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HAZARD ANALYSIS AND INJURY SURVEILLANCE

Photograph and caption
by Earl Dotter

After days of “hauling back” with short periods of sleep in between, exhaustion sets in. (Despite their fatigue) every night, one of the crew must relieve the captain on watch.

A COMMERCIAL FISHING VESSEL RISK ASSESSMENT AND REMEDIATION MODEL

MICHAEL GERMINARIO, M.S., P.E.
R. RABÁGO, M.A., M.S., P.E.
U.S. COAST GUARD, ATLANTIC AREA
PORTSMOUTH, VIRGINIA, U.S.A.
E-mail: mgerminario@lantd5.uscg.mil

Lieutenant Commander Mike Germinario has over twenty years of operational and engineering experience in the U. S. Coast Guard. He received a Bachelors Degree in Civil Engineering from the Coast Guard Academy in 1984 and holds Masters Degree in Civil Engineering from the University of Illinois and is a registered Professional Engineer in Virginia. In between Coast Guard facility planning and construction projects, he had three separate assignments operating Coast Guard cutters off the Atlantic seaboard, conducting counter narcotics and immigration operations in the Caribbean and most recently fishery law enforcement and rescue operations in the mid-Atlantic and New England offshore waters.

Currently as Deputy Chief of Law Enforcement in the Atlantic Area, he oversees the Coast Guard's operational efforts in their fisheries mission along the Atlantic seaboard. He is also the senior Coast Guard advisor on law enforcement and safety to the Mid-Atlantic Fishery Management Council and the Atlantic States Marine Fishery Commission.

BACKGROUND

Commercial fishing continues to rank as one of the most hazardous occupations in America. Eleven fatalities from four fishing vessel sinkings over a three-week period off the mid-Atlantic coast in January 1999 and the findings of the Fishing Vessel Casualty Task Force in April 1999, led the Coast Guard's Atlantic Area Commander, Vice Admiral John E. Shkor, to make the reduction of fishing vessel losses and fatalities his highest safety priority. Taking command of the Atlantic Area in September 1999, he remarked, "…Last winter saw an unusually high number of fatal accidents among our commercial fishermen…I do know another winter is coming and may well see a repeat of last year's tragedies. I intend that the cognizant commands in Atlantic Area focus on those elements of the industry most at risk and with our current limited authorities…Do as much as is possible to mitigate that possibility." Operation Safe Catch was developed to respond to this significant safety threat facing tens of thousands of commercial fishermen. For the first time, commercial fishing vessels in Atlantic Area's zone of responsibility were evaluated and visited using an innovative and extremely effective risk assessment and hazard remediation methodology that focused limited Coast Guard resources on those vessels most at risk.

DEVELOPMENT PROCESS

Operation Safe Catch was a cohesive operational effort involving hundreds of Coast Guard at-sea boarding officers and dockside examiners. The development and successful deployment of Safe Catch was a direct result of an integrated team of staff and field level components from both the Coast Guard Law Enforcement Operations and Marine Safety programs. Organizationally, up until Safe Catch, these programs would often work separate of each other, despite mission overlap in the area of commercial fishing vessel safety. Safe Catch was designed to bring these programs together to improve effectiveness by requiring frequent communication, consistent application of policy and cross-program training, throughout the Atlantic Area (East Coast, Gulf Coast and Great Lakes). Prior to Safe Catch, on the fishing grounds or at the docks, commercial fishermen would often see two distinct components of the Coast Guard; Operations personnel or Boarding Officers conducting safety and fisheries law enforcement inspections at-sea and Marine Safety personnel performing voluntary safety exams dockside. Despite having similar safety objectives, communications between these two entities was minimal. Through the framework of Safe Catch, each program shared common training tools, frequently worked side-by-side, and effectively exchanged information. Consolidated monthly reports with clear measures of effectiveness further encouraged teamwork between the programs. Operation Safe Catch invigorated the commercial fishing safety program by efficiently teaming all Coast Guard resources to focus their efforts on high risk fishing vessels.

Design of the Operation required teamwork from each of Atlantic Area's five regional Districts located in Boston, Massachusetts; Portsmouth, Virginia; Miami, Florida; New Orleans, Louisiana; and Cleveland, Ohio. Many factors were balanced by the Team to develop an operation that could be quickly implemented and effectively carried out throughout the entire Atlantic Area. These factors included regional differences in fishing fleets, seasonal weather, coastline geographies, training and availability of Coast Guard field personnel, policy and regulatory barriers, implementation of the operation before the onset of winter, public awareness, and consistent execution throughout the Atlantic Area. The Team's cross-organizational membership ensured that the operational tasking was in accordance with Coast Guard policy and was capable of being carried out by the field units. Remarkably, Safe Catch was successfully piloted in one District and then fully implemented in all five Districts in only six weeks.

An excellent example of the teamwork required to develop this Operation was realistically defining the scope of the Operation with the constraints of time and regulatory authority. The Team found that although each District had some regional safety program, the risk assessment criteria were inconsistent. The Team overcame this problem by establishing new objective criteria and a measurement system that could be used to gauge the quality and level of effort applied throughout the various regions within Atlantic Area. The Team worked diligently to narrow the high risk definition, devise new training standards and create methodologies to partner between the two programs. The Team was successful at meeting this critical balance. Results from the Operation indicate an unprecedented level of teamwork at every level of our organization that has had a measurable impact on the safety of commercial fishing.

PROBLEM SOLVING

In an effort to move quickly to provide guidance and direction to the field units before the onset of winter, the Team realized that a large information gap between the Operations and Marine Safety programs would have to be narrowed. In addition, there was little familiarity between these programs because of only sporadic contact at both staff and field levels. Accordingly, a conference was held and regional representatives participated in the creation of an operational order that tasked all Atlantic Area commands. The Safe Catch tasking provided clear risk assessment standards and lines of communication between the programs. The Team identified training as the key method to bring the programs together. Accordingly, a comprehensive training guidance document was established providing the necessary criteria for consistent risk assessment and hazard identification throughout Atlantic Area. The training document was based on assessment of all existing programs as well as the new criteria established by Safe Catch. The first phase of the Operation provided 30 days of field inter-program training using this document.

Those training sessions opened the critical lines of communications between the programs at the field level. The delivered training was extremely effective resulting in each program equally identifying approximately one-half of the high risk vessels noted during the Operation.

With nearly 80,000 commercial fishing vessels in Atlantic Area, the Safe Catch Team quickly identified that the management of risk assessment information on specific vessels was a potential problem area for the Operation. The Team innovatively used the assessment standards and the field training as tools to keep the data at a manageable level. The very narrow definition and associated training on high risk conditions as developed by the Team drove the field personnel to identify only the most hazardous vessels within the large commercial fishing fleet. During Safe Catch field personnel interacted with over 4,300 vessels both dockside and at sea and in some areas nearly 100 percent of the fishing fleet was contacted. However, this extremely focused high risk definition served as an effective screen, resulting in only 900 of those vessels being identified as high risk. Beyond simply identifying high risk vessels, follow-up interaction and remediation of those at-risk was a stated goal of the Operation. The narrow focused definition, which kept the total number of high risk vessels low, subsequently provided the field personnel adequate time to interact with those vessels identified as high risk resulting in over 600 of those 900 vessels moving into compliance through follow-up interaction by the Coast Guard.

CUSTOMER FOCUS

The Safe Catch Team realized that in order for the operation to be effective, the Coast Guard would need to work closely with the commercial fishing vessel owners and operators, our primary customer. Their support and ultimately their willingness to work with our Coast Guard field personnel would be critical to success of this operation. The Team launched a massive public affairs campaign that was designed to encourage support from the fishermen by explaining the importance of properly operating safety equipment and a seaworthy vessel. The campaign, which included press releases, local and national TV (CNN), newspaper, magazine, radio promotions, and many local town/fleet public meetings was tremendously effective. In fact, most fishermen knew of and supported our efforts prior to the Coast Guard interacting with them at-sea or at the dock. We received frequent feedback from the fishing communities about the safety “wake-up call” aspect of the campaign. The

Team's customer focus through the public affairs campaign likely resulted in many fishermen simply checking their own safety gear and vessels. These self-assessments helped us reach the thousands of fishing vessels that we will never be able to visit.

The Team recognized that Safe Catch's public sector customer, the fishermen, and our internal customer, the Coast Guard field personnel, would benefit from a consistent and simple way for both the fishermen and the field personnel to assess fishing vessel risk. For the Operation to be a success, this information would need to be developed and disseminated before the Operation began. The Coast Guard had an obligation to ensure a Safe Catch inspection in New England was the same as an inspection in the Carolinas. This was accomplished through a comprehensive 30-day training program delivered to Coast Guard field personnel from Maine to Texas and the Great Lakes. The training program was effectively developed and delivered by the Team. Using the response of the commercial fishing community as our gauge, on several occasions fishermen made the effort to praise the consistent work of the Coast Guard field units. Remarking on a recent boarding conducted during Operation Safe Catch, Capt. James Ruhle from the fishing vessel *Daranar R* stated, "If all boardings during this operation are conducted in this manner, I think that the industry and the U. S. Coast Guard will suffer no damage to the working relationship we are trying to build." The training program developed by the Safe Catch is currently being adapted and will be included as a core element in future training for Coast Guard boarding personnel, ultimately making the program a lasting element of Safe Catch that will continue to save fishermen's lives well into the future.

