjects covered in the study. Short answer questions asked fishers to add additional thoughts and comments about certain questions in the survey or describe their experiences. Parent codes refer to the specific questions that were asked. The parent codes consist of fall from vessel, weight scale, additional safety information, sleep deprivation and finally, additional information.

For the question about whether a fisher had either personally experienced or know someone who has fallen overboard while tying up to or untying from a tender during delivery, the surveys asked fishers to "describe where and when they fell from the boat and what were they doing?" Participants identified the bow and the side as the primary location from which themselves or someone they know fell off the gillnet vessel while delivering. One fisher recalled an event where someone was, *"Untying from the tender and became uncoordinated while throwing the lines back. Tried to save the lines from going in the water and reached too far. Overboard they went".* Another scenario describing falling overboard was crossing between the two boats. Finally, other responses described trip hazards being a cause of falling overboard. One captain said, *"the deckhand tripped over the cleat on the bow of the boat and fell off the side backwards. A boat behind us in the tender line threw him a line and was able to get him onboard unharmed."*

Like the falling overboard question, the survey asked fishers to "elaborate below" if they or someone they know has been hit in the head by a weight scale during delivery. Participants

identified a direct hit when describing how they or someone they know had taken a direct hit by a weight scale during delivery. For example, one deckhand stated they have been hit *"Several times, no stitches needed in any case."* Finally, fishers described that when they were hit, the cause was improper or inadequate crew training for both gillnet and tender deckhands. One deckhand said *"The scale came an inch from my dad's face when he was a kid. We always have a second man in charge of manning the scale on our boat because of his experience."* This quote indicates that there is some form of crew training and conversation about manning the weight scale while delivering.

When asked to "describe any additional safety controls you feel reduces risk during delivery", participants identified crew training, lighting, authoritative decision making, risk assessment, tender locations, equipment improvement, vessel, and visibility as primary additional safety measures. A deckhand responded to this question with their comment, *"Have a plan. Never walk between the tender and your vessel in bad weather, always use the outside rail. Be prepared to toss the line over and drive away. THREE POINTS OF CONTACT with the vessel."*

For the sleep deprivation question, participants were asked to "please provide additional thoughts and comments about how sleep deprivation affects fishers". Participants identified psychological and physical effects when prompted to provide additional thoughts and comments about how sleep deprivation affects them. One captain recalled a time when they, "... *made the decision to deliver in very rough seas and the drum broke loose and almost killed my precious daughter. [I] never made that mistake again. I hadn't slept in two days."* Additionally, they also reported responses that were categorized under occupational requirements and expectations of the job. For example, one captain said, *"If sleep is what you're after, - don't go commercial fishing."* Other responses that did not fit into these categories were labeled as "other".

Finally, the fishers were asked if "there was anything else you wish to describe to the researchers about the Bristol Bay gillnet fishery". Participants identified crew training, equipment improvement, occupational requirements and expectations, tender locations, mother nature and professionalism as primary additional information they wanted the research team to know. One deckhand stated, *"I feel that there is a lack of easily accessible information about how the fishery works. New deckhands are at the mercy of what their captain chooses to tell or not tell them. I would like to see more educational materials for crew and prospective crew who are considering fishing in Bristol Bay."*

The code book for qualitative questions is found in Appendix B and includes parent codes, sub-codes, definitions, and examples.

Discussion

This exploratory, descriptive research study sought to gain knowledge of the fishers' perceived risk, hazards during the delivery process and implementation of controls measures during tender offload.

The strengths of this study are the unique fishery experience of the researcher and the novel nature of the study. To the best of our knowledge, no prior study has explored fishermen safety during the specific event of delivering at the tender during the Bristol Bay drift gillnet fishery. As such, this study provides a first look at occupational safety impacts experienced by this population and provides an in-depth understanding of their experiences during delivery.

The results from our study indicate that fishers experience a variety of safety and psychological hazards during tender delivery. The fishers identified the opportunity for administrative and engineering controls such as pre-tied loops and pre-season training to reduce exposure to and impacts of these hazards. The response from deckhands and captains to this study was very positive and encouraging. Although the study population was challenging to reach, the fishers conveyed gratitude and support of the study's purpose. The willingness to participate indicates that these workers are willing to actively participate in studies addressing fisher health and safety. Findings from our study demonstrate fishermen experience a variety of occupational safety exposures. To the best of our knowledge, this is the first study of its kind to explore safety while at a tender vessel in Bristol Bay, AK. Here, we discuss several key findings from our study and suggest recommendations for fisher safety and future research.

Sleep deprivation

The researchers speculate that sleep deprivation is a factor that could influence injuries on deck. Fishers generally agreed or responded neutral to the question of whether sleep affects their awareness and critical thinking. Between both deckhands and captains, fishers slept on average 2-5 hours during a 24-hour period during the peak season. However, something to note is that these 2-5 hours of sleep could either be broken up into multiple naps, or one longer stretch of sleep if the fishing is closed for that amount of time. In derby fisheries like the Bristol Bay drift gillnet fishery, lack of sleep is considered part of the job. Short answer responses gave a more in-depth description of attitudes towards safety and sleep into the fishery.

The strengths of this study are the unique fishery experience of the researcher and the novel nature of the study. To the best of our knowledge, no prior study has explored fishermen safety during the specific process of delivering at the tender during the Bristol Bay drift gillnet fishery. As such, this study provides a first look at the occupational safety impacts experienced by this population and provides an in-depth question about how sleep affects. Fishers stated that "*If sleep is what you're after, -don't go commercial fishing. A 8-5 land job might be more your speed"*. Additionally, fishers stated that "*we rally through it"* and it "*is part of the job".*

Occupational expectations

In an intense fishery such as Bristol Bay, sleep deprivation can lead to increased accidents and worsen physical performance (Poux, 2021). In Bristol Bay, the need for sleep comes in cycles, like the tides that control the fishers every move. While working hard picking fish, the

excitement and adrenaline help fishers get by. It is thrilling to catch a lot of fish and the energy is visceral, and certainly contagious. However, during the down moments like driving to the tender or sitting on a slow fishing day, it is easy to get caught taking a back deck nap. At the tender when full attention is needed to hold onto the boat railing or avoid the weight scale, decreased awareness or coordination could result in a very different situation. In studies conducted to address sleep deprivation, researchers found that, "In otherwise healthy adults, short-term consequences of sleep disruption include increased stress responsivity, somatic pain, reduced quality of life, emotional distress and mood disorders, and cognitive, memory, and performance deficits" (Medic, G. et al., 2017). Some boats in the fishery work on a "bunk-rotation" schedule - if the fishing is slow, someone is often napping in their bunk. In some cases, captains have "alternate operators" who are trained to either make deliveries or participate in fishing, so their captain gets more sleep. Newer, larger boats have the capacity to sleep six or more fishers, while smaller, older boats may only have three bunks total. At times, it is possible to have one deckhand on the back deck, but it always depends on a captain's preference. One crew working the back deck could pose other safety hazards other than lack of sleep.

Our research also investigated the influence of years of experience. Like any job, the more time spent performing job tasks and learning the skills necessary to do the job, a person becomes more efficient and proficient. We found that fishers with less years of experience had lower Likert score values regarding questions about sleep deprivation compared to the fishers with more years of experience which could be due to personal coping mechanisms that fishers have developed over the years to compensate for lack of sleep. In a 2014 review, Høvdanum, A., et al., found only five articles published that concern fatigue in fishers (Høvdanum, A., et al., 2014). However, all five articles conclude that fatigue is a serious health issue for fishers and more research is warranted (Høvdanum, A., et al., 2014). During the summer of 2022, Jerry Dzugan, executive director of the Alaska Marine Safety Education Association (AMSEA), will be studying 200 commercial fishers for the next two years. The study seeks to quantify the problem and gauge concerns about sleep patterns and how it affects their overall health (Poux, 2021).

Controls

During the design phase of this study, the research team utilized the hierarchy of controls as a framework for identifying interventions. For example, the pre-tied loop from the tenders is a cost-effective engineering control, while pre-season training would be considered an administrative control implemented by captains. This work builds on previous literature that highlights safety controls such as the use of PFDs during gillnet fisheries. Participants in our study generally agree that a PFD would help them survive a fall overboard (figure 9). When compared to the other descriptors, fishers mostly disagreed on other statements such a "I feel unsafe when tying up to a tender" and disagreed or strongly disagreed that they have considered wearing a hardhat. The fishers felt neutral about maneuvering the weight scale and that a hardhat would prevent a serious injury if the weight scale were to hit them. In general, the attitudes towards PFD use seem to indicate more acceptance within the fishery. In the past few years, PFDs have become less bulky and more lightweight which could be contributing to the increased use. One of the barriers noted in PFD use was the possibility of it being a snag hazard with the net. While this is certainly true while participating in setting the net or picking fish, there are

fewer snag hazards while at the tender. Some captains noted that they require PFDs while delivering in rough weather and or anchoring in rough weather at night.

In 2012, Lucas, D. and Lincoln, J. et al conducted a study that assessed worker satisfaction with PFDs. The study found that fishers preferred PFDs that were lightweight and did not interfere with their work, did not snag on fishing gear and were easy to keep clean and easy to put on. Of the fishers in the 2012 study, 75% of gillnetters were concerned about snag hazards as a reason for not wearing a PFD. The study created an infographic that displays results from the study and other information about PFD use for gillnetters. For this study, it is informative to compare the results from our study to the one done published in 2012. In our study, a barrier to PFD use was that it could be a snag hazard, which is consistent with the findings from the 2012 study. Lucas, D et al also explored PFD use among gillnetters and found that 55% of those surveyed never wore a PFD. When asked about PFD use for our study, 50% of fishers reported never wearing one while tying up. Additionally, 62% of participants in our study reported never wearing a PFD on deck. Fishers wearing a PFD more often while tying up compared to while on deck could be because of an increase in exposure while on the bow. On most vessels, there is a railing on the back deck. Without the railing, the exposure to falling overboard is higher and wearing a PFD, for some fishers, could be a way to decrease vulnerability to drowning while in the water. It is important to note that by wearing a PFD, the hazard of falling overboard is not decreased but surviving a fall overboard is (Case, S. L., et al., 2018).

Although fishers seem to be neutral about the weight scale, qualitative responses recall multiple contact hits to the bodies of fishers during the season. Some of this could be due to weight scales not having a "tag-line" between the weight scale, or an inexperienced crane operator. One deckhand noted that getting hit "*happens every year to someone. Usually minor thankfully*." That situation described differs significantly from another deckhand that stated they "*saw a guy get his teeth bashed in."* When discussing hits to the head, one control measure could be the use of a hardhat. Fishers' median response to the use or consideration of a hardhat was either neutral, disagree or strongly disagree. A deckhand noted that these hits are "*usually a lateral blow which would not be avoided with hardhat. Hardhat blocks vision."* Other factors that could contribute to more weight scale contact injuries are rough weather, poor lighting, or deck configuration. One example is if the crane operator is based in a place on the tender where they cannot see the deck of the gillnet vessel that they are picking the brailer bags up from. In this case, another tender worker must act as a communication relay. This situation can pose many hazards both to the gillnet vessel crew and the tender crew. In other scenarios on calm days in the daylight, or on tenders with adequate lighting, maneuvering the weight scale can be a breeze. One fisher explained that "*in my experience over the last few seasons, there are tenders that are just on point no matter what the weather conditions or whatever daily challenges they are facing. Slow and steady always wins the race."* The environment on tenders like this would be a good place to begin assessing ways that tenders can reduce injuries to both tender and gillnet fishers.

At the end of the survey, there was a question that asked the fishers if there was anything else they wanted to state about the Bristol Bay drift gillnet fishery in general. Some responses discussed concerns that were not addressed in the survey, such as the "*dangers of the river currents are rarely recognized…unlighted set net skiffs, exhaust health uses, handling fuels without skin protection and radar emission"*. Others recalled that there is "*a wide range of*

professionalism in the fleet." However, a handful of responses still gave light to other attitudes on safety research. For example, fishers stated that "*there is a 2-week window in [which] the majority of the fish get caught. If you are worried about sleep, stay home!"* and stating that fishers "*do not want [their] response to cause any new laws in Bristol Bay."* Although this study did not directly address the current safety climate of the Bristol Bay, Alaska gillnet fishery, there was one participant that stated they would wear a PFD *"if everyone else was wearing one (social pressure".* One study published in 2006 found that "it was predicted that a strong organizational safety climate would attenuate the negative effects…on self-reported safety outcomes such as safety knowledge, safety compliance, accidents, and injuries (Probst, M. 2004). Safety climate differs between each boat that participates in the fishery.