CREATIVE AND INNOVATIVE TECHNIQUES

Operation Safe Catch was the first ever Atlantic Area effort to employ a highly focused operational risk management regimen to a major commercial vessel population. In contrast to a prevention/enforcement strategy that was previously used, the Safe Catch Team created a risk assessment/remediation strategy. Prior to Safe Catch, safety exams and prevention activities were random and often at the request of vessels already substantially in compliance. Because the exams were voluntary, the Coast Guard would rarely find themselves invited aboard those vessels most at risk of a marine casualty or fatality. Safe Catch used an aggressive strategy of identifying high risk fisheries and high risk fishing vessels and concentrating Coast Guard shore side and at-sea resources to actively engage those commercial fishing vessels most likely to have a marine casualty. Newly developed inspection standards, critical risk definitions and remediation tactics formed the core of the operation. At-sea boardings and voluntary dockside examinations sought to identify high risk vessels, checking safety items including immersion suits, life rafts, safety gear stowage, distress signals, emergency position indicating radio beacons, fire extinguishers and high water alarms. In addition, unique to Safe Catch, the material condition of each vessel was inspected. Those items included the vessel's watertight integrity, hoses, stability and loading. For vessels identified as high risk, Coast Guard personnel shore side would engage the owners, forming a partnership with the owners to reduce the risk on those vessels in an effort to bring them substantially into compliance with current safety standards. The results of this innovative approach and the strong partnerships that followed had a measurable result in that over 80 percent of those vessels identified as high risk willingly partnered with the Coast Guard to improve the condition of their vessel.

A major challenge for the Team was to quickly provide the field units with a simple method of managing the fishing vessel inspection data and simultaneously linking that data directly into the measures of effectiveness for the Operation. In response, the Team developed a uniformly formatted spreadsheet for data entry at the field unit level. The system included data fields and discrepancy coding which enabled the spreadsheet to be used by Coast Guard field inspectors as a daily worklist to assist in their follow-up visits to high risk fishing vessels. Given the short five-month duration of the Operation, the measurement system was developed to be near real-time, providing the senior operational commanders the "dash board gauges" needed to monitor the effectiveness and efficiency of their units and make adjustments to their tactics and efforts. The measures of effectiveness could be easily extracted for the spreadsheet and the simplified monthly reporting requirements required only that the spreadsheet be electronically forwarded from the field to the staff levels. The shared reporting and accountability necessary between the Operations and Marine Safety programs to support the spreadsheet and suite of measures powerfully reinforced that renewed partnership between the programs, resulting in rarely seen levels of collaboration between the two programs' resources. The utility and demonstrated success of this unique measurement system provides a highly effective model for use by the Coast Guard in the future.

RESULTS ACHIEVED

Coast Guard Atlantic Area's Operation Safe Catch significantly increased fishing vessel safety awareness and contributed to a reduction in fishermen's lives lost during the 1999-2000 winter. Remarkably, during Operation Safe Catch the number of lives lost was only about one-third the number that would have been expected based on the previous two winters and the number of vessels that fell victim to sinking or fires. During Safe Catch, 37 fishing vessels were lost, however, only 13 lives were lost. Although there were many factors that contributed to this, the Team's focus on the highest risk vessels and their safety equipment played a big part in this reduction.

The Safe Catch results that measured the level of risk assessment and remediation interaction by the Coast Guard with the commercial fishing community and greatly contributed to the reduction in lives lost at sea are remarkable. During the five-month winter period of Operation Safe Catch, 4,352 fishing vessels were inspected by the Coast Guard, in contrast to approximately 2200 inspected the previous year. Of those, 912 vessels were identified as high risk; and 80 percent of those vessels agreed to partner with the Coast Guard to improve the condition their vessels. By the end of the Operation, 613 of the 912 (67 percent) improved their compliance with the safety standards and are no longer operating in a high risk condition. The Operation relied on the precept that "reducing risk would save lives" and that is indeed what happened with Safe Catch.

The Team recommended to Coast Guard Headquarters a series of key Coast Guard-wide policy changes based on the lessons learned during Safe Catch including changes to commercial fishing vessel safety inspections, associated service-wide training needs and methods to foster the benefits of the Operations and Marine Safety partnership.

The Operation Safe Catch risk assessment and remediation strategy has been permanently adopted by Atlantic Area, creating a lasting fundamental change to Atlantic Area's approach to improving commercial fishing vessel safety. The renewed partnership between the Operations and Marine Safety resources will more effectively use Coast Guard resources, eliminate redundancies and encourage teamwork at all levels. The newly developed and embedded commercial fishing vessel safety training criteria will result in better trained Coast Guard boarding officers and dockside examiners, ultimately leading to continued reduction in loss of life at-sea. Finally, Safe Catch provides the necessary data to support the envisioned long-term Coast Guard Headquarters regulatory policy changes to improve commercial fishing vessel safety.

SAFETY ENGINEERING IN THE COMMERCIAL FISHING VESSEL INDUSTRY

Vincent Wilczynski, Ph.D.
Associate Professor, Mechanical Engineering
U.S. Coast Guard Academy
New London, Connecticut,usa
E-MAIL: vw@alum.mit.edu

CDR Vince Wilczynski, USCG, is an Associate Professor of Mechanical Engineering at the U.S. Coast Guard Academy. His professional interests are in the areas of data-acquisition and analysis, turbulent flow, automatic control systems, and design education. As a volunteer, he serves as a national officer of the American Society of Mechanical Engineers and the American Society for Engineering Education and is an evaluator for the New England Association of Schools and Colleges and the Connecticut Advisory Committee on Accreditation. As a Harvard Visiting Scholar, and in conjunction with the Coast Guard's Marine Safety Office, Portland, Maine, he has directed cadet research of fishing vessel component failures and enhancing safety in the scallop fishing industry.

The commercial fishing industry is one of the most dangerous professions in the U.S. Fishermen suffer from serious accidents such as vessel capsizing and acute injury to crew members working on deck. Investigations of causal factors leading to these events indicate that engineering design modifications and a heightened sense of safety engineering could have prevented many of these casualties.

This paper summarizes the engineering design analysis on commercial fishing vessel casualties that has been conducted at the U.S. Coast Guard Academy. This work has been conducted as part of the Mechanical Engineering curriculum at the Academy and at the University of Michigan, Department of Naval Architecture and Marine Engineering. In these studies, students have investigated failures to discover the engineering failure sequence. Four case studies are presented: steering failures on a lobster boat, equipment handling considerations on a scallop boat, propeller support failure on a whale watching boat, and an analysis of the naval architecture and equipment design on the Northeastern Scallop fleet. Overall, these case studies document how the safety of the commercial fishing industry can be improved by treating the

vessel and its handling equipment as a composite machine that includes both the fisheries equipment and the hull form.

INTRODUCTION

The U.S. Coast Guard Academy is the Coast Guard's principal source for career officers. Graduates of the Academy's four-year undergraduate program receive a Bachelor of Science degree in one of six technical majors (Electrical, Civil, Mechanical or Marine Engineering, Operations Research, Marine Science) or two non-technical majors (Government, Management). In addition to the degree, graduates also receive commissions as Ensigns in the U.S. Coast Guard Academy. The average size of the cadet corps is 875, with approximately 200 cadets graduating each year.

Since these graduates assume leadership positions in all of the Coast Guard's missions, including Maritime Safety and Environmental Protection, it is appropriate that these missions be incorporated into their education and training. As such, the Academy's Mechanical Engineering section has been incorporating safety engineering topics within the curriculum by integrating fishing vessel safety topics into existing courses in the curriculum.

One method for doing so has been directed study projects. A group of cadets may investigate the artifacts of a marine casualty and search for the engineering causes of the event. Typically, a group of cadets will work for the entire semester on one casualty, and receive academic credit for their work. Marine casualties have also been used in existing courses in the Mechanical Engineering curriculum as projects in Mechanical Engineering design courses.

An investigation hypothesis technique has been developed to guide most inquiries. The typical scenario for a cadet investigation begins with a U.S. Coast Guard Marine Safety Office delivering artifacts of a casualty and a case history file to the Academy. From there, the cadet team examines the material to understand the circumstances surrounding the casualty. An initial hypothesis for failure is then proposed by the cadet team, and the investigation explores the validity of this hypothesis using a macro-to-micro examination sequence. On the macro scale, the team studies the case history (which include photos and statements) and the artifacts themselves. Mechanical analysis of the system is conducted to understand the forces acting on the object. Magnification of components provides a more detailed view, followed by mounting, chemical etching and higher magnification to see more intricate structures. Additionally, chemical analysis of the failed components is conducted to determine the material's chemical composition [Nutt 1976].

The results of these examination levels are then combined to determine if the initial hypothesis for failure was correct. If needed, a new hypothesis is generated, and the examination results applied to that hypothesis. To complete the education component of the investigations, lessons learned and suggestions on how to avoid similar casualties are prepared and returned to the Marine Safety Office.

The purposes of this work are dual: it introduces an important Coast Guard mission area to cadets and it serves as a research tool for the Coast Guard's Marine Safety community. While the casualties are real, the work of the cadets is for educational purposes only, and is not used as part of official Coast Guard investigations. In each case study, the names of the vessels have been changed to a fictional name. In this paper four case studies are presented to document this work and solicit feedback from fishing vessel safety professionals.