The results indicate that fishers do favor some safety controls over others. The median response to the use of pre-tied loops on the tender tie up lines was the most popular. A small loop at the end of a line may seem like a small change. However, when the weather is rough, and a deckhand is standing on the bow holding onto the rail, the loop makes tying up significantly more efficient; a deckhand may not even have to take both hands off the railing to catch the line and place the tie up line loop over the cleat. One factor that contributes to the deckhand-on-the-bow-in-rough-weather-situation is the general configuration of most of the boats. Gillnet vessels in Bristol Bay are typically built with the house-forward and working deck near the rear. In recent years, boats called "bow pickers" and "thru-pickers" have gained popularity among fishers (see figure 14). One deckhand noted that they were "on a thru-picker… much safer when tying up on the bow, much more deck space to stay out of the way of brailers." This quote expresses the importance of injury prevention through design. A question worth asking in a future survey about fishery safety could address how different boats experience delivering based on how their deck is configured.

Figure 14: On the left is a "stern-picker" style drift gillnet vessel. In the middle shows a thru-picker. On the right shows a bow-picker style vessel. (Left-to-right: Photo 1: Jim Purdum. Photo 2: FiskerForum.com. Photo 3: permitmaster.com).

One factor that could have influenced survey results was the fact that 2021 was a record-breaking year for the salmon return. The excitement was heightened as fishers were confronted with a historic run size and fish in their nets. Alongside the large salmon run came some big weather. Winds gusted from 45-60 knots at their peak and 9-10' seas rocked 32' boats like corks in the water. Over the radios, talk of injuries at tenders during delivery resulted in some tenders shutting down operations until the weather improved or moving to a more sheltered anchorage.

Many deckhands expressed gratitude to the research team and were encouraging of the initiative to make tender delivery safer.

Communication

The survey results show that captains prefer pre-season drills and the drill instructor course as a way to receive and or deliver safety training materials. Deckhands had similar responses with pre-season drills being the most common choice. Another common response for deckhands was that they did not receive training which was second behind the pre-season drills. In recent years, there have been more classes for deckhands to take to learn basic skills like net mending and mechanical skills. One course was offered in Naknek in the summer of 2021, but there is no information about the program online. AMSEA offers drill instructor courses every year in Seattle, WA, Naknek, AK and other locations near fishing ports in Alaska and Washington. Captains preferred both emails from their processors and communication from their processors, while deckhands preferred to get information from their captains and Facebook. Facebook was also a popular communications medium for captains. Many fishers are members on Bristol Bay fishing Facebook groups where they can discuss happenings in the fishing community. Of the pre-filled choices, posters were the least preferred method to get information. One reason for this could be lack of space for posters to be placed in Naknek, King Salmon, Dillingham, Egegik and other places where fishers would see them. The findings from the communications tables (tables 22 and 23) will inform future work for Aim 3 which seeks to create a safety resources tool and communicate findings to fishers.

Study Limitations

Although our sample size allowed us to achieve saturation of key themes in our qualitative study, our study may be subject to non-response bias. In King Salmon and Naknek, Alaska, cellular service and Wi-Fi are scarce, which may have prevented some fishers from hearing about the survey or access to take it. It is possible that those who were unable to take the survey due to these reasons were systematically different from those that did or had very different experiences while on board. However, the diversity of participants and achievement of saturation in key themes reduces these concerns.

In addition, surveys were distributed before the season began which was 10 months from the last time a fisher had delivered salmon at a tender in Bristol Bay, introducing the possibility of recall bias. We provided participants with an opportunity to take the survey after the season to assess the accuracy of the researcher's experience during the season.

We also acknowledge that participants may be unaware of certain administrative controls implemented on tenders or under processors' policies, which may have influenced the hazards fishers interacted with, and the topics discussed in their short answer responses.

As in any study, the researcher's own biases may have influenced the style of questions as well as interpretation of responses. The researcher used a second coder to discuss interpretation of themes and response categorization. The researcher had prior experience with the fishery and prior relationships with some of the participants of this study.

Conclusion

Tender delivery injuries are a persistent problem during the Bristol Bay drift gillnet season. Understanding current attitudes towards perceived risk and safety is the first step to thinking about how to implement safety controls for fishers in a way that will be accepted and utilized. Interventions aimed at decreasing injuries while delivering should be tailored to each vessel type and crew dynamic and focus on modifying the significant barriers to fisher attitude and beliefs towards safety. The interventions that follow the hierarchy of controls -engineering, administrative and then PPE are key to saving lives. Familiarizing fishers with ways to decrease injury through pre-season training may be a helpful step for deckhands and captains alike. Communication about job expectations and PFD use would be a beneficial approach to decreasing hazards during delivery.

Programs that incentivize PFD use and pre-season training for gillnet captains may aid in accessibility to these tools. Subsidized or free PPE may encourage captains and deckhands to wear PFDs more often while at the tender, thus increasing acceptability. Furthermore, talking with tender workers about pre-tied loops and the potential for more crane operator training may aid in decreasing gillnet injuries.

Further research with tender workers could be done to address the interactions between tenders and gillnetters and potential implementations may help bridge the gap between the two operations that are literally tied together.

This study is the first to take a deeper look at gillnet commercial fishing safety risk, specific to delivering fish to a tender. Similar work in other fisheries has been explored in Alaska, Oregon, Washington, and some fisheries on the East Coast. This work will inform fishers, captains, processors, tender workers about safety while at the tender. Additional research is needed in the Bristol Bay gillnet fishery to evaluate safety measures discussed and recommended in this study.

Aim 3: Communicate findings to fishers, partner agencies, conferences and to the public

Findings from this study will be presented at the Pacific Northwest Safety Symposium in May 2022 in Ellensburg, Washington. The audience of this conference includes occupational health and safety professionals, academics, and students from across the state. The goal of this presentation will be to inform audience members of my work and to increase awareness of commercial fishers and their experiences on deck.

Findings from this study will also be presented in a public thesis defense that will be advertised on Bristol Bay fishing worker social media pages to watch and participate. The audience of this zoom webinar will include academics, students, Bristol Bay fishers and the public. The goal of this presentation will be to inform audience members of my work and to communicate survey findings to Bristol Bay fishers and the public.

Lasty, we share findings on a "fisher safety" website page on the Bristol Bay Regional Seafood Distribution Association website. The findings will be used to inform fishers about perception of risk and associated factors as well as potential controls they can use to reduce risk while at the tender. There will be additional safety resources for fishermen, with the potential for an open forum to discuss what other fishers use and prefer.

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Appendix A: Additional Quantitative Figures

Figure A1: Boxplots showing Likert scores for the questions about how sleep affects fishers. Captains were asked: "I feel that lack of sleep affects my deckhands'....". Deckhands were asked to answer, "I feel that lack of sleep affects my""

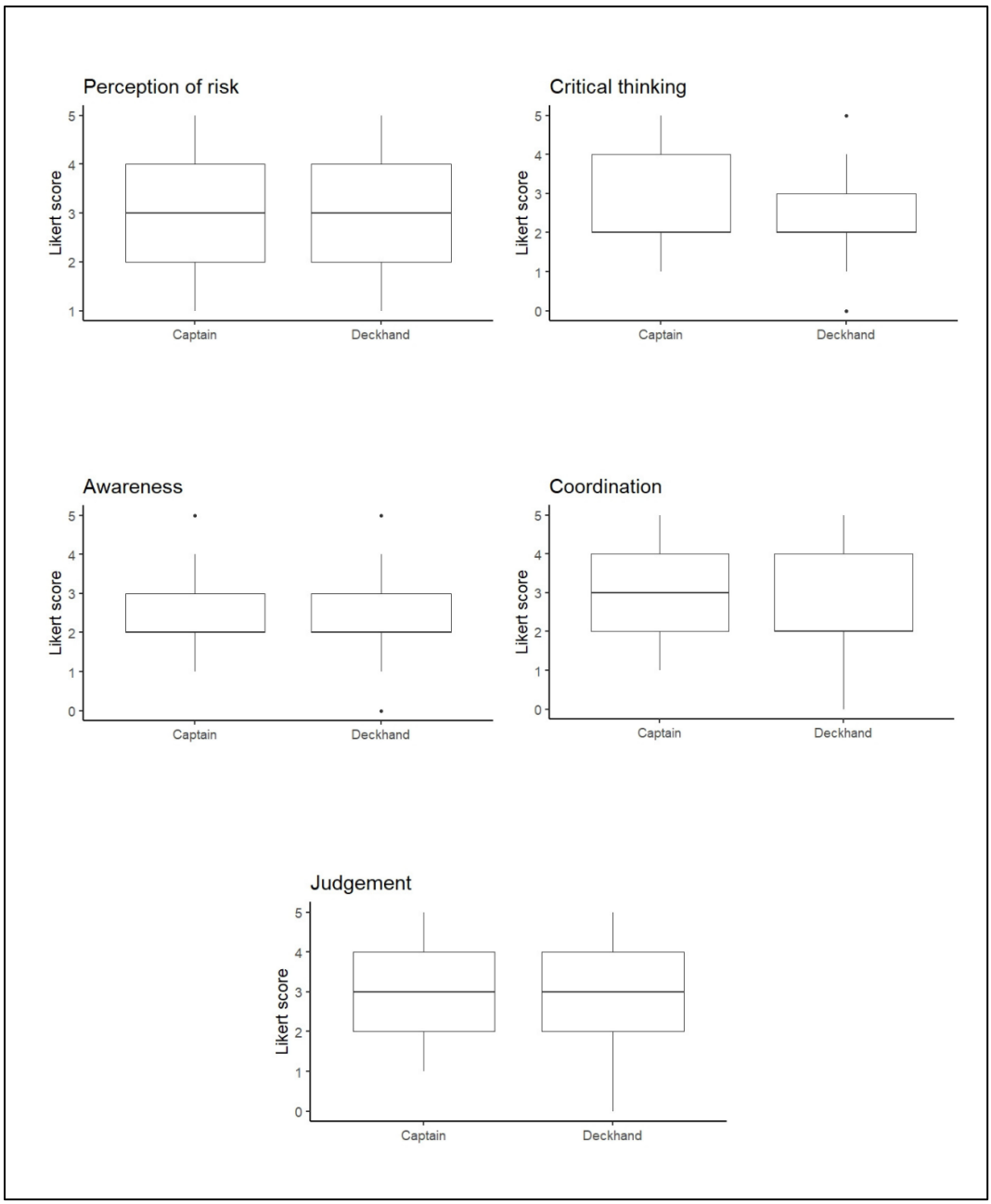


Figure A2: Donut plots displaying data from the question about falling overboard.

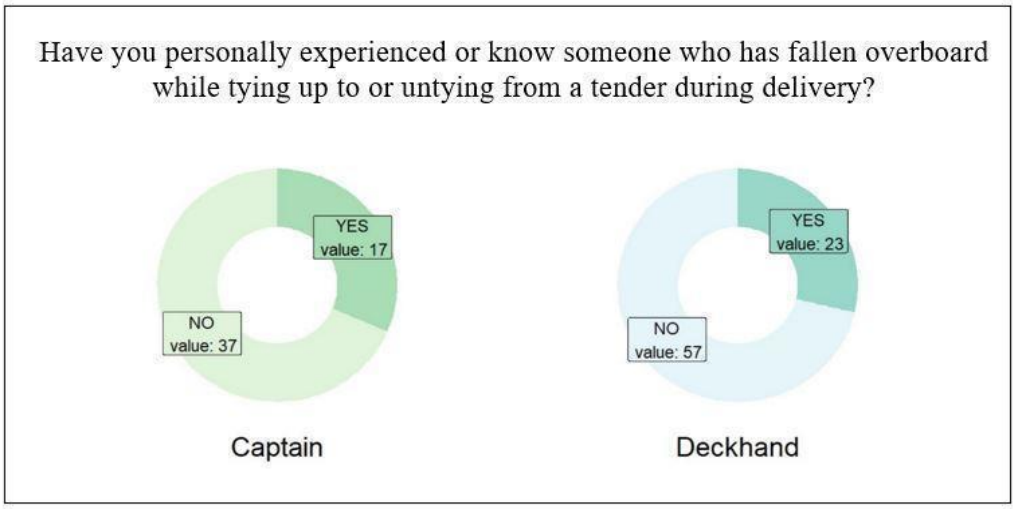
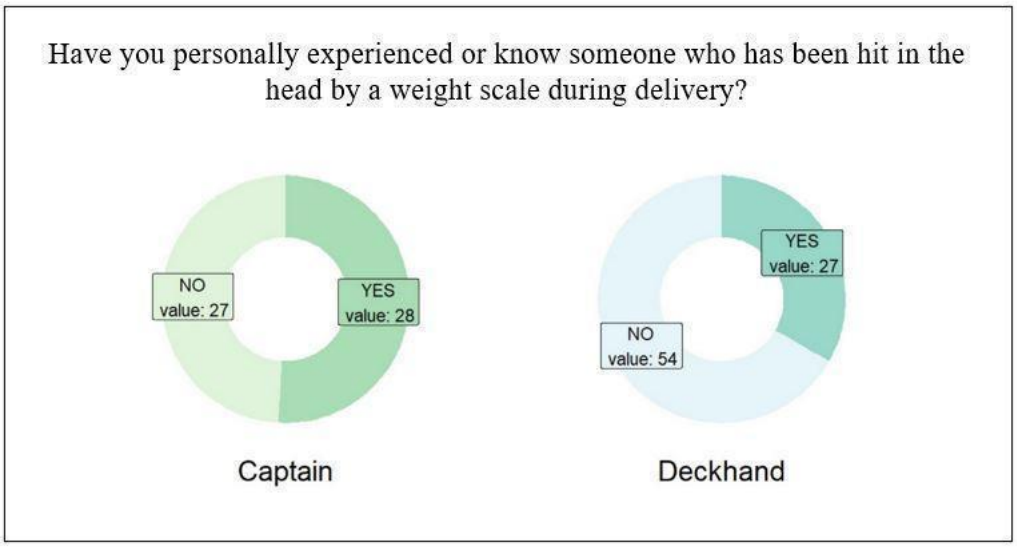


Figure A3: Donut plots displaying data from the question about the weight scale.