CASE STUDY ONE: LOBSTER BOAT STEERING FAILURES

Two casualties of lobster boat steering have been examined and illustrate a potential class problem for these vessels. Two brief summaries are presented: the motor vessel *Mr. Morgan* and the motor vessel *King of Calm*.

The *Mr. Morgan* was a 65 ft lobster boat used in northern U.S. waters for lobster fishing in the summer and urchin fishing in the winter. The original engine in this vessel was replaced with a 350 horsepower engine, in part to enable the boat to be competitive in summer time lobster boat races. During urchin fishing, it was not uncommon for the vessel to ground itself as it worked the tidal zone areas for urchin.

Over a period of time, the master experienced the following sequence of events: with the vessel fully loaded, the rudder would be hard over, the throttle placed ahead-full, followed by a loud crack from the stern. After placing the vessel in a tide crib, the stainless steel rubber post was found to have failed along the weld that connected the post to the rudder. On its final voyage, the scenario repeated itself and a loss of steering was encountered as the vessel made its way back to harbor. After taking a tow and removing the crew, the vessel capsized and sank in 60 feet of water.

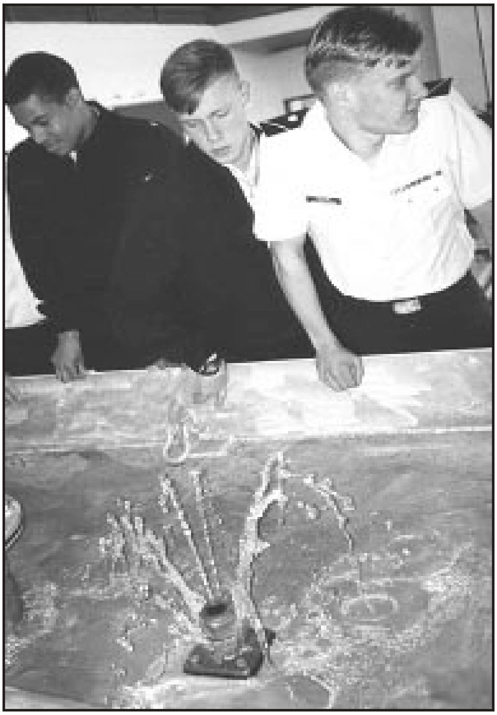
The vessel was recovered, and was examined by a Coast Guard inspector. The inspector found that the rudder post housing was cracked into four pieces. This failure led to the loss of steering, and allowed sea water to freely enter the aft steering compartment. The three pieces of the housing were removed from the damaged vessel, and sent to the Academy.

Examination by a team of cadets discovered that the rudder post housing failure was not a catastrophic failure, but rather a progressive failure that occurred over a period of time. Macro and micro examination of the failed components illustrated that the cracks originated from high stresses placed on the rudder housing from the vessel groundings, and that these cracks propagated due to high loads placed on the vessel while getting underway from a dead

Photo 1: A Failed Rudder Post Housing

stop, rudder hard over condition. The chemical composition of the material indicated that the original component was indeed adequate for the initial design, but not for the additional load that resulted when the engine size was increased. It was hypothesized that the majority of cracks in the rudder post housing existed for a long period of time, and could have been readily detected by an examination of the vessel steering system.

In addition to the written report of their findings, the cadet team documented their investigation for the Marine Safety Office with an educational video that detailed the failure sequence and promoted regular inspections of the vessel's engineering systems by vessel owners. Also, the failure was replicated on a mobile damage control trainer used by the Marine Safety Officer to illustrate the volume of water that can result from cracks in the rudder post housing.



U.S. Coast Guard Academy

Photo 2: A Cadet Investigation Team at Work

This case study was duplicated in another that examined the loss of steering on the *King of Calm*. The original rudder post bearing on the vessel's keel was replaced from a brass bearing to a Teflon block by the owner to allow for quieter steering. A bearing mount was machined into this Teflon block, and the rudder post was placed in this new bearing. Over time, the captain of the *King of Calm* noticed a slow degradation of steering that eventually resulted in a complete loss of steering.

Upon examination by a CG inspector, the rudder post was found to be sitting on top of the Teflon block. It had worn a new bearing hole into the block. As with the *Mr. Morgan*, the rudder post housing was also found to be cracked in four locations and the mounting holes of the housing were worn into oval shapes. The case history and the failed rudder post housing were delivered to the USCGA Mechanical Engineering section for analysis. In this case, a group of cadets examined the components as a project in their Machine Design course and examined the failure with respect to specific topics covered in this course.

Examination by the cadet team led to the hypothesis that the alignment of the Teflon bearing block was not correct and that this misalignment had forced the rudder to jump out of the machined bearing hole. While resting on the Teflon block, the rudder post slowly wore a new bearing hole into the Teflon, with the shape of this hole being oblong as well. By analyzing the forces on the rudder, the cadet team determined that the unbalanced load on the misaligned rudder caused the cracks in the rudder post housing.

Here too, vessel alterations were the cause of the progressive failure of the rudder post housing. Regular inspections of the vessel's operating system would have detected the cracks in the rudder post housing and allowed the master to correct the problem before it manifested itself as the more dangerous loss of steering condition.

CASE STUDY TWO: SCALLOP EQUIPMENT HANDLING

Two cadets studied the Northeast Scallop Fishing fleet as a directed studies project to examine how safety in this industry could be increased. Working with MSO Portland, Maine and the vessel classifications established by MSO inspector Mr. Jeff Ciampa, the cadets focused on studying the Washington County rig for scallop fishing [Ciampa 2000].

In this rig, fishermen work directly below the boom head and drag net while its contents are emptied on a sorting table. With a combined weight of nearly 5,000 lbs supported by a single connection point (cable and pulley), there is great potential for severe injury if the cable or support fails.

After spending time on-board scallop vessels, talking with vessel examiners and fishermen, the cadet team developed possible solutions to increase safety should components fail. The team documented their design alternatives with a series of models that were used to illustrate their ideas and solicit feedback from scallop fishermen. Based on the community feedback principle, input from the fishermen was essential for the cadet team to further develop their ideas [Backus 2000].

To improve safety in this industry, the cadets designed a secondary support mechanism for the net as well as a set of operating procedures to help reduce injuries. Of special note is that the cadet research on this work received first place in the national student paper competition sponsored by the American Society of Mechanical Engineers Safety Engineering and Risk Analysis Division and the National Institute for Occupational Safety and Health [Plumley and Pisares 1998].

CASE STUDY THREE: PROPELLER SUPPORT

A 100-ft whale-watching vessel was the subject of a forensic engineering investigation of a failed propeller shaft strut. This structural member, which supported a 3-foot run of a 3-inch diameter shaft, cracked along its weld to the hull. The case history reported the operators hearing a loud noise, followed by severe vibrations as the suspended strut rotated on the spinning shaft.

The cadet investigation for this case was notable since the work was conducted as a project in a course on Finite Element Analysis. The strut was modeled using finite element methods and the model was then examined to see which of a series of loads and vibrations yielded a stress concentration field that matched the failed component. This analysis ruled out shaft misalignment as the cause, and indicated that a stress concentration started at the leading section of the strut and then propagated to the rear of the vessel, most likely from ingesting a submerged line that then wrapped itself around the spinning shaft.

Photo 3: Hull damage

HULL FORM AND EQUIPMENT HANDLING IMPACT ON STABILITY

Upon graduation, cadets become Ensigns and are assigned to floating Coast Guard units for their first tour of duty. Specialization in a Coast Guard mission area follows that initial tour, with graduate school in engineering as one option for officers working as engineering specialists. In one example, a USCGA graduate conducted master's level research in the field of fishing vessel safety, thereby demonstrating the applicability of this area to graduate work as well.

Working with MSO Portland, Maine and faculty at the University of Michigan Department of Naval Architecture and Marine Engineering, a former cadet examined the influence of operations on scallop vessel stability. In this case, the vessel and the equipment were treated as a composite system, and the reserve stability was calculated for the vessel in each operating condition. Correlating with the industry's casualty occurrence rate, the greatest decrease in stability was demonstrated to occur on the single point side rig vessels during haul back.

SUMMARY

These case studies illustrate how the topic of fishing vessel safety can be integrated into the undergraduate and graduate engineering curriculum. In each case, engineering analysis was applied to investigate the vessel's condition and identify unsafe operating procedures. This method has been quite successful not only as a tool to engage future Coast Guard officers in an important mission area, but also to serve as a research arm of the Coast Guard Marine Safety Offices. In each project, safety was found to be a function of not just the separate components, but rather the integrated system of components and hull form.

ACKNOWLEDGMENTS

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MEASURING RISK OF CUMULATIVE MUSCULOSKELETAL TRAUMA IN FISHING VESSELS

Scott Fulmer
Bryan Buchholz
Work Environment Department
University of Massachusetts, Lowell, U.S.A.
E-mail: scott_fulmer@uml.edu

Scott Fulmer began researching health issues among fishermen in his hometown, Gloucester, Massachusetts, in 1992 while earning an M.S. in Ergonomics from UMass-Lowell. He worked for five years as a fellow and staff at the Center for Community Responsive Care in Dorchester, Massachusetts, a Preventive Medicine/Public Health Residency Fellowship. Mr. Fulmer investigated fishing vessel ergonomics for two years through a grant from Northeast Center for Agricultural and Occupational Health, as well as ergonomics of fruit harvesting among migrant workers in the Northeast U.S. He is presently the Ergonomics Project Manager of the Construction Occupational Health Program at UMass-Lowell, since fall of 1999, researching ergonomics hazards and solutions in highway construction on a grant from the Center to Protect Workers' Rights.