Appendix B: Coding Tables

Table B1: Coding for quantitative data

	Definition	Code
Gender		
	Male	0
	Female	1
	Queer	2
Age		
	18-24 years	1
	25-44 years	2
	45-64 years	3
	65+ years	4
Job position		
	Captain	0
	Deckhand	1
Experience		
	>1 season	0
	1-2 seasons	1
	3-5 seasons	2
	6-9 seasons	3
	10-20 seasons	4
	21+ seasons	5
Likert Scales		
	Strongly Disagree	5
	Disagree	4
	Neutral	3
	Agree	2
	Strongly agree	1
	Never	5
	Some of the time	4
	Neutral	3
	Most of the time	2

	All of the time	1

Table B2: Qualitative coding structure for question that asked, "Please provide additional thoughts and comments about how sleep deprivation affects Bristol Bay fishermen(optional)".

Parent code	Sub- code	Definition	Example
Sleep			
	Psychological	Responses that recount the physiological effects of sleep deprivation.	*"I notice my deckhand's motivation and assertiveness going down if we do not sleep and eat regularly. "*
	Physical	Responses that recount the physical effects of sleep deprivation.	*"Lack of sleep causes poor coordination"*
	Occupational requirements and expectations	Responses that recount certain occupational requirements and expectations regarding the work and sleep deprivation	*"Is part of the job". "We rally through it."*
	Other	Responses that cannot be categorized in the above sub-codes	*"I think the fleet would like to know what the end game of this survey and study is hoping to accomplish. I sure hope you aren't trying to force us to nap like truckers"*

Table B3: Qualitative coding structure for question that asked, "Have you personally experienced or know someone who has fallen overboard while tying up to or untying from a tender during delivery? If YES, please describe below. Where and when did they fall from the boat and what were they doing? (Example: fell from bow while approaching tender during night delivery)"

Parent code	Sub- code	Definition	Example
Fall from vessel			
	Bow	Responses that recount falling from the bow (front) of the vessel into the water	*"Fell from bow and got keelhauled but survived and continued the season as normal- very common"*

	Side	Responses that recount falling from the side of the vessel into the water	*"Fell between tender and fishing boat, pulled out of water safely"*
	Crossing	Responses that recount falling while crossing between the tender and the gillnet vessel.	*"Fell when going to tender. Fell between gilnetter and tender and landed on buoy bag. Did not fall into the water."*
	Tripped	Responses that recount tripping and then falling into the water	*"The deckhand tripped over the cleat on the bow of the boat and fell off the side backwards. "*

Table B4: Qualitative coding structure for question that asked "Have you personally experienced or know someone who has been hit in the head by a weight scale during delivery?. If YES, please describe below".

Parent code	Sub- code	Definition	Example
Weight scale injuries			
	Direct hit	Responses that recount being hit anywhere on the body by the weight scale or pelican hook	*"Direct hit to the face, broke his jaw and lost several teeth"*
	Equipment improvement	Responses that call for improvement of equipment used while at the tender that would reduce injury	*"A 3–4-foot tag line to the bottom of the scale so you can keep it away from the guys heads when hooking up the pelican."*
	Crew training	Responses that can be categorized under anything having to do with proper deckhand training, awareness, how they conduct themselves on both tender and gillnet vessels.	*"I always have two crew assist with the delivery one to specifically assist with the scale"*

Table B5: Qualitative coding structure for question that asked, "Please describe any additional safety controls you feel reduces risk during delivery:"

Parent code	Sub- code	Definition	Example
Additional safety measures			

	Crew training	Responses that can be categorized under anything having to do with proper deckhand training, awareness, how they conduct themselves	*"Tender crane operators that are WELL trained"*
	Lighting	Responses that discuss how lighting affects the environment at the tender	*"Lights walking up to bow would also be tricky. But the more light the better. Maybe more light coming from the tender."*
	Authoritative decision making	Responses that discuss how captains make decisions and how it affects safety while at the tender	*"As the captain, knowing when to call it quits and step in. The safety of the crew lies solely on the captain"*
	Risk assessment	Responses that discuss how risk assessment affects the environment at the tender	*"Being aware of what's going on AT ALL TIMES plays a key role is surviving on the bay"*
	Tender location	Responses that concern where tenders are anchored during bad weather	*"Delivering in protected spots when bad weather happens (in River for Naknek)."*
	Equipment improvement	Responses that call for improvement of equipment used while at the tender that would reduce injury	*"I think every tender should throw us an eye and then cinch the boat up wherever they want it."*
	Vessel	Responses that address how the limit on vessel length, or vessel deck configuration affect safety at the tender	*"The biggest problem is the fact that these boats are too small to make safety gear like hard hats or pfds convenient. A lot of the issues are also based around the type of crane (boom length and joints) and the crane operator. Fish hold location and design can also be the cause of a lot of problems."*
	Visibility	Responses that address how visibility of the tender crane operator and the deck of the gillnet vessel affect safety at the tender	*"The most important factor is an experienced crane operator with a clear view of the whole fishing vessel deck operation and a clear chain of communication between the*

			deck crew on the fishing vessel and the crane operator."

Table B6: Qualitative coding structure for question that asked "If there is anything else you wish to describe to the researchers about the Bristol Bay gillnet fishery? Please elaborate below: (Optional)."

Parent code	Sub- code	Definition	Example
Additional information about fishery			
	Crew training	Responses that can be categorized under anything having to do with proper deckhand training, awareness, how they conduct themselves	*"This will be my 43rd season in the bay. Not much has changed when delivering our fish safety wise but what would really help is massive training for crane operators on tenders picking up brailers out of the holds. Every close call we've ever had was from a poor operator."*
	Equipment improvement	Responses that call for improvement of equipment used while at the tender that would reduce injury	*"Proper tie up lines providing a stretch factor would go a long way. Falling down while delivering is generally caused by tenders using tie up lines that don't stretch. This causes the boat to violently lurch while riding waves at the tender. "*
	Vessel	Responses that address how the limit on vessel length, or vessel deck configuration affect safety at the tender	*"As vessel deck size increases and flush decks become the industry standard are more or less delivery accidents occurring? It seems as though crews have more room now with modern large flush deck vessels to get away from*

			overhead brailers and to increase their distance from scales during offloading but some of the modern house forward jet boats have very little bow spce for the crew during tie up"
	Occupational requirements and expectations	Responses that recount certain occupational requirements and expectations regarding the work and sleep deprivation	*"We aren't truckers. We don't need naps."*
	Mother nature	Responses that discuss how mother nature (the weather) affect safety at the tender	*"Mother Nature is the main problem"*
	Professionalism	Responses that discuss professionalism in the fishing industry and how it affects safety at the tender	*"Wide range of professionalism in the fleet"*

Table B7: All quotes from all short answer questions (Captain survey)

Parent code: sleep deprivation	
	Responses
Psychological	*"Everyone is short tempered."* *". I notice my deckhands motivation and assertiveness going down if we do not sleep and eat regularly. "* *"Moral/attitude"* *"grouchy, slow at the get go."* *"Mood Attitude Performance"*
Physical	*"Deckhand speed is sometimes diminished"* *"Less sleep = more mistakes"*

	"Ignoring Footing obstacles and proper use of handholds and overhead hazards during tie up delivery and vessel anchoring are likely my biggest concerns with crew regardless of sleep levels" *"Lack of sleep causes poor coordination and awareness."* *"Deckhands are less proactive and less likely to address any risk issues they see if sleep deprivation is an issue."* *" sleep deprivation makes all of us slower to react however proper and safe conduct during deliveries is still achieved"* *"Once I made the decision to deliver in very rough seas and the drum broke loose and almost killed my precious daughter. Never made that mistake again. I hadn't slept in two days"* *" It causes slower reaction time and in some cases poor judgment"*
Occupational requirements and expectations	*"Is part of the job"* *"We rally through it."* *"If sleep is what you're after,- don't go commercial fishing. A 8 - 5 land job might be more your speed.* *I've been commercial fishing for 33 years now and if there is one thing certain about it:* *A sleeping fisherman doesn't make any money."* *"It is part of the business, if you can't handle it get a 9-5 job."* *"If that's a insurmountable challenge, don't go commercial fishing. There are other ways to make a living."*
Other	*"I think the fleet would like to know what the end game of this survey and study is hoping to accomplish. I sure hope you aren't trying to force us to nap like truckers"*
Parent code: fall from vessel	
Bow	*"Fell off bow when attempting to reach buoy hanging off tender in order to hang behind."*

	“captain got paperwork off bow and a wake came unseen and he fell in between boats, lucky he was ok” *“From the bow but where able to grab rail and pull them selfs back on the boat”* *“As we were untying while in a tender line my deckhand missed the hand rail”* *“my brother while trying up,”* *“Fall from bow while anchoring”* *“A friend lost a crewman while setting anchor and wasn't recovered for a few days.”* *“Untying from the tender and became uncoordinated while throwing the lines back. Tried to save the lines from going in the water and reached to far. Overboard they went”* *“I am aware of one deckhand who fell from bow”*
Side	*“Fell off the side”* *“Fell from flying bridge during rough water delivery”* *“ a crewman rushing to the deck after untying the tow line from the bow.”* *“My deckhand fell off the boat while unloading and fortunately grabbed the tender bumper and did not go al the way into the water. Very rough weather and boats were snapping pretty hard.*
Crossing	*“My dad was being a dumbass ans jumped from the tender to his untied boat”* *Boat came untied and the captain tried to jump to the boat like an imbecile and fell in.”* *“Mostly folks fall overboard going to and from the tender”* *“Captain fell crossing the rail to get on the tender in Egegik and hit head on rail knocked out and fell between the fishing vessel and the*

	tender and went into the water his crew saved him by untying the vessel and rescuing the captain from the water. I do not know when."
Tripped	*"The deckhand tripped over the cleat on the bow of the boat and fell off the side backwards. A boat behind us in the tender line threw him a line and was able to get him onboard unharmed."*
Parent code: weight scale injuries	
Direct hit	*"I knew a guy that was flown out due to being hit in the head."* *" direct hit to the face, broke his jaw and lost several teeth"* *'My deckhand saw the scale coming at him and he just stood there and the scale hit him in the forehead. He did not react at all. It was calm and easy offload but he was over tired."* *'Been hit more than once."* *"Me. It was rough and just lost my grip. Just one big goose egg. Lol"* *"I have been hit in the head with the scale and the pelican hook"* *"was hit in the head but did not suffer a significant injury"* *"One time it lightly hit a crewman's head because the crane operator dropped it too far. "* *"Pendulum effect swung headache ball into fellow deckhands forehead. He was knocked unconscious but made it through"*
Equipment improvement	*" a 3-4 foot tag line to the bottom of the scale so you can keep it away from the guys heads when hooking up the pelican."* *" if there is a line hanging down below the scale that hooks onto brailers the problem is almost 100% soleved"*

Crew training	*"Tender crew are very unsafe and routinely cause problems with the scale."* *"During a foul weather delivery an inexperienced crane operator lowered the scale onto a deckhand"* *'have one of the crew hold the scale to protect other guy"* *"I always have two crew assist with the delivery one to specifically assist with the scale"*
Parent code: additional safety measures	
Crew training	*"Tender deckhands should be trained well on the crane."* *"Good Crane operator"* *"Tendermen with proper crane training"* *"Everyone should know there jobs and what is going on""* *"Trained tender crew"* *" Proper tenderman/crane operator training and experience."* *"A major portion of fishing crews safety relies on the tender crews training."* *"Well prepared tendering and deck hands on the tender. In rough weather speed on the tender can be key to reducing risk."*
Light	*"Lights walking up to bow would also be tricky. But the more light the better. Maybe more light coming from the tender."*
Authoritative decision making	*"As the captain, knowing when to call it quits and step in. The safety of the crew lies solely on the captain"* *" ability to call it quits during rough weather, assess the dangers and make changes to the game plan like delivering in river or someplace*

	protected, and intervening and stepping in and helping during deliveries when it's rough is key" *"risk assessment by Captain and use necessary available means to manage risk such as waiting to deliver when conditions are safer (like tide change)"*
Risk assessment	*"Taking your time. Safety over speed."* *"t can be scary and when people are scared they make mistakes. Eliminating that possibility and keeping new deckhands out of harms way is and should be the priority."* *"Having one dedicated person control the scale and hook that's coming overhead"*
Crew training	*"My crew never walks back from the bow, after tying up, on the tender side of the boat."* *"Never walk to the bow between the boat and the tender - always the outside."* *" we require pfd when heading to the bow at night"* *" Loop, life jacket WITH light for going fwd at night"*
Tender location	*"The tenders should anchor as shallow a water thar is safe for them."* *"Tenders being able to maneuver their boat to keep the delivering boats in the lee of the weather."*
Equipment improvement	*"Pre tied loops on tender tie up lines are THE WAY TO GO."* *" I like the suggestion on tenders throwing a bow loop so my crew doesn't have to spend more time than necessary on the bow."* *"Most Silverbay tenders have pretied eye on Bow line. Just pun on the cleat Done. Go hook up brailes."*
Vessel	*"Please larger boats. Remove the 32' limit"*

	“It”’s not practical to put railings to the bow on a 32’ Gillnetter”
Visibility	*“ The most important factor is an experienced crane operator with a clear view of the whole fishing vessel deck operation and a clear chain of communication between the deck crew on the fishing vessel and the crane operator.”*
Parent code: additional information about fishery	
Crew training	*“I generally go to great lengths to vet crewmen and try to find people that I can trust to operate safely while being efficient. “* *“A pre season video or training should be required by the processors through their fleet managers as a pre requisite to delivering any fish for a given year”* *“A greater concern of mine is poorly trained tendermen. I will go out of my way to avoid certain tenders in bad conditions. The majority of the tender fleet for most processors high new crew every year and finding people with crane experience is difficult. In the end my crew has to compensate for dangerous behavior on the tenders part. Training for a trenderman seems just as valuable as for fishing boat crews.”* *“This will be my 43rd season in the bay. Not much has changed when delivering our fish safety wise but what would really help is massive training for crane operators on tenders picking up brailers out of the holds. Every close call we’ve ever had was from a poor operator.”* *“The biggest and most effective way to reduce overboard fatality is a PFD. The problem is finding one that is low profile enough. It needs to be seamless so it doesn't snag the net or any other gear with zippers, pockets or edges. It needs to be light and sleek enough to go under the rain jacket. I still haven't found one that fits all this criteria and works. Inflatable PFDs are not viable or reliable.* *“*
Equipment improvement	*“Proper tie up lines providing a stretch factor would go a long way. Falling down while delivering is generally caused by tenders using tie up lines that don't stretch. This causes the boat to violently lurch while riding waves at the tender. “*

Vessel	*"Certain tenders are better to deliver to in unsafe conditions because of the setups and their crew."* *"As vessel deck size increases and flush decks become the industry standard are more or less delivery accidents occurring? It seems as though crews have more room now with modern large flush deck vessels to get away from overhead brailers and to increase their distance from scales during offloading but some of the modern house forward jet boats have very little bow spce for the crew during tie up"* *"Larger boats would create safer environments drastically,"*
Mother Nature	*"Mother Nature is the main problem"*
Occupational requirements and expectations	*"We aren't truckers. We don't need naps."* *"I don't find it too dangerous delivering but there has been a couple scary times in the Nush where I didn't leave the helm for safety if line snapped."* *"Big boy summer camp! I love it"* *"The peak is intense and the conditions can be very bad and add to that lack of sleep it makes for a very unsafe working environment. It is what it is... unless you can get the salmon to cooperate and come over a longer period of time and spread it out there's not much to do about it."* *"It's a fast paced fishery. I think safety is commonly over looked to save time"*
Professionalism	*"Wide range of professionalism in the fleet"* *"The biggest hazard in this fishery is directly related to the many different kind of people involved and their independent nature"* *" In addition there is a component of alcohol and drug use while in the fishery. the best way to influence change to the fleet is through the markets."*

Table B8: All quotes from all short answer questions (Deckhand survey)

	Responses
Parent code: sleep deprivation	
Psychological	*"It can make people irritable and less able to work as a team"* *"limits critical thinking, limits awareness of situation, and judgement of situations. Sleep is one thing, but also hunger is a big factor."* *"Makes them irritable"* *"Lowered motivation"* *"Makes people grumpy!"* *"Mood, energy levels"* *"I think sleep is important but in most scenarios you can work through sleep deprivation with minimal issues"* *"Decision making and ability to react safely to situations that could put self/others is significantly reduced with fatigue."* *"My experience is that sleep deprivation can cause feelings of distraction (obsessing on the thought of getting in the bunk) and urgency to finish the work (cutting corners, arguing with other deckhands about doing the work). I think deckhands with experience often handle sleep dep better than greenhorns."*
Physical	*"Lack of awareness for the first part of fishing after waking up. Exhaustion can create forgetfulness and sometimes cause potent ion hazards due to skipped steps in set up/ fishing process"* *"I think it makes deckhands a little slower when they need to be thinking quickly"* *"Dulls alacrity and connection to surroundings and circumstances, slows response time"* *"Fatigue makes you move slower,"* *"Makes me hungry and become a nicotine addict"*

	" youre without the ability to think as clearly its like drunk and high and concussed. Its scary but the silver lining is that you can push through it as the men before us did."
Occupational requirements and expectations	*"Cabin fever plus lack of sleep correlates with incidence of wild behavior! The high-intensity environment makes people act in ways they wouldn't if they were "down south""* *"job isn't for everyone that's for sure"* *"Sleep affects everything! But we push through."*
Parent code: Fall from vessel	
Bow	*"Fell from bow while tying up"* *"Fell from the bow"* *"Fell from bow "* *"Tying up the bow line"* *"Fell from the bow I am not sure of the exact circumstances I wasn't there"* *"Fell from bow while trying to catch tie up line from tender"* *"Tying up the bow line"* *"Slipped while tying up and somehow managed to not get crushed between the fishing vessel and tender"* *"Fell while reaching out to catch the tie up line thrown from the tender"* *"Front, grabbing tie up line"* *"Fell over and came up on other side of tender"* *"Our deckhand was reaching down to grab the line to hang off the tender during a busy day and when he reached down a wave chit the boat and he went overboard"*

	"Tying up to tender" *"Fell between tender and fishing boat, pulled out of water safely"* *"Tying up to tender my dad fell over and popped up at the stern when he was young he was recovered. Another captain I know had thr same thing happen to a crew member he was recovered."* *"Fell when going to tender. Fell between gilnetter and tender and landed on bouy bag. Did not fall into the water."* *"Fell from bow and got keelhauled but survived and continued the season as normal- very common"* *"I fell off the rail while going to the bow for delivery."*
Crossing	*"A guy fell between the boat and tender while trying to tie up the boat"* *"Tender crew fell into the water. Reason for falling was unknown."*
Other	*"Egegik river tying up to the Bella K, we dropped a brailer and the boat behind us tried to maneuver to grab it for us but bumped the tender knocking a deckhand off balance and over board, she was recovered in under 45 seconds and was completely fine"*
Parent code: weight scale injuries	
Direct hit	*"It wasn't me. It got caught on the rail and wiped off of the rail and hit him"* *"I had it graze my hat and almost crush my head"* *"It wasn't too bad but we know it could be, we make sure to always have someone holding the scale while it is on board"* *:Several times, no stitches needed in any case. Falling into a fishhole during delivery has happened more often."* *"Not in the head. Other body parts, yes"* *"Rough weather caused it to drop on me"* *"I get hit every season"*

	"Kinda happens every year to someone. Usually minor thankfully" *"I've not seen anyone get full on hit with it swinging, but I've personally had it drop on my head when the boat is really moving in rough weather tied up to the tender and I'm trying to attach it to the brailer."* *"Not bad, but things do fly around on the boat."* *"I saw a guy get his teeth bashed in by the scale one year"* *"A crew member had his head down and wasn't paying attention while hooking up tag lines. He stood up and into the scale while it wasn't moving."* *"Multiple instances. Usually a lateral blow which would not be avoided with hard hat. Hard hat blocks vision."*
Crew training	*"Swung out in bad weather and bad crane operators"* *"Honestly in my experiences over the last few seasons, there are tenders that are just on point no matter what the weather conditions or whatever daily challenges they are facing. Slow and steady Always wins the race. Other tenders just show pure negligence on deck. Its not always the weight ball and pelican swinging around the deck at various heights... sometimes its the guy behind the controls that has absolutely no idea whats going on."* *"I have a huge problem with inexperienced tender crane operators. We have had several instances of inept operators slamming crew members while offloading"* *"Not too hard, but it's pretty common for a new crane operator to jerk the scale and hit you in the head while reaching down to put the brailer on the pelican."* *"Crane operator was swinging the boom around like a crazy person and i got hit by the pelican when the crane should have stayed over on the tender for the time being."* *"The scale came an inch from my dads face when he was a kid. We always have a second man in charge of manning the scale on our boat because of his experience."*
Equipment improvement	*"It's never been serious. Rubber padding on the scale could be an easy solution"*

Parent code: additional safety measures	
Crew training	*“just the bow in crazy seas thats about it and better crane operators”* *“Tender crane operators that are WELL trained.”* *“Well trained crane operators”* *Having 3 guys on the back deck and one designated to hold the scale while hooking up bags* *Common sense* *Clear communications* *Pre license learning class/video* *Communication. It's not just up to your cap to figure out where the boat should be positioned at each different tender. Ask the crane op if he's within earshot "WHERE DO YOU WANT ME" if you're doing the bow line. If the crane op is out of ear shot, hopefully the individual throwing the line from the tender to the deckhand on the bow know the proper position for your particular vessel.* *One deckhand should always have their hands on the scale, preventing the scale from hitting whoever is hooking the bags up.* *It helps to always have a crewmember with their hand on the scale while it's over the fishing vessel. This prevents the scale from swinging around - especially in poor weather. We also have a policy where we are near the house and on the opposite side of a brailer bag being picked.* *The more times you do it the safer it is.* *overall clear communication between boat crew and tender crew* *Tender deckhands properly trained on all aspects of applicable boat operation while taking fish* *If it’s rough out and you’re on the bow, use the other side of the boat to get up on the bow to avoid getting crushed between the boats in pitchy seas.* *Don’t stand in the bite or in the aft corners. Watch the swing as the brailer bags come out and away. Always keep your hand on the weight if it’s above your deck and never stand underneath it because the roll*

	from the boat can put your nog in contact with the scale that way. Keep a clear deck- no tripping hazards. *Make sure someone always knows you are heading up to the bow.* *In general, three points of contact on a boat, especially for delivery. Always make sure you're hanging on to something!*
Light	*"Back deck lights, cleared deck"*
Authoritative decision making	*"The captain staying engaged, perhaps on the flying bridge to keep an eye on things and jump in where needed"*
Risk assessment	*"Being aware."* *"Have each other's back. Pay attention."* *"Have a plan. Never walk between the tender and your vessel in bad weather, always use the outside rail. Be prepared to toss the line over and drive away. THREE POINTS OF CONTACT with the vessel."* *"Being aware of whats going on AT ALL TIMES plays a key roll is surviving on the bay."* *"Be aware. Eat your meal."*
Tender location	*"Delivering in protected spots when bad weather happens (in River for Naknek)."* *"Canneries not allowing deliveries under bad weather conditions."* *Delivering on the leeward side of the tender in bad weather*
Equipment improvement	*Hard hats will be a hazard that will offer little protection from a lateral blow.* *I disagree on hard hats as a possible solution. As a shipbuilder, I find that they add to the risk when not completely necessary - as they block your peripheral vision and add additional height to your body so you end up bumping into things you usually would not.*