INTRODUCTION

Fishing has long been recognized as a dangerous occupation, consistently ranking at or near the top of all occupations in fatalities in states where the industry employs a significant population. Between 1992 and 1996, the fatality rate for fishing was 140/100,000 workers: eight percent of the fatalities were from the Massachusetts' fleet [Drudi1998]. Systematic measures of response to fishing vessel emergencies implemented in the last ten years may have resulted in declining rates of lives lost at sea. Measures of prevention of injuries or vessel emergencies have not been as widely adopted, nor have rates of non-fatal injuries or rates of vessel emergencies been shown to be decreasing [Lincoln 1997, BLS 1990-1997]. Literature continues to grow which link certain occupational risk factors to the incidence of injury and illness. Specifically, repetitive motions, forceful exertions, awkward or static postures, cold temperatures and vibration contribute to cumulative musculoskeletal disorders. By reducing these risk factors through ergonomic measures, a corresponding reduction in injuries would be expected. For example, Törner

[1988] showed that hull redesign could reduce knee bending and contact stress to the knee among fishermen in Sweden.

This study characterized the work processes involved in different types of fishing in Massachusetts. Specifically, observations were made to qualify and quantify risk factors that may be reducible by applying ergonomic principles to the design of the work environment in fishing vessels. Many different methods of harvesting fish are used throughout the various fisheries of Massachusetts. Fishing boats are classified by their gear type. The boats investigated in this study were two lobster boats, a gillnetter and an otter trawler. The three gear types observed in this study make up about 70 percent of all fishing boats licensed in Massachusetts.

METHODS

Two of the four boats observed were lobstering operations, one was a gillnetter and the other was a trawler. Each had a crew of two – one captain and one sternman – except the trawler, which had an extra sternman for a crew of three. The boats were out of Gloucester, Rockport, and Fairhaven, Massachusetts, and selected by convenience.

Each crew voluntarily completed a health assessment questionnaire. The questionnaire was composed of questions regarding occupational experience, health history, and health treatment.

Direct observations of the four boats were made during their regular operations in order to quantify risk factors for musculoskeletal disorders, acute injury, and noise-induced hearing loss. Video recordings were made of the operations, which helped in analyzing the elements of the required tasks. In addition, still photography was employed to document hazardous conditions.

An ergonomic job analysis in which the observed risk factors for musculoskeletal disorders that were described was completed for each boat [Keyserling 1991]. The risks were identified after reducing the work description to an elemental level, then associating those elements with postural risk factors. Categories for postural risk factors were derived from the PATH (Posture, Activity, Tools and Handling) method, a work sampling-based approach for collecting ergonomic hazard data in non-routine jobs [Buchholz et al 1996]. The duration of the various routine cycles of work were measured and used to determine the overall workload and percent of time an individual would be exposed to a particular risk factor. Noise was measured using an audio dosimeter (model MK3, DuPont) clipped to the observer. The condition of tools (sharpness of knives, integrity of handles, rust, etc.) and estimated weights were noted when possible.

RESULTS AND DISCUSSION

The three kinds of fish harvesting observed involved gear designed for that particular fishery. Lobstering and gillnetting are classified as stationary gear, while otter trawling is classified as mobile gear. Each of the gear types is designed to trap and remove fish or shellfish from their natural environment. Successful production in commercial fishing is simply a matter of volume, with limits on species regulated by state and federal governing bodies. Crews try to haul in as much fish or shellfish as possible, clean and prepare it for storage as needed, and stow it into some kind of holding area. Beyond regulations on gear size, harvesting equipment is not standardized.

The major risk factors to musculoskeletal disorder are related to materials handling. The frequent hauling of traps requires some awkward posturing, frequent and sometimes forceful lifts. Handling bait and removing catch did not usually require great force, but was repetitive and required both speed and precision.

The movement of the fishing boats at sea was significant, yet was not fully predictable. Although these were less than ideal working conditions, experienced individuals had some skills in compensating, as the work demanded smoother handling practices that fully utilized mechanical advantages. The sternmen on the lobster boats were able to use the rising boat to create inertia when lifting the traps.

Work stress resulted from the condition and management of the fisheries. One captain pointed to concerns he had for the "big picture". He was most concerned about over-fishing. In particular, he felt that the government has not taken adequate measures to manage fishery resources, and will be forced to react too forcefully to what will be an unavoidable need for emergency protection. When this happens, competitive forces will make economic survival more of a challenge than it is presently. These forces, or the mere perception of these forces, present an increased risk for poor health outcomes in multiple ways. Primarily, they put pressure on the observed vessels to put more time at sea to compensate for the decrease in the fishery resource. More time at sea increases the exposure to the known risk factors. Secondly, but no less significantly, there is additional systemic stress to fish harvesters who may perceive that the work that they are doing is not truly a path to economic well-being. Although they may have felt that the work is not worth the risk, they were bound and committed to it by virtue of being boat owners or experienced hands who had no immediately viable alternatives. Karasek and Theorell [1990] have demonstrated risk for undesirable health outcomes in any work environment where such a high job demand is exacerbated by low decision latitude.

LOBSTERING

Lobstering has the most repetitive haul and set cycle of the three types of operations observed. On the day they were observed, one crew handled 240 traps, the other 290. Both captains commented that they commonly handle 300 traps on most days.

The two operations observed are interesting in comparison because their techniques differed in three major ways that affect health and safety. One boat set traps individually attached to buoys, known as singles, the other set groups of ten or twenty traps attached to buoys, know as trawls. The crew of the boat setting and hauling trawls did so for 45 percent of the day, whereas hauling and setting strings of singles required about 70 percent of the day. Lifting and pulling the trap onto the boat was necessary only ten percent of the time on the trawling set than on the singles set. Awkward postures of the back and upper extremities and high force were associated with this lifting and pulling. The captain, who was the one who performed the lift, of the boat setting and hauling singles was exposed to ten times the number of these awkward lifts than the captain of the trawl set. The rate of repetition in either boat is strictly under the control of the captain, who operates the boat.

The second effect of the trawl set regarded the lines. The lines used to connect the traps to each other in the trawl set were piled on the deck at the feet of the crew, and were a risk for entanglement and loss of life from drowning. In contrast, the lines connected to the single strings were immediately placed on top of the trap at waist height once the trap was hauled in, which decreased the risk of entanglement.

The third difference in technique was not related to the traps, but to the bait loading. One boat ran a spike through the bait-fish's eye sockets and then down a string attached to the trap. The other loaded bait-fish into onion bags and tied the bag into the trap with a drawstring. Neither sternman reported pain associated with this task, but significant differences in wrist posture were noted. The associated repetition and postures would make this task an area of concern for reducing risk for MSD.

The technique of hauling and setting the traps was otherwise similar between the two lobster boats. Captains were exposed to the awkward trunk and upper extremity postures, high force, and repetition of pulling in the trap. Additionally, sternmen were exposed to repetition, high force and awkward posture of handling traps in their back and shoulders, as well as to repetition and awkward postures associated with gauging and banding the lobster.

Noise levels were close to OSHA's standard of 90 dBA for eight hours on one boat, but much less on the other. Both captains attributed the noise level differences to the differences in engine manufacturers.

OTTER TRAWLING

Otter trawling is a method of dragging named for the large doors that hold open the mobile gear (the net) while it is dragged either through mid-water or across the bottom. When the doors shimmy through the water, they look like otters swimming. The opening of the net is very large, and narrows to a "cod end" where the catch gets trapped.

Otter trawling is a less repetitive process than lobstering, and among all types of gear, it has been known as "gentlemen's work". On the observed day, the crew set and hauled back the net three times. They were idle while the net was dragging.

The large otter doors required forceful exertions to guide them as they were hoisted from their secure slot into the water to begin the haul, and, in the reverse process, to secure the door into its slot after hauling back the net. Static force was required to hold a bar against the cable in order to guide and prevent tangling when the cable was wrapped around a large spool during haul back. The crew sorted the fish into baskets after the net was hauled back and the catch emptied onto the deck of the boat after dragging for about two hours. The work surface was below the feet, and required severe forward trunk flexion and/or kneeling for extended periods. Once in baskets, the catch was loaded into the hold without mechanical aids. The captain estimated that full baskets weighed up to 80 lbs, and were passed from above deck by one man to below deck to another. The second man's arms had to be fully extended above his head to grab the basket from above deck. An extremely forceful pull was required to haul in the "bird", a 200 lb winged iron weight on each side of the boat set out during dragging to dampen the movement of the hull of the vessel. High force may be required for irregular lifts of any large objects dragged off the ocean floor, such as oil cans, boulders, or broken and discarded fishing equipment.

GILLNETTING

Gillnetting is another form of stationary gear. An extremely long and practically invisible net (monofilament fiber) is set vertically like a fence in mid-water or near the floor and hauled back after about 12 hours. Fish swim unaware into the net and are entangled. The haul back is slow, and the fish were untangled and removed from the net one at a time by the crew.

Though gillnetting was similar to dragging by being completed in a few reiterations, one iteration of removing all of the fish from the gillnet involved highly repetitive motions of the arms, often forceful and jerking motions, with the elbows above shoulder height. This high degree of repetition did not have predictable cycles, in contrast to the cycles of handling lobster traps. The lobstermen's routine had shorter cycles, allowing for one to three minutes of idle time between about 12 minutes of intense materials handling. Gillnetters responded to each fish as the net was slowly hauled back by the lifter. So, when fish close together in the net got hauled in, a flurry of work would continue until the net happened to be empty for a few feet. Conceivably, the repetition could last for the entire haul back, which lasted about an hour for each net.

Two brief lifts were particularly forceful: when the "stone" – a large piece of iron used to weight one end of the net to the bottom – was thrown overboard, and when the anchor was hauled in to the bow. On longer trips, the catch would need to be iced below deck. Removing the iced catch required forceful shoveling in very awkward positions.

GENERALIZABLE RISK FACTORS

Repetition was an important risk factor for injury in each of the fisheries. The volume of catch was a major determinant in how much repetition, except in handling lobster traps (where each trap had to be hauled, new bait set, and then reset in the water regardless of the trap's contents). The captains determined the rate of the repetition, and they had to judge whether increased rate of repetition actually resulted in increased volume of catch (the ultimate goal).

Forceful lifts in awkward posture were seen on each boat. In lobstering, and less consistently in gillnetting, these were accompanied by the risk factor of repetition when handling the gear. Forceful exertions of the hand and wrist were also seen in handling of the catch in lobstering and gillnetting. Given existing technologies, these tasks would be required on any boat of the respective gear type.

Additional strain due to force of muscles needed to maintain balance as the boats move somewhat unpredictably is more prevalent in the smaller boats. None of the boats observed were big enough to dampen the effects of the waves moving the boat, even on calm days. Decks, gear, and catch were always wet, a factor that also tends to increase the strain on the musculoskeletal system: grip forces need to be higher and footing needs to be securer than with similar circumstances under dry conditions.

Irregular tasks also put the worker at higher risk. In lobstering, the high force and awkward wrist angle during line repair was only observed once in 20 hours of work. In otter trawling, high force and awkward posture was required to move an old and full lobster trap that got hauled in by the net.

These operations were observed for one fishing trip each. Crews commented that the long workdays and sleep deprivation accompanied by overnight trips does contribute to stress. This work stress is compounded, as mentioned before, by the economic issues facing the entire industry. Engine noise has a negative effect on work stress, too. Heat and sun in the summer and cold temperatures in the winter also are factors.

INTERVENTIONS GENERALIZABLE TO INDUSTRY

Available workspace determined posture for some of the repetitive tasks, such as stacking traps in lobstering, icing fish in gillnetting, and sorting fish in otter trawling. In ergonomic intervention of any kind, attention should be given to ensuring that maximum utility of the limited space is achieved and that the work processes require as little unnecessary lifting as possible. Bigger boats ease some of this pressure on efficiency.

However, the biggest boat observed, the otter trawler, could improve the biomechanical aspects of the job by putting a workstation in the hold of the boat. The described process of sorting fish while kneeling could be eliminated if the catch were lowered onto a sorting table under the deck. The catch could be sorted and iced by sliding the fish, and the work height would be near waist level. The forceful and repetitive lifting of the baskets would be eliminated also. In the wintertime, it would be warmer below deck. However, the noise may increase.

In lobstering, a hoist that engages the trap buoy overboard and hauls the trap or trawl of traps up to and then onto the boat would eliminate a very large proportion of highly forceful and highly repetitive lifts done in awkward postures. Some of the stress to hands and wrists could be eliminated by changing the banding tool and gauging tool handles to reduce the need for non-neutral postures.

The subjects in this study were creative problem solvers. The nature of the industry seems to challenge one's basic survival and creative energy. Certainly, fishermen would make excellent ergonomists if given useful training and information. Ergonomic training in the fishing industry should include an understanding of what the risk factors for musculoskeletal injuries are and how they relate to the work they do. Vessel stability is a specialized science that must be taken into account with respect to any alteration of a boat.

ACKNOWLEDGEMENT

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Photograph and caption by Earl Dotter

A woman sorts the urchin catch at the culling table in frigid 20 knot gusts with a wind chill of minus nine degrees Fahrenheit. Should cables or the headgear above her fall, the violent release of energy could send wire cable whipping.

SURVEILLANCE FOR NONFATAL WORK-RELATED INJURIES IN THE ALASKA FISHING INDUSTRY

Bradley J. Husberg, B.S.N., M.S.P.H.
Alaska Field Station, National Institute for Occupational Safety and Health
Anchorage, Alaska, U.S.A.

Commander Husberg is an officer in the U.S. Public Health Service working as an Epidemiologist and Occupational Safety and Health Specialist. He is assigned to the Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Division of Safety Research, Alaska Field Station in Anchorage, Alaska where he has been for the last five years. The primary focus of his studies in Alaska is injury surveillance and prevention for nonfatal work-related injuries. After receiving a Bachelor of Science degree in Nursing (BSN) at the University of Utah he worked in an urban hospital Emergency Department as a trauma coordinator; and triage and air transport nurse. During this time he completed a Master of Science in Public Health (MSPH) degree at the University of Utah College of Family and Preventative Medicine. In 1989, he was assigned the U.S. Public Health Service Indian Health Service Hospital in Bethel, Alaska where he was the Chief of Inpatient Pediatric Pediatrics for two years and served another year as the hospitals Assistant Administrator for Patient Support Services. In 1992, he transferred to the Centers for Disease Control and Prevention working with the National Institute for Occupational Safety and Health, Division of Respiratory Disease Studies in Morgantown, West Virginia. During this time he was a medical and environmental Project Officer for Health Hazard Evaluations and worked with a long-term occupational asthma project. In February 1996, he transferred to his present position at the Alaska Field Station.

INTRODUCTION

Information for injury surveillance can come from many different data sources. Fatality information is generally gathered from death certificates, which are a clearly defined endpoint. However, information for nonfatal injuries can be a little more difficult to define and locate. This point can be more clearly portrayed by looking at injuries in the commercial fishing industry. Recent injury surveillance has shown that work-related fatal injuries in the Alaska commercial fishing industry are more commonly a result of the loss of a vessel resulting in the loss of fishermen's lives [NIOSH 1997] .When nonfatal injuries occur in the commercial fishing industry it is more commonly a result of machinery or falls that occur while working on deck. This paper will focus on hospitalized nonfatal injuries in the Alaska commercial fishing industry using injury surveillance data from the Alaska Trauma Registry (ATR).

METHODS

The ATR is used as a tool for hospital quality assurance for the care of patients with traumatic injuries. It is also used extensively for injury surveillance in Alaska. Data are collected and maintained by the Alaska State Department of Health and Social Services, Division of Public Health, Section of Community Health and Emergency Medical Services in Juneau, Alaska.

There are many unique aspects regarding the use of the ATR for injury surveillance. One of these is the fact that all 24 acute care hospitals in Alaska contribute data to the registry. Also there are very few hospitals located across the Alaska border. The result is that few people who are injured in Alaska will be seen at a hospital outside of the state before being seen in an emergency department (ED) at a hospital in Alaska. These points make the ATR a useful population-based data source for injury surveillance.

The ATR only has information for patients admitted to a hospital in Alaska. To be included in the ATR a patient has to sustain a traumatic injury defined by an ICD 9 CM discharge diagnosis code ranging from 800.00 through 995.99. The patient also has to be either admitted to a hospital in Alaska; transferred to a hospital with a higher level of care after being admitted to a hospital or seen in an ED in Alaska; or declared dead in the hospital emergency department or after being admitted.

Cause of injury information is taken from the ICD 9 CM "E code." Nature of injury and body region injured are extracted from the ICD 9 CM "N code" given to the primary discharge diagnosis. The ATR has a narrative "injury description" field where additional information on the cause and circumstances of injury can be obtained. Hospital costs are taken from hospital discharge information.

RESULTS

Currently, the ATR contains complete data for the years 1991 through 1998. During this time period there were 34,306 injuries recorded in the ATR. Ten percent (3,582) of these injuries were work-related with 587 occurring to workers in the commercial fishing industry. For the years 1991 through 1997 the commercial fishing industry had the highest number of work-related injuries in the ATR [Husberg 1998]. With the inclusion of the 1998 data, the construction industry had the highest number of injuries for the eight-year period. Annual trends show a decreasing number of commercial fishing injuries where the construction industry has a gradually increasing trend.

When looking at injury rates by industry, commercial fishing ranks third, with four hospitalized injuries per 1,000 workers. The industries with the highest hospitalized injury rates in Alaska were logging (18/1,000) and construction (6/1,000).

Bradley Husberg

Photo 1: Pot being positioned on pot launcher by crane

Bradley Husberg

Photo 2: Pot launcher in up position launching a pot over the side of the boat

Leading causes of injuries in the commercial fishing industry include machinery (187), falls (149), and being struck by an object (98). The E code system does not have a further breakdown for the machinery injuries. However, after reviewing the injury description field in the ATR, it became obvious that most of these injuries were caused by crab pot launchers (CPL) and cranes. The injuries caused by falls can be broken down further using the E code. Most of the falls were from slips or tripping (37) followed by falls from a structure (7). The injury description field in the ATR shows that most of the objects striking workers were crab pots and fish nets.