	Tender should maintain clean and non oily lines. Tying up on the lee side of tender *You don't really need a life jacket… sometimes they majorly get in the way. If you fall overboard during delivery, someone will see you. You really want that life jacket for late night pees.* *tern line also being pre-tied as typically people have to bend down to tie to the cleat and that puts their head in between the boat and tender* *The tie up locations provided by tender crews and the strength of the lines they provide* *I think every tender should throw us an eye and then cinch the boat up wherever they want it.* *I would like to emphasize that a tie up line from the tender with a loop - and the tender is responsible for snugging us in is something I especially want as a deckhand. In previous seasons it seemed like more tenders offered this, but I felt like it was almost never offered in my fleet in 2021.* *The scale/pelican hooks having obvious and convenient handles with which to hold and control the swing* *Long lines on the pelican hooks (or extensions on brailers) so deckhands can string them while keeping space between them and the scale.* *Pelican hooks go forward over the hatches and hatch covers stay out of the way- not upside down on deck.* *A 6 foot strap Betsy hook & scale, eliminating getting hit by scale. Also a great crane operator is essential*
Vessel	*The biggest problem is the fact that these boats are too small to make safety gear like hard hats or pfds convenient. A lot of the issues are also based around the type of crane (boom length and joints) and the crane operator. Fish hold location and design can also be the cause of a lot of problems.* *Being attached to the boat is dangerous, you could get trapped, especially when a stanchion is used for bowline attachment. Railing is a hazard.*

	Enclosed bow design can work eg; f/v Skagerrak. Lights can cause glare, a better solution is tender lighting above which most have. Lights at eye level on the bow are terribly blinding.
Parent code: additional information about fishery	
Crew training	*The AMSEA cold water immersion survival course should be a requirement for all fishermen to get their crew license.* *Any required information to watch would be helpful* *I feel that there is a lack of easily accessible information about how the fishery works. New deckhands are at the mercy of what their captain chooses to tell or not tell them. I would like to see more educational materials for crew and prospective crew who are considering fishing in Bristol Bay.* *Tender tie up and crane configuration is the biggest variable when delivering, some boats are easier than others to deliver to. For example, the Camai has good cranes and good operators, the Michelle Adele has very poor cranes and questionable operators.* *Everyone is responsible for being safe, however , I feel that most accidents/incidents come from inexperienced tender operators. Fairly common for there to be 2-4 "first season" crewmen on a tender.*
Equipment improvement	*Get all tenders to throw pre tied loops instead of having deckhands tie off to a cleat when it's rough out. That shit sucks.*
Vessel	*I was on a thru-picker. Much safer when tying up on the bow, much more deck space to stay out of the way of brailers.*
Occupational expectations and requirements	*Tow lines can be more dangerous when they loose slack. Most humans try to preserve their life even with lack of sleep. Bristol Bay less dangerous then deadliest catch makes muggles think fishing is.* *If you haven't experienced this fishery for multiple seasons on deck, I don't think your input is valid.*

	Good luck making this fishery safer. Lots of hard heads in that bay, we don't wanna wear a hard hat. *Don't ruin it like you've ruined towboating.* *One huge hazard is the location of the RSW valve below decks, it would be simple to install the valve handle above decks to empty the RSW and would prevent injuries and deaths from getting caught in the driveshaft, this valve must be turned twice at every delivery so it's absurd that the valves are still all below decks. Use of high visibility rain gear and PFDs as a requirement.* *I have worked on commercial fishing boats my entire life (purse seining for salmon and squid, coastal crabbing). I am 27 years old. I grew up on a fishing boat. The closest I have ever come to falling overboard happened this year on a Bristol Bay tie up to the tender. It is one of the most dangerous routine procedures that happens in fishing.*
Professionalism	*Be professional.* *Most often a high schooler or college kid are fishing on deck and don't know enough or are careless.*
Other	*The speed of deliveries is important both to the fishermen and the tender operators, and often being faster at the tender means more sleep. Safety measures that do not slow the process will be more likely to be adopted and followed by fishermen*

Appendix C: Surveys

C1: Captain survey

Captain survey

About this survey

The objective of this study is to describe current risk perception for captains and crew during the delivery process. Additionally, this project will use the hierarchy of controls to identify and recommend potential measures that could reduce overboard falls and injury during tender offload. Having fishermen participate is very important as it will produce relevant data that is impactful to this specific fishery. The end goal is to gather data from these surveys to make control recommendations and also communicate the findings to fishermen and stakeholders in an efficient and meaningful way.

About the research team:

My name is Anna Mounsey and I am a Masters Student at the Univeristy of Washington. I have decided to study occupational health and safety within commercial fishing as my thesis topic. As a commercial fishermen for the past 8 years, I hope take my unique position and translate my experience into my research.

Risk and benefits to participation

Your responses to the questions will be kept confidential and data you provide will be anonymized. While we discourage provision of any identifiable information in your free-form response, it is possible that the information that you provide may be able to identify you. We cannot offer any compensation for participation, and there are no direct benefits to participation. However, it is possible that findings from this study can be used to inform ongoing response activities for future fishermen safety. Data that has been de-identified may be placed in a data repository for use in future research or to answer alternative research questions. Any data that is shared in such a repository or with other researchers will be anonymous.

Questions?

If you have any questions about the survey, please contact Dr. Tania Busch Isaksen.
tania@uw.edu

1. What is your age?

Mark only one oval.

- ◯ 18-24
- ◯ 25-44
- ◯ 45-64
- ◯ 65+

2. What is your gender?

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Prefer not to say
- ◯ Other: _____

3. Do you own the boat you operate?

Mark only one oval.

- ◯ Yes
- ◯ Currently leasing
- ◯ No, I am a hired skipper
- ◯ No, I am an alternate operator and deckhand

4. How many seasons have you operated a gillnet vessel in Bristol Bay?

Mark only one oval.

- ◯ 2021 is my first season
- ◯ 1-2 seasons
- ◯ 3-5 seasons
- ◯ 6-9 seasons
- ◯ 10-20 seasons
- ◯ 21+ seasons

5. Did you work as a deckhand in Bristol Bay before operating a boat?

Mark only one oval.

- ◯ Yes
- ◯ No

6. Have you operated boats in other fishing industries besides Bristol Bay where you deliver your catch to a tender at sea? Purse seine, gillnet, etc.

Mark only one oval.

- ◯ Yes
- ◯ No

7. How many people are usually on your boat in Bristol Bay? (Include peak person)

Mark only one oval.

- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7+

8. How many people are typically awake and helping during a delivery? (Include captain and/or alternate)

Mark only one oval.

- 2
- 3
- 4
- 5
- 6
- 7+

9. During peak season, on average how many times does your vessel deliver fish to a tender in a 24 hour period?

Mark only one oval.

- Less than one time
- 1-2 times
- 3-4 times
- 5+ times

10. During that same 24 hours, on average how many hours of sleep do you get?

Mark only one oval.

- 0-1 hours
- 2-3 hours
- 4-5 hours
- 6-7 hours
- 8+ hours

11. I feel that lack of sleep affects my:

Check all that apply.

	Strongly disagree	Disagree	Neutral	Agree	Stronly agree	I don't know
Perception of risk	☐	☐	☐	☐	☐	☐
Awareness	☐	☐	☐	☐	☐	☐
Coordination	☐	☐	☐	☐	☐	☐
Judgement	☐	☐	☐	☐	☐	☐
Critical thinking	☐	☐	☐	☐	☐	☐

12. I feel that lack of sleep affects my deckhands':

Mark only one oval per row.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
Perception of risk	⬭	⬭	⬭	⬭	⬭	⬭
Awareness	⬭	⬭	⬭	⬭	⬭	⬭
Coordination	⬭	⬭	⬭	⬭	⬭	⬭
Judgement	⬭	⬭	⬭	⬭	⬭	⬭
Critical thinking	⬭	⬭	⬭	⬭	⬭	⬭

13. Please provide additional thoughts and comments about how sleep deprivation affects Bristol Bay fishermen(optional)

14. Please check the best descriptor for each statement listed

Mark only one oval per row.

	Never	Some of the time	Neutral	Most of the time	All of the time	Not applicable
I feel my crew is unsafe when tying up to a tender	⬭	⬭	⬭	⬭	⬭	⬭
I feel my crew is unsafe when maneuvering the weight scale or being underneath it	⬭	⬭	⬭	⬭	⬭	⬭
I feel my crew is at risk of being crushed by the brailer bags as they are being lifted from the holds	⬭	⬭	⬭	⬭	⬭	⬭
A hard hat would prevent serious injury to my deckhands' head from the weight scale	⬭	⬭	⬭	⬭	⬭	⬭
A PFD would help my deckhands survive a fall overboard	⬭	⬭	⬭	⬭	⬭	⬭
I have considered providing a hard hat to my deckhands when the weight scale is on the gillnet deck	⬭	⬭	⬭	⬭	⬭	⬭
My deckhands wear a PFD while tying up to the tender	⬭	⬭	⬭	⬭	⬭	⬭
My deckhands wear a PFD while on deck during delivery	⬭	⬭	⬭	⬭	⬭	⬭

15. What conditions would prompt you to encourage deckhands to wear a PFD when tying up to the tender and deliverying? Check all that apply:

Check all that apply.

- [ ] I always wear a PFD regardless of conditions
- [ ] Bad weather (seas over 4')
- [ ] Night delivery
- [ ] Night delivery and bad weather
- [ ] My captain requires I wear a PFD while delivering
- [ ] I never wear a PFD while deliverying
- [ ] Other: _____

16. What are some potential barriers to wearing a PFD when tying up and delivering? Check all that apply:

Check all that apply.

- [ ] Time to locate and put it on
- [ ] Space to store on the vessel
- [ ] Uncomfortable to wear
- [ ] It is not required
- [ ] It is not provided
- [ ] Cost
- [ ] Other: _____

17. What would encourage you and your deckhands to wear a PFD when tying up and delivering at the tender? Check all that apply:

Check all that apply.

- [ ] Hung up in an obvious and reachable spot
- [ ] Small and compact -does not get in the way
- [ ] Comfortable
- [ ] If the PFD is provided
- [ ] If my captain requires it
- [ ] It is affordable
- [ ] Other: _____

18. Have you personally experienced or know someone who has fallen overboard while tying up to or untying from a tender during delivery?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not applicable

19. If YES, please describe below. Where and when did they fall from the boat and what were they doing? (Example: fell from bow while approaching tender during night delivery)

_____

_____

_____

_____

_____

20. Have you personally experienced or know someone who has been been hit in the head by a weight scale during delivery?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not applicable

21. If YES, please elaborate below

22. Implementing the following control measures would help reduce risk while at the tender:

Mark only one oval per row.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
Pre-season training						
PFD use						
Railing installed along bow						
Harness style clip to the bow railing						
Pre-tied loop on the tie-up line from tender (Do not have to cinch to cleat)						
Hard hat while lifting brailer bags						
Lights on the walkway to the bow						
Lights on the bow						
Non-skid strips or paint on walk surfaces						

23. Please describe any additional safety controls you feel reduces risk during delivery:

24. My prefered way to receive and or deliver safety training materials is: Check all that apply:

Check all that apply.

- [ ] Pre-season drills
- [ ] Safety brochures
- [ ] Safety posters
- [ ] Pre-season video trainings
- [ ] Drill instructor course
- [ ] I do not receive training
- [ ] Other: _____

25. What are the ways in which you get information for the Bristol Bay fishery? Check all that apply:

Check all that apply.

- [ ] From my captain
- [ ] Emails from processor
- [ ] Bristol Bay Regional Seafood Development Association newsletter
- [ ] Facebook
- [ ] Posters
- [ ] Other: _____

26. Would you be willing to participate in a captain's interview regarding the results and recommendations from the study? (During Fall 2021). If YES, insert email address in "OTHER" box. Your email will only be used to follow-up on this survey.

Mark only one oval.

- ◯ No
- ◯ Other: _____

27. If there is anything else you wish to describe to the researchers about the Bristol Bay gillnet fishery? Please elaborate below: (Optional).

28. To compare responses between pre and post season, please enter a 4 number identifier. (Eg: last four digits of phone number).

Appendix C2: Deckhand survey

Deckhand Survey

About this survey

The objective of this study is to describe current risk perception for captains and crew during the delivery process. Additionally, this project will use the hierarchy of controls to identify and recommend potential measures that could reduce overboard falls and injury during tender offload. Having fishermen participate in this survey is very important as it will produce relevant data that is impactful to this specific fishery. The end goal is to gather data to make recommendations and also communicate the findings to fishermen and stakeholders in an efficient and meaningful way.

About the research team:
My name is Anna Mounsey and I am a Masters Student at the Univeristy of Washington. I have decided to study occupational health and safety within commercial fishing as my thesis topic. As a commercial fishermen for the past 8 years, I hope take my unique position and translate my experience into my research.

Risks and benefits to participation

Your responses to the questions will be kept confidential and data you provide will be anonymized. While we discourage provision of any identifiable information in your free-form response, it is possible that the information that you provide may be able to identify you. We cannot offer any compensation for participation, and there are no direct benefits to participation. However, it is possible that findings from this study can be used to inform ongoing response activities for future fishermen safety. Data that has been de-identified may be placed in a data repository for use in future research or to answer alternative research questions. Any data that is shared in such a repository or with other researchers will be anonymous.

Questions?
If you have any questions about the survey, please contact Dr. Tania Busch Isaksen.
tania@uw.edu

1. What is your age?

Mark only one oval.

- 18-24
- 25-44
- 45-64
- 65+

2. What is your gender?

Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Prefer not to say
- ◯ Other: _____

3. What best describes your job in Bristol Bay?

Mark only one oval.

- ◯ Deckhand
- ◯ Captain

4. How many seasons have you worked on a gillnet vessel in Bristol Bay?

Mark only one oval.

- ◯ 2021 is my first season
- ◯ 1-2 seasons
- ◯ 3-5 seasons
- ◯ 6-9 seasons
- ◯ 10-20 seasons
- ◯ 21+ seasons

5. Have you worked in other fishing industries where you deliver fish to a tender? Ex: purse seine, southeat gillnet, etc

Mark only one oval.

- ◯ Yes
- ◯ No

6. How many people are usually on your boat in Bristol Bay? (Include peak person)

Mark only one oval.

- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7+

7. How many people are typically awake and helping during a delivery? (Include captain and/or alternate)

Mark only one oval.

- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7+

8. During peak season, on average how many times does your vessel deliver fish to a tender in a 24 hour period?

Mark only one oval.

- ◯ Less than one time
- ◯ 1-2 times
- ◯ 3-4 times
- ◯ 5+ times

9. During that same 24 hours, on average how many hours of sleep do you get?

Mark only one oval.

- ◯ 0-1 hours
- ◯ 2-3 hours
- ◯ 4-5 hours
- ◯ 6-7 hours
- ◯ 8+ hours

10. I feel that lack of sleep affects my:

Check all that apply.

	Strongly disagree	Disagree	Neutral	Agree	Stronly agree	I don't know
Perception of risk	☐	☐	☐	☐	☐	☐
Awareness	☐	☐	☐	☐	☐	☐
Coordination	☐	☐	☐	☐	☐	☐
Judgement	☐	☐	☐	☐	☐	☐
Critical thinking	☐	☐	☐	☐	☐	☐

11. Please provide additional thoughts and comments about how sleep deprivation affects deckhands (optional)

12. Please check the best descriptor for each statement listed

Mark only one oval per row.

	Never	Some of the time	Neutral	Most of the time	All of the time	Not applicable
I feel unsafe when tying up to a tender	⬭	⬭	⬭	⬭	⬭	⬭
I feel unsafe when maneuvering the weight scale or being underneath it	⬭	⬭	⬭	⬭	⬭	⬭
I feel at risk of being crushed by the brailer bags as they are being lifted from the holds	⬭	⬭	⬭	⬭	⬭	⬭
A hard hat would prevent serious injury to my head from the weight scale	⬭	⬭	⬭	⬭	⬭	⬭
A PFD would help me survive a fall overboard	⬭	⬭	⬭	⬭	⬭	⬭
I have considered wearing a hard hat when the weight scale is on the gillnet deck	⬭	⬭	⬭	⬭	⬭	⬭
I wear a PFD while tying up to the tender	⬭	⬭	⬭	⬭	⬭	⬭
I wear a PFD when on deck during delivery	⬭	⬭	⬭	⬭	⬭	⬭

13. What conditions prompt you to wear a PFD when tying up to the tender and deliverying? Check all that apply:

Check all that apply.

- [ ] I always wear a PFD regardless of conditions
- [ ] Bad weather (seas over 4')
- [ ] Night delivery
- [ ] Night delivery and bad weather
- [ ] My captain requires I wear a PFD while delivering
- [ ] I never wear a PFD while deliverying
- [ ] Other: _____

14. What are some potential barriers to wearing a PFD when tying up and delivering? Check all that apply:

Check all that apply.

- [ ] Time to locate and put it on
- [ ] Space to store on the vessel
- [ ] Uncomfortable to wear
- [ ] It is not required
- [ ] It is not provided
- [ ] Other: _____

15. What would encourage you to wear a PFD when tying up and delivering at the tender? Check all that apply:

Check all that apply.

- [ ] Hung up in an obvious and reachable spot
- [ ] Small and compact -does not get in the way
- [ ] Comfortable
- [ ] If the PFD is provided
- [ ] If my captain requires it
- [ ] Other: _____

16. Have you personally experienced or know someone who has fallen overboard while tying up to or untying from a tender during delivery?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not applicable

17. If YES, please describe below. Where and when did they fall from the boat and what were they doing? (Example: fell from bow while approaching tender during night delivery)

18. Have you personally experienced or know someone who has been been hit in the head by a weight scale during delivery?

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Not applicable

19. If YES, please elaborate below

20. Participating in the following control measures would help reduce risk while at the tender:

Mark only one oval per row.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
Pre-season training						
PFD use						
Railing installed along bow						
Harness style clip to the bow railing						
Pre-tied loop on the tie-up line from tender (Do not have to cinch to cleat)						
Hard hat while lifting brailer bags						
Lights on the walkway to the bow						
Lights on the bow						
Non-skid strips or paint on walk surfaces						

21. Please describe any additional safety controls you feel reduces risk during delivery:

22. My prefered way to receive safety training materials is: Check all that apply:

Check all that apply.

- [ ] Pre-season drills
- [ ] Safety brochures
- [ ] Safety posters
- [ ] Pre-season video trainings
- [ ] Drill instructor course
- [ ] I do not receive training
- [ ] Other: _____

23. What are the ways in which you get information for the Bristol Bay fishery? Check all that apply:

Check all that apply.

- [ ] From my captain
- [ ] Emails from processor
- [ ] Bristol Bay Regional Seafood Development Association newsletter
- [ ] Facebook
- [ ] Posters
- [ ] Other: _____

24. If there is anything else you wish to describe to the researchers about the Bristol Bay gillnet fishery? Please elaborate below: (Optional).

25. To compare responses between pre and post season, please enter a 4 number identifier. (Eg: last four digits of phone number).