The nature of injury listed most commonly included a fractured bone (279), open wound (73), and burn (29). Body regions most commonly injured include the upper extremities (184), lower extremities (171), and the spine (35).

Hospital costs ranged from U.S. $219 to U.S. $165,324. The average hospital cost was U.S. $2,063.

CONCLUSION

From review of the causes we find that many of the injuries occur in the crab fishery. The initial approach to the machinery injuries was to look at the CPL in depth. The CPL is a platform, approximately 7ft. by 7 ft. square made of steel pipe. One side of the platform is permanently attached to the gunwale of the boat by hinges, the other side is free to raise and lower by hydraulic power. When a crab pot is ready to be placed in the water the hydraulic ram raises the free end of the CPL platform where the crab pot can slide into the sea. The free end rests on the deck except when it is raised to deploy a crab pot. An empty crab pot in the larger crab fisheries measures 7x7x3 feet and weighs approximately 700 pounds, empty.

Many of the injuries, caused by the CPL, identified by the ATR were crushing injuries to the lower extremities and feet. Possible injury prevention measures could be to weld two steel blocks (~4x4x4 inches) on the bottom of the free end of the CPL where it rests on the deck. This would reduce the contact surface with the deck and minimizing the area where feet and toes could be crushed. Another measure to prevent injuries working around the CPL is to paint a yellow boundary around area the CPL covers on the deck. This would increase fisherman's awareness of areas to avoid when the CPL is in operation. Finally, on some vessels the controls to the hydraulics for the CPL are located far away from the CPL itself making it difficult for the operator to have a clear view of the work (the controls for the CPL are usually located with the controls for cranes, and power blocks). Locating the CPL controls closer to the CPL or with a good view of the working area could help decrease these injuries. Another possibility is to locate an emergency shut off switch near the CPL to be used if someone was caught under the CPL platform.

The ATR has been very useful in identifying hazardous work practices and injury prevention measures in the commercial fishing industry. With information from the ATR, injury prevention programs focusing on machinery injuries in crab fisheries fishermen are underway.

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AUDIT OF THE USE OF ACCIDENT AND EMERGENCY DEPARTMENTS BY FISHERMEN WORKING IN THE CATCHING SECTOR OF THE SCOTTISH FISHING INDUSTRY.

Sarah Morrison
Catriona Matheson
Thane Lawrie
Department of General Practice and Primary Care, University of Aberdeen
Scotland, United Kingdom

INTRODUCTION AND BACKGROUND

This study was conducted as part of a wider programme of research that began in October 1999, looking at health issues affecting fishermen working in the catching sector of the Scottish fishing industry. The research program was facilitated by the Fishing Industry Safety and Health (FISH) consortium, which was formed to address health issues affecting fishermen.

To gain a more accurate impression of the health issues currently affecting this population group, multiple data collection sources were used. The audit itself was designed to describe the types and frequency of injuries and illnesses arising both on shore and at sea. Data was collected by recording emergency admissions to accident and emergency departments in the North East of Scotland, Orkney, and Shetland.

This paper will briefly set out the aims and objectives of this study, describe the methodology used, and present some of the preliminary findings from the study.

AIMS AND OBJECTIVES

The overall aim of the research programme is to identify health issues affecting fishermen working in the Scottish catching sector. Key objectives of the audit are: to illustrate the nature and frequency of injuries and illnesses affecting fishermen; and to determine the nature and frequency of medical emergencies that arise among this population group.

METHODOLOGY

SITES

Accident and emergency departments and minor injury units of hospitals around the coast of Scotland, near major fishing ports, were initially identified and contacted to see if they would be interested in participating in the study. It was decided however, only to include those in the North East of Scotland, Orkney and Shetland, as this is where the majority of fishing activity occurs. This selection would also facilitate regular site visits by the researcher to participating sites.

DATA COLLECTION

Data collection took place on a prospective basis over six months from March to the end of August at eight accident and emergency departments. This period was considerably longer than initially anticipated but given that hospital staff were keen to participate and a longer data collection period would be more valuable, the period was extended.

DATA COLLECTION TOOL

Data was collected using a structured data collection form and was completed by the attending nurse or doctor. The form was relatively short with mostly close-ended questions, to make the forms as user-friendly as possible. Instructions for completion were given in each form. Data was collected on the patient's occupation on a fishing boat, method of arrival at the department, frequency of visits to accident and emergency departments and whether the patient was currently registered with a general practitioner. Medical details on the presenting complaint, final diagnosis, date, time and place of occurrence, treatment, and outcome of the visit were also gathered. Forms were completed exclusively for fishermen and only new presenting conditions were recorded. If follow-up treatment was advised then both this and the type of treatment required would be indicated on the form. Patient confidentiality was stressed.

PILOT STUDY

A pilot study was conducted over one month (February 2000) with five of the participating departments. Hospital staff were consulted as to the structure, content and method of data collection. Their input was vital to the success of the audit. Introductory meetings were held with members of staff where any queries or concerns could be discussed. A gatekeeper was established and this individual acted as the main point of contact between the researcher and hospital staff.

SITE SUPPORT

Regular site visits were made to maintain contact and interest in the audit amongst staff. Reminders were issued to staff at each participating department at regular intervals, again to maintain interest. Patient information leaflets and posters were also used to raise awareness of the audit amongst the patients themselves.

Introductory meetings were held with members of staff at the relevant departments before launching the pilot study in March with the remaining sites. These meetings acted as a vehicle for information dissemination and feedback. A gatekeeper was established and this or these individual/s acted as the main point of contact between the researcher and hospital staff.

DATA ANALYSIS

Data were entered and stored in a database (SPSS) for analysis. Simple descriptive statistics were used and some cross tabulations. Chi square tests were run to determine the statistical significance of results. However, given the relatively small number of cases, the statistical power was reduced.

PRELIMINARY RESULTS
BACKGROUND AND DEMOGRAPHICS

There were 164 recorded instances of fishermen attending accident and emergency departments over a six month period, from March to the end of August 2000, at the eight participating sites, as shown in Figure 1. The greatest number of attendances, 29 percent (n=47), were recorded at the Gilbert Bain Hospital, Shetland. Peterhead and Fraserburgh had a similar number of recorded attendances, 22 percent (n=36) and 19 percent (n=31) respectively. Chalmers Hospital, Banff recorded 15 percent (n=24), Aberdeen Royal Infirmary 9 percent (n=14), Dr. Gray's, Elgin 4 percent (n=7) and Seafield Hospital, Buckie, recorded 3 percent (n=5) attendances. Balfour Hospital, Orkney, did not record any attendances of fishermen over the six-month period.

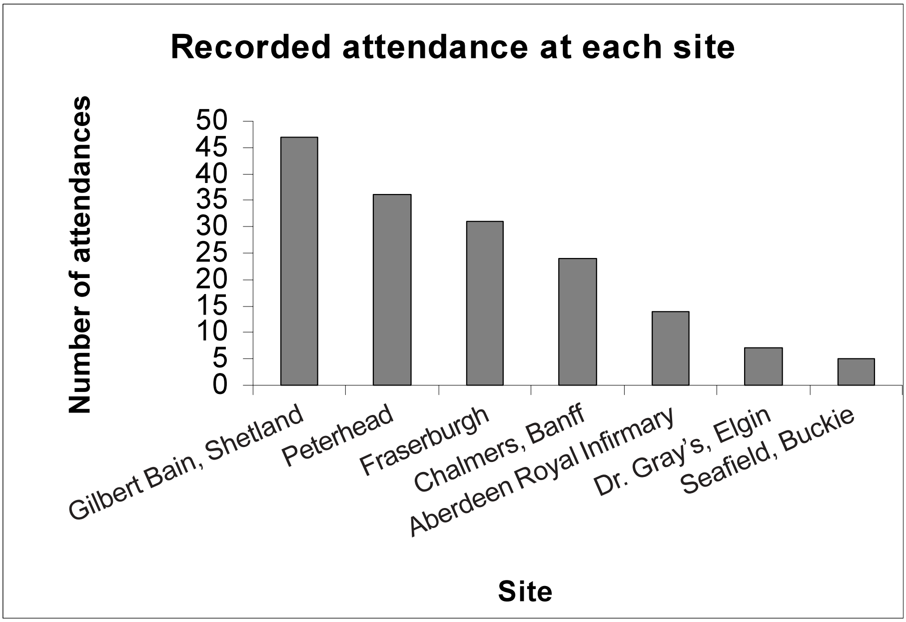

Figure 1: Recorded attendance at each site

SITE DETAILS AND ATTENDANCE

There was a steady decline in the total number of attendances each month over the study period, illustrated by Figure 2. During the first month, 29 percent (n=48) of the all attendances in the study were recorded, compared to 11 percent (n=18) in August.

Attendance across each of the sites was evenly distributed over the course of the week and time of day, with no definite pattern in attendance. However, there were fewer overall attendances at the weekend

CASUALTY DEMOGRAPHICS

All respondents were male. Twenty-three percent (n=38) participants were 15 to 25 years of age, 35 percent (n=57) were aged 26 to 35 years, 18 percent (n=29) were aged 36 to 45 years. The remainder, 20 percent (n=32) were over 46 years of age.