Appendix D: R Code

Appendix D1: Sleep

```
library(ggplot2)
library(dplyr)
library(broom)
library(ggpubr)
library(Exact)
library(geepack)
library(plyr)
library(sandwich)
library(survival)
library(rigr)
##Perception of risk
perceptionofriskbox
ttest(
   deckhandperceptionofrisk$Response,
    captainperceptionrisk$Response,
    by = NA,
    geom = FALSE,
    null.hypoth = 0,
    alternative = "two.sided",
    var.eq = FALSE,
    conf.level = 0.95,
    matched = FALSE,
    more.digits = 0
  )
# Awareness
ttest(
```

```
  captainaware$Response,
  deckhandaware$Response,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
#coordination
ttest(
  captaincoord$Response,
  deckhandcoord$Response,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
#judgement
judgecap <- judgementbox %>% subset(Group=="Captain")
judgedeck <- judgementbox %>% subset(Group=="Deckhand")
```

```
ttest(judgecap$Response,
  judgedeck$Response,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
capcritical <- subset(criticalbox, Group =="Captain")
deckcritical <- subset(criticalbox, Group=="Deckhand")
#critical thinking
ttest( capcritical$Response,
  deckcritical$Response,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
#pre season training
ttest(
  pre_season_training$Captain,
```

```
  pre_season_training$Deckhand,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
# Implementing the following control measures would help reduce risk while at the tender: [PFD use]
ttest(
  PFD_use$Captain,
  PFD_use$Deckhand,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
# railing along bow
ttest(
  railing$Captain,
  railing$Deckhand,
  by = NA,
```

```
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
# harness
ttest(
  harness$Captain,
  harness$Deckhand,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
# pre tied loop
ttest(
  pretied_loop$Captain,
  pretied_loop$Deckhand,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
```

```
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
# hard hat
ttest(
  hardhat$Captain,
  hardhat$Deckhand,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
# walkway lights
ttest(
  walkway_lights$Captain,
  walkway_lights$Deckhand,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
```

```
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
#bow lights
ttest(
  bow_lights$Captain,
  bow_lights$Deckhand,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
  more.digits = 0
)
#nonskid
ttest(
  nonskid$Captain,
  nonskid$Deckhand,
  by = NA,
  geom = FALSE,
  null.hypoth = 0,
  alternative = "two.sided",
  var.eq = FALSE,
  conf.level = 0.95,
  matched = FALSE,
```

```
  more.digits = 0
)
####box plots
 library("Sleuth2")
##Coordination
 Coordination %>%
   ggplot(aes(x = Group, y = Response)) +
   geom_boxplot() +
   theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
   xlab("") +
   ylab("Likert score") +
   ggtitle("Coordination")+
   theme_classic2(base_size = 18)
 ###perception of risk
perceptionofriskbox%>%
   ggplot(aes(x = Group, y = Response)) +
   geom_boxplot(size = .75) +
   geom_jitter(alpha = .5) +
   theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
   xlab("") +
   ylab("Likert score") +
   ggtitle("Perception of risk")+
  theme_classic2(base_size = 18)
###awareness
awarenessbox%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot(size = .75) +
  geom_jitter(alpha = .5) +
```

```
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Awareness")+
  theme_classic2(base_size = 18)
##Critical thinking
criticalbox%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot(size = .75) +
  geom_jitter(alpha = .5) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Critical thinking")+
  theme_classic2(base_size = 18)
#Judgement
judgementbox%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot(size = .75) +
  geom_jitter(alpha = .5) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Judgement")+
  theme_classic2(base_size = 18)
###pERCEPTION OF RISK ###
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(perceptionofriskbox$Experience)
```

```
NULL
#Convert that column to a factor
perceptionofriskbox$Experience <- factor(perceptionofriskbox$Experience)
#Now it has levels.
levels(perceptionofriskbox$Experience)
[1] "1" "2" "3"
###perception of risk
 perceptionofriskbox%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Perception of risk")+
  theme_classic2(base_size = 18)
summary(perceptionofriskbox)
captainperceptionrisk <- subset(perceptionofriskbox, Group=="Captain")
captainperceptionrisk
summary(captainperceptionrisk)
deckhandperceptionofrisk <- subset(perceptionofriskbox, Group=="Deckhand")
summary(deckhandperceptionofrisk)
###perception of risk
OtherPofR%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Perception of risk")+
```

```
  theme_classic2(base_size = 18)
###### Critical thinking ###
###CRITICAL THINKING####
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(criticalbox$Experience)
NULL
#Convert that column to a factor
criticalbox$Experience <- factor(criticalbox$Experience)
#Now it has levels.
levels(criticalbox$Experience)
[1] "1" "2" "3"
###CRITICAL THINKING####
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(othercritical$Experience)
NULL
#Convert that column to a factor
othercritical$Experience <- factor(othercritical$Experience)
#Now it has levels.
levels(othercritical$Experience)
[1] "1" "2" "3"
#######
criticalbox%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Critical thinking")+
```

```
  theme_classic2(base_size = 18)
captaincritical <- subset(criticalbox, Group=="Captain")
captaincritical
summary(captaincritical)
deckhandcritical <- subset(criticalbox, Group=="Deckhand")
summary(deckhandcritical)
othercritical%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Critical thinking")+
  theme_classic2(base_size = 18)
######### COORDINATION ####
###COORDINATION###
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(Coordination$Experience)
NULL
Coordination$Experience <- factor(Coordination$Experience)
#Now it has levels.
levels(criticalbox$Experience)
[1] "1" "2" "3"
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(othercoord$Experience)
NULL
#Convert that column to a factor
othercoord$Experience <- factor(othercoord$Experience)
```

```
#Now it has levels.
levels(othercoord$Experience)
[1] "1" "2" "3"$Experience <- factor(Coordination$Experience)
#Now it has levels.
levels(criticalbox$Experience)
[1] "1" "2" "3"
##Coordination
Coordination %>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Coordination")+
  theme_classic2(base_size = 18)
captaincoord <- subset(Coordination, Group=="Captain")
summary(captaincoord)
deckhandcoord <- subset(Coordination, Group=="Deckhand")
summary(deckhandcoord)
##Coordination
othercoord %>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Coordination")+
```

```
  theme_classic2(base_size = 18)
### AWARENESS ####
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(awarenessbox$Experience)
NULL
#Convert that column to a factor
awarenessbox$Experience <- factor(awarenessbox$Experience)
#Now it has levels.
levels(awarenessbox$Experience)
[1] "1" "2" "3"
awarenessbox%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Awareness")+
  theme_classic2(base_size = 18)
captainaware <- subset(awarenessbox, Group=="Captain")
summary(captainaware)
deckhandaware <- subset(awarenessbox, Group=="Deckhand")
summary(deckhandaware)
otherAware%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
```

```
  ggtitle("Awareness")+
  theme_classic2(base_size = 18)
#####Judgement ####
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(judgementbox$Experience)
NULL
#Convert that column to a factor
judgementbox$Experience <- factor(judgementbox$Experience)
#Now it has levels.
levels(judgementbox$Experience)
[1] "1" "2" "3"
judgementbox%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Judgement")+
  theme_classic2(base_size = 18)
#Judgement
otherjudge%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Judgement")+
  theme_classic2(base_size = 18)
```

```
######### Captain subsetting

###Perception of risk

na.omit(perceptionofriskbox)

PofR_captain_subset <-perceptionofriskbox %>% select(Experience, Response, Group, contains('Captain'))

PofR_captain_subset

ggplot(PofR_captain_subset, aes(x = PofR_captain_subset$Experience, y = PofR_captain_subset$Response, fill=Experience)) +

  geom_boxplot() +

  theme_classic2(base_size = 18)+

  xlab("Experience") +

  ylab("Likert score") +

  ggtitle("Perception of Risk")+

  scale_fill_discrete( name = "Legend",

                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")

  )

perception_of_risk_captain_plot

#### Critical thinking

CriticalThink_captain_subset <-criticalbox %>% select(Experience, Response, Group, contains('Captain'))

CriticalThink_captain_subset

CriticalThink_captain_plot <- ggplot(CriticalThink_captain_subset, aes(x = CriticalThink_captain_subset$Experience, y = CriticalThink_captain_subset$Response, fill=Experience)) +

  geom_boxplot() +

  theme_classic2(base_size = 18)+

  xlab("Experience") +

  ylab("Likert score") +

  ggtitle("Critical thinking")+
```

```
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")
  )
CriticalThink_captain_plot
###Coordination
Coordination_captain_subset <-Coordination %>% select(Experience, Response, Group, contains('Captain')
Coordination_captain_subset
Coordination_captain_plot <- ggplot(Coordination_captain_subset, aes(x = Coordination_captain_subset$Experience, y = Coordination_captain_subset$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Coordination")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")
  )
Coordination_captain_plot
#### Awareness ###
Awareness_captain_subset <- awarenessbox %>% select(Experience, Response, Group, contains('Captain'))
Awareness_captain_subset
Awareness_captain_plot <- ggplot(Awareness_captain_subset, aes(x = Awareness_captain_subset$Experience, y = Awareness_captain_subset$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
```

```
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Awareness")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")
  )
Awareness_captain_plot
###Judgement
judgement_captain_subset <-judgementbox %>% select(Experience, Response, Group, contains('Captain'))
judgement_captain_subset
judgement_captiain_plot <- ggplot(judgement_captain_subset, aes(x = judgement_captain_subset$Experience, y = judgement_captain_subset$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Judgement")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")
  )
judgement_captiain_plot
############ Deckhand subsetting
###Perception of risk
PofR_deckhand_subset <-perceptionofriskbox %>% select(Experience, Response, Group, contains('Deckhand'))
PofR_deckhand_subset
```

```
perception_of_risk_Deckhand_plot <- ggplot(PofR_captain_subset, aes(x = PofR_captain_subset$Experience, y = PofR_captain_subset$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2()+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Perception of Risk")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")
  )
perception_of_risk_Deckhand_plot

#### Critical thinking

CriticalThink_Deckhand_subset <-criticalbox %>% select(Experience, Response, Group, contains('Deckhand'))

CriticalThink_Deckhand_subset

CriticalThink_Deckhand_subset_plot <- ggplot(CriticalThink_Deckhand_subset, aes(x = CriticalThink_Deckhand_subset$Experience, y = CriticalThink_Deckhand_subset$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2()+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Critical Thinking")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")
  )
CriticalThink_Deckhand_subset_plot

###Coordination
```

```
Coordination_Deckhand_subset <-Coordination %>% select(Experience, Response, Group, contains('Deckhand'))

Coordination_Deckhand_subset

Coordination_Deckhand_plot <- ggplot(Coordination_Deckhand_subset, aes(x = Coordination_Deckhand_subset$Experience, y = Coordination_Deckhand_subset$Response, fill=Experience)) +

  geom_boxplot() +

  theme_classic2()+

  xlab("Experience") +

  ylab("Likert score") +

  ggtitle("Coordination")+

  scale_fill_discrete( name = "Legend",

                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")

  )

Coordination_Deckhand_plot

#### Awareness ###

Awareness_Deckhand_subset <- awarenessbox %>% select(Experience, Response, Group, contains('Deckhand'))

Awareness_Deckhand_subset

Awareness_Deckhand_subset_plot <- ggplot(Awareness_Deckhand_subset, aes(x = Awareness_Deckhand_subset$Experience, y = Awareness_Deckhand_subset$Response, fill=Experience)) +

  geom_boxplot() +

  theme_classic2()+

  xlab("Experience") +

  ylab("Likert score") +

  ggtitle("Awareness")+

  scale_fill_discrete( name = "Legend",

                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")
```

```
  )
Awareness_Deckhand_subset_plot
###Judgement
judgement_Deckhand_subset <-judgementbox %>% select(Experience, Response, Group, contains('Deckhand'))
judgement_Deckhand_subset
judgement_Deckhand_subset_plot <- ggplot(judgement_Deckhand_subset, aes(x = judgement_Deckhand_subset$Experience,
                                                                        y = judgement_Deckhand_subset$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2()+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Judgement")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20 seasons", "21+ seasons")
  )
regress(Response ~ Experience +Group, data = awarenessbox)
regress("mean", Response ~ Experience +Group, data = awarenessbox)
regress("mean", Response ~ Experience +Group, data = Coordination)
regress("mean", Response ~ Experience +Group, data = criticalbox)
regress("mean", Response ~ Experience +Group, data = judgementbox)
regress("mean", Response ~ Experience +Group, data = perceptionofriskbox)
```

Appendix D2: Controls

```
library(ggplot2)
library(dplyr)
library(broom)
```

```
library(ggpubr)
library(Exact)
library(geepack)
library(plyr)
library(sandwich)
library(survival)
library(rigr)
cosideredcap <- subset(Considered_hardhat, Group=="Captain")
cosideredcap
summary(cosideredcap)
cosidereddeck <- subset(Considered_hardhat, Group=="Deckhand")
cosidereddeck
summary((cosidereddeck))
##############################################
crushedcap <- subset(crushed_by, Group=="Captain")
crushedcap
summary(crushedcap)
crusheddeck <- subset(crushed_by, Group=="Deckhand")
crusheddeck
summary((crusheddeck))
##############################
hardhatcap <- subset(hardhat_prevention, Group=="Captain")
hardhatcap
summary(hardhatcap)
hardhatdeck <- subset(hardhat_prevention, Group=="Deckhand")
hardhatdeck
summary((hardhatdeck))
```

```
crushedcap <- subset(crushed_by, Group=="Captain")
crushedcap
summary(crushedcap)
crusheddeck <- subset(crushed_by, Group=="Deckhand")
crusheddeck
summary((crusheddeck))
################################################
deckpfdcap <- subset(PFD_on_deck, Group=="Captain")
deckpfdcap
summary(deckpfdcap)
deckpfddeck <- subset(PFD_on_deck, Group=="Deckhand")
deckpfddeck
summary((deckpfddeck))
################################################
preventpfdcap <- subset(PFD_prevention, Group=="Captain")
preventpfdcap
summary(preventpfdcap)
preventpfddeck <- subset(PFD_prevention, Group=="Deckhand")
preventpfddeck
summary((preventpfddeck))
################################################
pfdtieupcap <- subset(PFD_tying_up, Group=="Captain")
pfdtieupcap
summary(pfdtieupcap)
pfdtieupdeck <- subset(PFD_tying_up, Group=="Deckhand")
pfdtieupdeck
summary((pfdtieupdeck))
################################################
```

```
scalecap <- subset(scale_maneuver, Group=="Captain")
scalecap
summary(scalecap)
scaledeck <- subset(scale_maneuver, Group=="Deckhand")
scaledeck
summary((scaledeck))
######################
tyingcap <- subset(Tying_up_to_tender, Group=="Captain")
tyingcap
summary(tyingcap)
tyingdeck <- subset(Tying_up_to_tender, Group=="Deckhand")
tyingdeck
summary((tyingdeck))
#### Convert numerical to factors ##
###cONVERT EXPERIENCE TO FACTOR FOR ALL DESCRIPTORS####
## Considered hard hat ###
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(Considered_hardhat$Gender)
NULL
#Convert that column to a factor
Considered_hardhat$Gender <- factor(Considered_hardhat$Gender)
#Now it has levels.
levels(Considered_hardhat$Gender)
[1] "1" "2" "3"
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(Considered_hardhat$Experience)
NULL
```

```
#Convert that column to a factor
Considered_hardhat$Experience <- factor(Considered_hardhat$Experience)
#Now it has levels.
levels(Considered_hardhat$Experience)
[1] "1" "2" "3"
#### Crushed by ###
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(crushed_by$Gender)
NULL
#Convert that column to a factor
crushed_by$Gender <- factor(crushed_by$Gender)
#Now it has levels.
levels(crushed_by$Gender)
[1] "1" "2" "3"
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(crushed_by$Experience)
NULL
#Convert that column to a factor
crushed_by$Experience <- factor(crushed_by$Experience)
#Now it has levels.
levels(crushed_by$Experience)
[1] "1" "2" "3"
##### hard hat prevention
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(hardhat_prevention$Gender)
NULL
#Convert that column to a factor
hardhat_prevention$Gender <- factor(hardhat_prevention$Gender)
```

```
#Now it has levels.
levels(hardhat_prevention$Gender)
[1] "1" "2" "3"
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(hardhat_prevention$Experience)
NULL
#Convert that column to a factor
hardhat_prevention$Experience <- factor(hardhat_prevention$Experience)
#Now it has levels.
levels(hardhat_prevention$Experience)
[1] "1" "2" "3"
### PFD on deck ###
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(PFD_on_deck$Gender)
NULL
#Convert that column to a factor
PFD_on_deck$Gender <- factor(PFD_on_deck$Gender)
#Now it has levels.
levels(PFD_on_deck$Gender)
[1] "1" "2" "3"
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(PFD_on_deck$Experience)
NULL
#Convert that column to a factor
PFD_on_deck$Experience <- factor(PFD_on_deck$Experience)
#Now it has levels.
levels(PFD_on_deck$Experience)
[1] "1" "2" "3"
```

PFD prevention

#currently, there are no levels in the `a` column, since it's numeric as you point out.

levels(PFD_prevention$Gender)

NULL

#Convert that column to a factor

PFD_prevention$Gender <- factor(PFD_prevention$Gender)

#Now it has levels.

levels(PFD_prevention$Gender)

[1] "1" "2" "3"

#currently, there are no levels in the `a` column, since it's numeric as you point out.

levels(PFD_prevention$Experience)

NULL

#Convert that column to a factor

PFD_prevention$Experience <- factor(PFD_prevention$Experience)

#Now it has levels.

levels(PFD_prevention$Experience)

[1] "1" "2" "3"

PFD tying up###

#currently, there are no levels in the `a` column, since it's numeric as you point out.

levels(PFD_tying_up$Gender)

NULL

#Convert that column to a factor

PFD_tying_up$Gender <- factor(PFD_tying_up$Gender)

#Now it has levels.

levels(PFD_tying_up$Gender)

[1] "1" "2" "3"

#currently, there are no levels in the `a` column, since it's numeric as you point out.