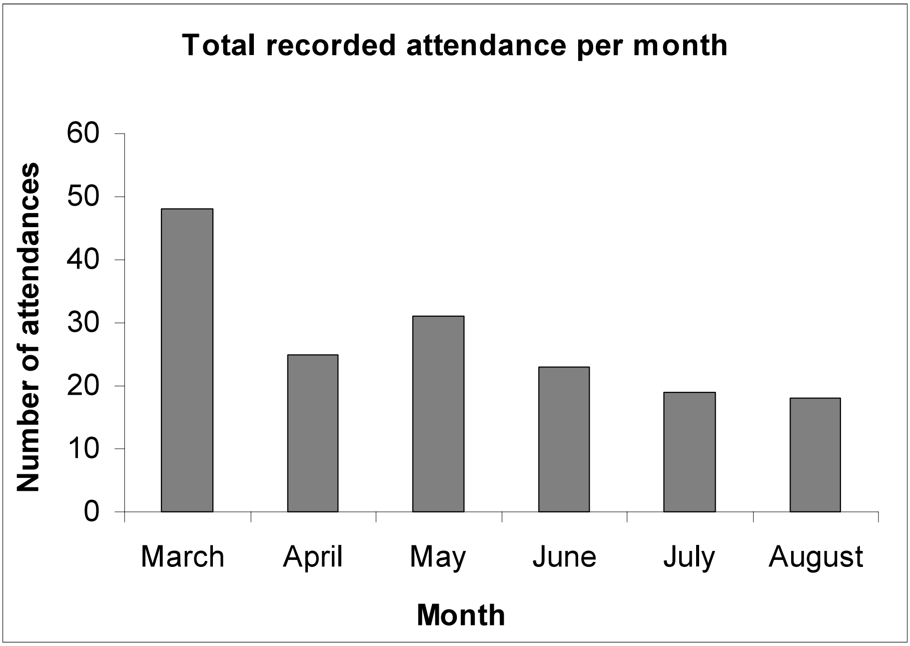

Figure 2: Months of Attendance

OCCUPATION DETAILS

Ninety-three percent (n= 153) of participants worked on a full-time basis, 4 percent (n=6) on a part-time basis, with 0.6 percent (1) retired. One of the fishermen (0.6 percent) worked on an 'other' basis which was not stated. Three respondents (1.8 percent) did not answer this question. The majority of participants, 45 percent (n=73) worked most often on a trawler greater than 24 m, 31 percent (n=50) on a trawler less than 24 m, 9 percent (n=15) on a seine netter, 6 percent on a shellfish boat. Other boats, of which there were 4 percent (n=6), included multi-purpose vessels. (Ten respondents, or 6 percent did not answer this question). The type of boat is displayed in Figure 3.

The majority of participants reported working as crewmen (44 percent, n=72), 29 percent (n=47) as mates and 9 percent (n=15) as skippers, as shown in Figure 4.

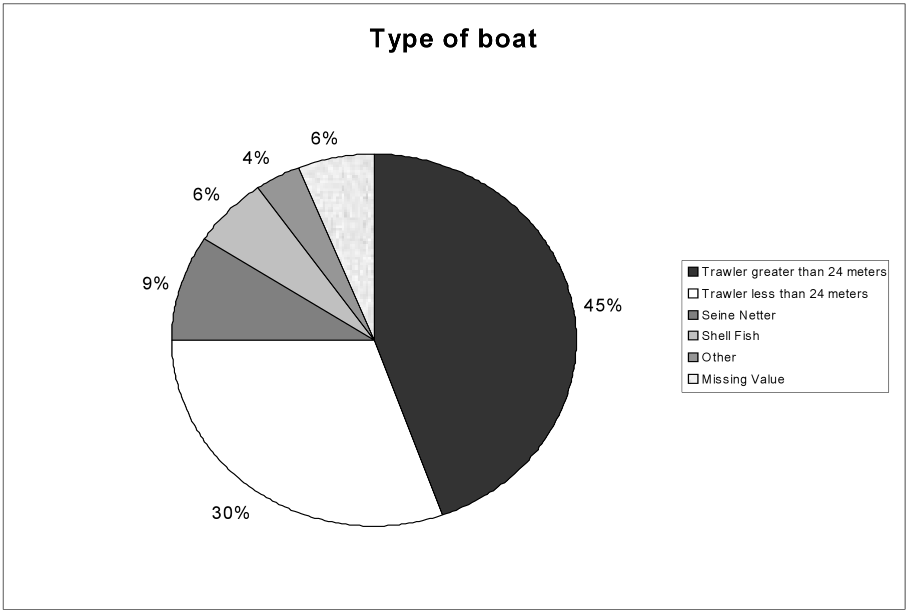

Figure 3: Type of Boat

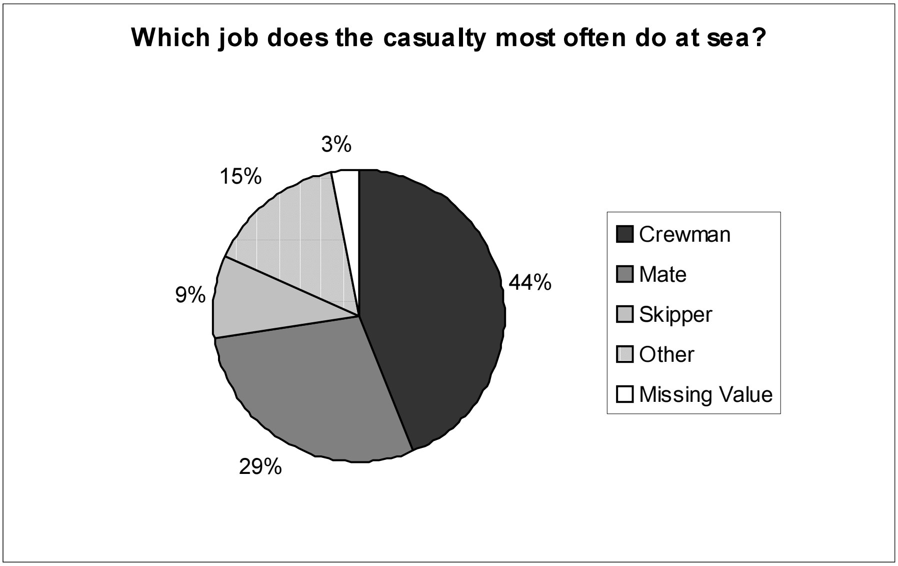

Figure 4: Job Title of Person Injured at Sea

MEDICAL DETAILS

Figure 5 illustrates the number of injuries and illnesses presented. Eighty-one percent (n= 133) of participants presented injuries, 12 percent (n=19) presented illnesses. Four percent (n=6) of cases could not be identified as either injuries or illnesses. (Four percent, n=6, did not answer this question).

Figure 6 illustrates the location where symptoms were reported as first arising. Respondents were also asked when they were next traveling to sea. The majority reported that they were going to sea within seven days.The types of injury presented were predominantly lacerations (28%, n=46) and soft tissue injuries (24%, n=39). The remainder included fractures (9 percent, n=14), foreign bodies (7 percent, n=12) and burns, including sunburn (2 percent, n=3). Twelve percent (n=19) could not be identified. Figure 7 shows the part of the body most susceptible to injury. This was the hand, wrist and finger (28 percent, n=46) and the head, face and throat though other body parts were also prone to injury.

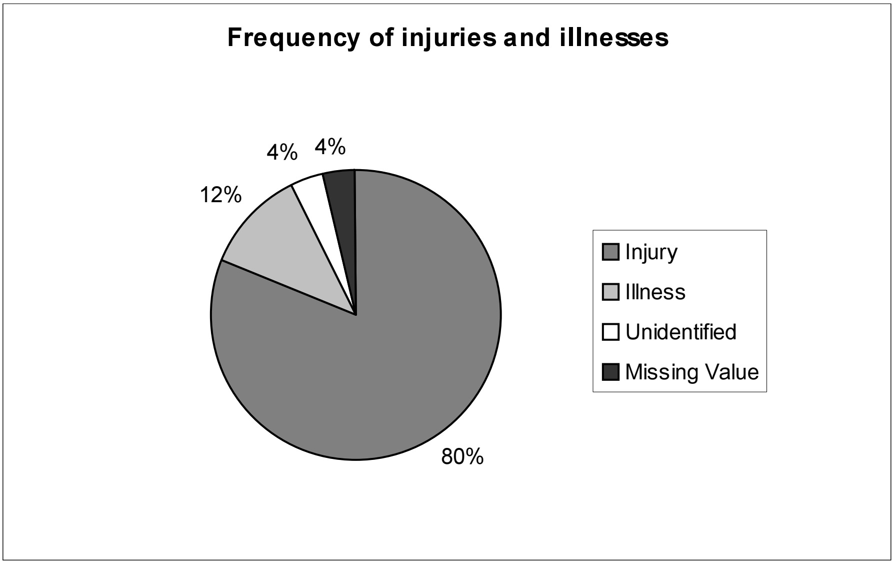

Figure 5: Distribution of Injuries and Illnesses

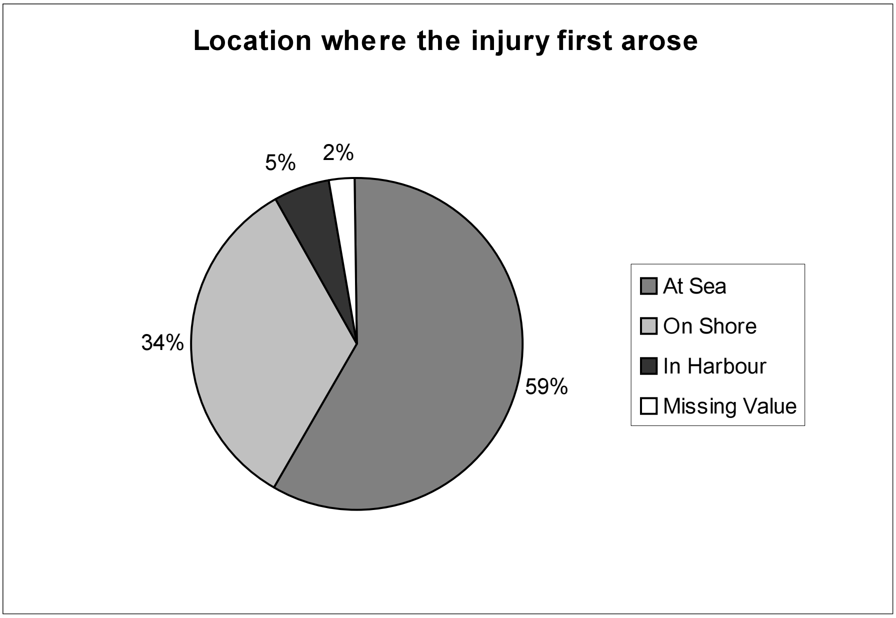

Figure 6: Location where the injury or illness first arose

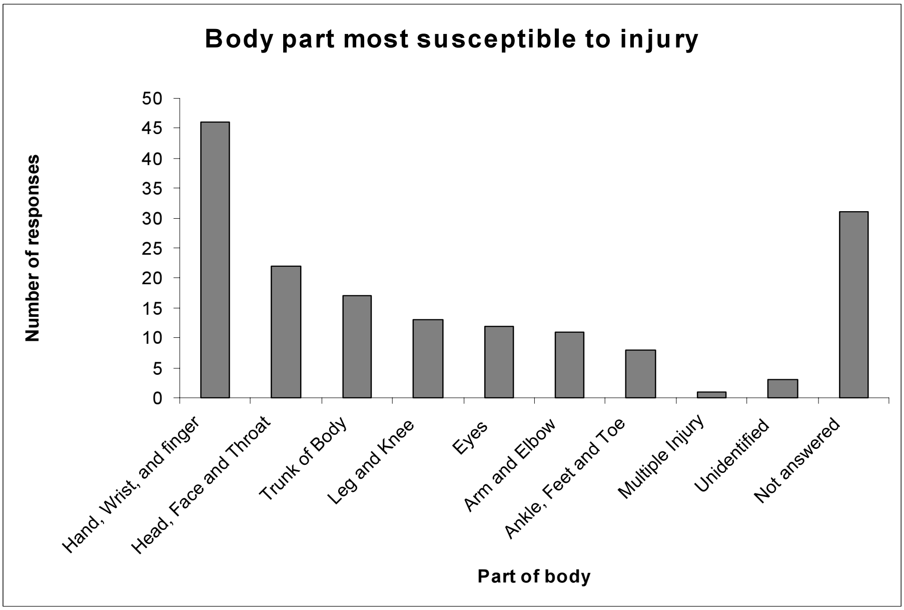

Figure 7: Body Parts Injured

GENERAL MEDICAL PRACTITIONER REGISTRATION AND SOURCES OF ADVICE

Sixty-nine percent (n= 113) of participants reported being registered with a local general practitioner at the time of attendance. Twenty-three percent (n=37) were registered with a general practitioner outwith the area in which the site was located. Less than one percent (n=1) were not registered with a general practitioner. Five percent (n=8) were of an overseas nationality. Three percent (n=5) did not answer. Fishermen were asked if they had sought advice from another source. Almost three quarters had not. The general practitioner was the most common source of advice (12 percent) and others included other hospitals, district nurses' health centers, first aid responders or skipper on board and radio-medical advice.

PREVIOUS ATTENDANCE AT ACCIDENT AND EMERGENCY DEPARTMENTS

The majority of participants (62 percent, n=102) had never been treated in *any* accident and emergency department. Twenty percent (n=32) had been treated once before, 13 percent (n=21) had been treated between 2 and 3 times. In two percent (n=4) of cases this information was not known and in three percent (n=5) of cases there was a non- response.

OUTCOME OF THE VISIT

The majority of participants (61 percent, n=100) were discharged home after their visit. Eleven percent (n=18) were referred to a general practitioner, 7 percent (n=11) were admitted to a ward on site, 2 percent (n=4) were referred to an outpatient clinic, 2 percent (n=4) were admitted to a ward in another hospital, 2 percent (n=3) were admitted to another hospital's accident and emergency department, 1 percent (n=2) discharged themselves against medical advice, 1 percent (n=2) were deceased, 1 percent (n=2) had a different outcome from their visit. There was an 11 percent (n=18) non-response to this question.

FOLLOW-UP TREATMENT

The majority of fishermen in this study (78 percent, n=128) were advised that they did not require any follow-up treatment and 22 percent (n=36) were advised to seek follow-up treatment.

SEEKING ALTERNATIVE MEDICAL ADVICE- INJURIES AND ILLNESSES FIRST ARISING AT SEA

Seventy-four percent (n=62) of participants with injuries that had first arisen at sea had not sought alternative medical advice prior to attending the accident and emergency department. Twenty-six percent (n=22) had however sought alternative advice (14 percent, n=12) from another source; and 12 percent (n=10) from a general practitioner. Of all fishermen with illnesses that first arose at sea, 57 percent (n=4) had not sought alternative medical advice. Twenty-seven percent (n=2) sought advice from another source, 14 percent (n=1) had sought advice from a general practitioner. In the four cases where the condition could not be identified as either illness or injury, 75 percent (n=3) of participants had not sought alternative advice, and one fisherman had sought advice from an other source and none from a general practitioner. In 73 percent (n=69) of all conditions first arising at sea, fishermen had not sought alternative advice, 16 percent (n=15) sought advice from another source and 12 percent (n=11) from a general practitioner.

Of the injuries and illnesses that first arose on shore, 91 percent (n=38) of participants did not seek alternative advice for injuries, 7 percent (n=3) sought advice for injuries from another source and 2 percent (n=1) sought advice from another source. Of the illnesses that arose on shore 55 (n=6) did not seek alternative advice, 9 percent (n=1) sought advice from another source and 36 percent (n=4) from a local general practitioner. Of the two presenting conditions that could not be determined as injuries or illnesses, one sought advice from another source and one from a local general practitioner. In total, for injuries and illnesses first occurring on shore, 80 percent (n=44) did not seek alternative advice, 9 percent (n=5) sought advice from another source and 11 percent (n=6) sought advice from a local general practitioner.

STATISTICAL RELATIONSHIPS WITH LOCATION (ON SHORE AND AT SEA)

In total there were 95 fishermen presenting symptoms that had arisen whilst they were at sea. Of these, 84 were injuries, 7 were illnesses and in 4 cases could not be determined. Of the conditions that first arose on shore, 42 were injuries and 11 were illnesses, another two presenting symptoms could not be determined as being either injury or illness.

Illnesses were significantly more likely to arise on shore and injuries at sea (Chi-squared, p=0.017). However, there was no statistically significant relationship between injuries and illnesses which first arose on shore and at sea and: the age of the participant; the type of vessel that the participant most often worked on; and the occupation of the participant at sea.

DISCUSSION

LIMITATIONS

There were a number of limitations to this study. The main limitation was the time period. Six months did not allow seasonal variations in attendance to be taken into consideration. Ideally, the study would have been conducted over a 12-month period. Furthermore, data collection was heavily reliant on members of staff completing the forms and under pressure they may not have time to complete the form, or may simply forget to do so. In addition to this, only five of the eight participating departments record occupation, along with other personal patient details. There was the risk that in cases where the accident or illness was not directly work related or did not happen at sea, that the attending member of staff may not be able to identify whether that person was a fisherman. However, the sites where this information was not automatically recorded were small community hospitals with close social networks. Therefore most of the staff knew who the patients were and what they do. These limitations highlight some of the main points for discussion and further work: there are difficulties in accessing reliable data; there is not a uniform method of collecting patient information between treatment centers; occupation is not always recorded; and non-computerized registration systems can hinder data collection.

PREVIOUS RESEARCH

There has been little previous research into health issues affecting fishermen. However, other research conducted in the United Kingdom indicates that injuries are more prevalent than illnesses [Grainger 1992; Reilly 1988; Richardson 1981; Schilling 1971; Moore 1969/1] in this occupation group. This supports the findings of the present study.

The preliminary results of this study highlight a number of key findings: the majority of symptoms presented were injuries; illnesses were statistically more likely to arise on shore and injuries at sea; the body parts most greatly affected by injury were hand, wrist and fingers, followed by head, face and throat; and the most frequent type of injuries presented were lacerations and soft tissue injuries.

SUMMARY

From these findings, a number of recommendations can be made. Firstly, the need to emphasize the importance of first aid at sea for fishermen and the use and knowledge of medicines at sea amongst this occupation group. Secondly, the frequency and nature of injuries occurring at sea should be addressed. These results will contribute to the overall findings of the research program and will be used to inform future health care service provisions and training programs for fishermen who work in the catching sector of the industry.

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