levels(PFD_tying_up$Experience)

```
NULL
#Convert that column to a factor
PFD_tying_up$Experience <- factor(PFD_tying_up$Experience)
#Now it has levels.
levels(PFD_tying_up$Experience)
[1] "1" "2" "3"
###Scale maneuver ###
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(scale_maneuver$Gender)
NULL
#Convert that column to a factor
scale_maneuver$Gender <- factor(scale_maneuver$Gender)
#Now it has levels.
levels(scale_maneuver$Gender)
[1] "1" "2" "3"
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(scale_maneuver$Experience)
NULL
#Convert that column to a factor
scale_maneuver$Experience <- factor(scale_maneuver$Experience)
#Now it has levels.
levels(scale_maneuver$Experience)
[1] "1" "2" "3"
####Tying up ###
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(Tying_up_to_tender$Gender)
NULL
```

```
#Convert that column to a factor
Tying_up_to_tender$Gender <- factor(Tying_up_to_tender$Gender)
#Now it has levels.
levels(Tying_up_to_tender$Gender)
[1] "1" "2" "3"
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(Tying_up_to_tender$Experience)
NULL
#Convert that column to a factor
Tying_up_to_tender$Experience <- factor(Tying_up_to_tender$Experience)
#Now it has levels.
levels(Tying_up_to_tender$Experience)
[1] "1" "2" "3"
### Create plots###
Considered_hardhat%>%
  ggplot(aes(x = Group, y = Response, na.rm = TRUE)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Considered wearing a hardhat")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)
summary(Considered_hardhat)
```

```
hardhat_prevention%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("A hardhat would prevent \n serious injury")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)

PFD_on_deck%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Use of PFD on deck")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)

PFD_prevention%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("A PFD would help fishers \n survive a fall overboard")+
  theme_classic2(base_size = 25) +
```

```
  expand_limits(y = 1)


PFD_tying_up%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Use of PFD while \n tying up to a tender ")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)
################################################################################
#####
crushed_by%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Feeling at risk of being \ncrushed by lifted brailer bags")+
  theme_classic2(base_size = 25)


scale_maneuver%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Feeling at risk while\nmaneuvering the weight scale")+
```

```
  theme_classic2(base_size = 25)


Tying_up_to_tender%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Feeling unsafe while \n tying up to a tender")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)


ggplot(crushed_by, aes(x = crushed_by$Experience,
                       y = crushed_by$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Feeling at risk of \nbeing crushed by lifted brailer bags")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20
seasons", "21+ seasons")
  ) +
  theme(legend.position="none") +
  expand_limits(y = 1)


##############################################################################
#######

ggplot(Considered_hardhat, aes(x = Considered_hardhat$Experience,
```

```
                    y = Considered_hardhat$Response, fill=Experience, na.omit())) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Considered wearing a hardhat")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20
seasons", "21+ seasons")
  ) +
  theme(legend.position="none") + theme(plot.title = element_text(size=22)) +
  expand_limits(y = 1)
####
ggplot(hardhat_prevention, aes(x = hardhat_prevention$Experience,
                       y = hardhat_prevention$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("A hardhat would prevent serious injury")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20
seasons", "21+ seasons")
  ) +
  theme(legend.position="none") +
  expand_limits(y = 1)
###
ggplot(PFD_on_deck, aes(x = PFD_on_deck$Experience,
                       y = PFD_on_deck$Response, fill=Experience)) +
```

```
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Use of a PFD on deck")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20
seasons", "21+ seasons")
  ) +
  theme(legend.position="none") +
  expand_limits(y = 1)
####
ggplot(PFD_prevention, aes(x = PFD_prevention$Experience,
                       y = PFD_prevention$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("A PFD would help fishers \n survive a fall overboard")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20
seasons", "21+ seasons")
  ) +
  theme(legend.position="none")+
  expand_limits(y = 1)

#####
ggplot(PFD_tying_up, aes(x = PFD_tying_up$Experience,
                       y = PFD_tying_up$Response, fill=Experience)) +
```

```
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Use of a PFD while tying up")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20
seasons", "21+ seasons")
  ) +
  theme(legend.position="none") +
  expand_limits(y = 1)


####
ggplot(scale_maneuver, aes(x = scale_maneuver$Experience,
                           y = scale_maneuver$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Feeling at risk while\nmaneuvering the weight scale")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20
seasons", "21+ seasons")
  ) +
  theme(legend.position="none") +
  expand_limits(y = 1)


####
```

```
ggplot(Tying_up_to_tender, aes(x = Tying_up_to_tender$Experience, y =
Tying_up_to_tender$Response, fill=Experience)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Feeling unsafe while \n tying up to a tender")+
  scale_fill_discrete( name = "Legend",
                       labels = c(">1 seasons", "1-2 seasons", "3-5 seasons", "6-9 seasons", "10-20
seasons", "21+ seasons")
  ) +
  theme(legend.position="none")+
  expand_limits(y = 1)
##### Gender ############
ggplot(Considered_hardhat, aes(x = Considered_hardhat$Gender,
                               y = Considered_hardhat$Response, fill=Gender, na.rm = FALSE)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Gender") +
  ylab("Likert score") +
  ggtitle("Considered wearing a hardhat")+
  scale_fill_discrete( name = "Legend",
                       labels = c("0:Male", "1:Female", "2:Queer")
  )
ggplot(crushed_by, aes(x = crushed_by$Gender,
```

```
                y = crushed_by$Response, fill=Gender)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Feeling at risk of being \n crushed by lifted brailer bags")+
  scale_fill_discrete( name = "Legend",
                labels = c("Male", "Female", "Queer")
  )

####
ggplot(hardhat_prevention, aes(x = hardhat_prevention$Gender,
                    y = hardhat_prevention$Response, fill=Gender)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("A hardhat would prevent serious injury")+
  scale_fill_discrete( name = "Legend",
                labels = c("Male", "Female", "Queer")
  )
####
ggplot(PFD_on_deck, aes(x = PFD_on_deck$Gender,
                 y = PFD_on_deck$Response, fill=Gender)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
```

```
  ggtitle("Use of a PFD on deck")+
  scale_fill_discrete( name = "Legend",
                       labels = c("Male", "Female", "Queer")
  )
####
ggplot(PFD_prevention, aes(x = PFD_prevention$Gender,
                           y = PFD_prevention$Response, fill=Gender)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("A PFD would prevent serious injury")+
  scale_fill_discrete( name = "Legend",
                       labels = c("Male", "Female", "Queer")
  )
#####
ggplot(PFD_tying_up, aes(x = PFD_tying_up$Gender,
                         y = PFD_tying_up$Response, fill=Gender)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Use of a PFD while tying up")+
  scale_fill_discrete( name = "Legend",
                       labels = c("Male", "Female", "Queer")
  )
####
ggplot(scale_maneuver, aes(x = scale_maneuver$Gender,
```

```
                    y = scale_maneuver$Response, fill=Gender)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Feeling at risk while\nmaneuvering the weight scale")+
  scale_fill_discrete( name = "Legend",
                       labels = c("Male", "Female", "Queer")
  )


####
ggplot(Tying_up_to_tender, aes(x = Tying_up_to_tender$Gender, y =
Tying_up_to_tender$Response, fill=Gender)) +
  geom_boxplot() +
  theme_classic2(base_size = 18)+
  xlab("Experience") +
  ylab("Likert score") +
  ggtitle("Feeling unsafe while \n tying up to a tender")+
  scale_fill_discrete( name = "Legend",
                       labels = c("Male", "Female", "Queer")
  )



?regress
regress("mean", Response ~ Experience +Group, data = Considered_hardhat)
regress("mean", Response ~ Experience +Group, data = crushed_by)
regress("mean", Response ~ Experience +Group, data = hardhat_prevention)
regress("mean", Response ~ Experience +Group, data = PFD_on_deck)
regress("mean", Response ~ Experience +Group, data = PFD_prevention)
```

```
regress("mean", Response ~ Experience +Group, data = PFD_tying_up)
regress("mean", Response ~ Experience +Group, data = scale_maneuver)
regress("mean", Response ~ Experience +Group, data = Tying_up_to_tender)
View(PFD_tying_up)
PFD <- PFD_tying_up %>%
  select(Response)
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(PFD$Response)
NULL
#Convert that column to a factor
PFD$Response <- factor(PFD$Response)
#Now it has levels.
levels(PFD$Response)
[1] "1" "2" "3"
summary(PFD$Response)
#currently, there are no levels in the `a` column, since it's numeric as you point out.
levels(PFD_on_deck$Response)
NULL
#Convert that column to a factor
PFD_on_deck$Response <- factor(PFD_on_deck$Response)
#Now it has levels.
levels(PFD_on_deck$Response)
[1] "1" "2" "3"
summary(PFD_on_deck$Response)
```

Appendix D3: Interventions

```
library(ggplot2)
library(dplyr)
library(broom)
library(ggpubr)
library(Exact)
library(geepack)
library(plyr)
library(sandwich)
library(survival)
library(rigr)
bowrailing_cap <- Bow_railing %>% subset(Group=="Captain")
bowrailing_deck <- Bow_railing %>% subset(Group=="Deckhand")
summary(bowrailing_cap)
summary(bowrailing_deck)
summary(Bow_railing)
bowlights_cap <- bow_lights %>% subset(Group=="Captain")
bowlights_deck <- bow_lights %>% subset(Group=="Deckhand")
summary(bowlights_cap)
summary(bowlights_deck)
hardhat_cap <- hardhat %>% subset(Group=="Captain")
hardhat_deck <- hardhat %>% subset(Group=="Deckhand")
summary(hardhat_cap)
summary(hardhat_deck)
harness_cap <- harness_clip %>% subset(Group=="Captain")
harness_deck <- harness_clip %>% subset(Group=="Deckhand")
summary(harness_cap)
summary(harness_deck)
```

```
nonskid_cap <- nonskid %>% subset(Group=="Captain")
nonskid_deck <- nonskid %>% subset(Group=="Deckhand")
summary(nonskid_cap)
summary(nonskid_deck)
PFD_cap <- PFD_use %>% subset(Group=="Captain")
PFD_deck <- PFD_use %>% subset(Group=="Deckhand")
summary(PFD_cap)
summary(PFD_deck)
preseason_cap <- preseason_training %>% subset(Group=="Captain")
preseason_deck <- preseason_training %>% subset(Group=="Deckhand")
summary(preseason_cap)
summary(preseason_deck)
loop_cap <- pretied_loop %>% subset(Group=="Captain")
loop_deck <- pretied_loop %>% subset(Group=="Deckhand")
summary(loop_cap)
summary(loop_deck)
walklights_cap <- walkway_lights %>% subset(Group=="Captain")
walklights_deck <- walkway_lights %>% subset(Group=="Deckhand")
summary(walklights_cap)
summary(walklights_deck)
library(ggplot2)
library(dplyr)
library(broom)
library(ggpubr)
library(Exact)
library(geepack)
library(plyr)
library(sandwich)
```

```
library(survival)
library(rigr)
library(readxl)
### Box plots ###
bow_lights%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Lights on the bow")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)
Bow_railing%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Railing installed along \nthe bow")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)
hardhat%>%
  ggplot(aes(x = Group, y = Hardhat)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
```

```
  ggtitle("Use of a hardhat \nwhile delivering")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)

harness_clip%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Harness with a clip to bow railing")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)

nonskid%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Non-skid on walking surfaces")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)

PFD_use%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
```

```
  xlab("") +
  ylab("Likert score") +
  ggtitle("PFD use")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 0)

preseason_training%>%
  ggplot(aes(x = Group, y = Response)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Pre-season training")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)

pretied_loop%>%
  ggplot(aes(x = Group, y = `Pretied loop`)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
  xlab("") +
  ylab("Likert score") +
  ggtitle("Pre-tied loop on the \ntie up line from the tender")+
  theme_classic2(base_size = 25) +
  expand_limits(y = 1)

walkway_lights %>%
  ggplot(aes(x = Group, y = Response)) +
```

```
geom_boxplot() +
theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust = 1)) +
xlab("") +
ylab("Likert score") +
ggtitle("Lights along the walkway \nto the bow")+
theme_classic2(base_size = 25) +
expand_limits(y = 1)
```

Appendix E: Photo Consent Forms

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_____Lillian Saul_____
_____ FULL NAME (PRINTED) SIGNATURE

54 Bonaventure Avenue, St. John's, NL, CA A1C 3Z6_____
__ ADDRESS (STREET) (CITY) (STATE) (ZIP)

_____843-801-1385_____Feb. 2, 2022_____ EMAIL
ADDRESS TELEPHONE NUMBER DATE

PARENT/GUARDIAN CONSENT FOR INDIVIDUALS UNDER THE AGE OF 18

_____
_____ PARENT/ GUARDIAN FULL NAME (PRINTED) PARENT/ GUARDIAN SIGNATURE

_____

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_____ PARENT/ GUARDIAN EMAIL ADDRESS TELEPHONE NUMBER DATE

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_____

__ TITLE

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Cassidy Butler Cassidy Butler

FULL NAME (PRINTED) SIGNATURE

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cassandmid@gmail.com

EMAIL ADDRESS TELEPHONE NUMBER DATE

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PARENT/ GUARDIAN FULL NAME (PRINTED) PARENT/ GUARDIAN SIGNATURE

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TITLE DEPARTMENT DATE

ANNA

UNIVERSITY of WASHINGTON

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