Tuesday, October 24, 2000

SUCCESSFUL INTERVENTION PROGRAMS

Photograph and caption by Earl Dotter

After a net is released, heavy steel doors weighing a ton each are deployed. They open the mouth of the net and keep it to the bottom as the boat trawls forward at about 3 knots. The crewmember says, "When it's flat...calm like this, we'll sure pay for it later."

THE ICELANDIC SHIP REPORTING SYSTEM
ICE-REP

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Captain Snorrason was born in Reykjavik in 1957. He started as an AB seaman in the Icelandic merchant fleet in 1973 and finished the Navigation School in Reykjavik in 1978. CAPT Snorrason served as a deck officer on RO/RO, general cargo and pallet carriers and was promoted to Master in 1984 in Icelandic State Shipping. He joined the National Life-saving Association of Iceland (now Icelandic Association of Search and Rescue (ICE-SAR)) in 1991 as a principal and manager for the Maritime Safety and Survival Training Centre and a master of the training vessel Saebjorg. CAPT Snorrason has been in the Icelandic Maritime Accident Investigation Committee since 1996, member of the Safety Education Committee since 1992 and several committees regarding maritime safety related matters. He has been the Vice-Chairman of the International Association for Safety and Survival Training (IASST) since 1999.

In the early 1960s Icelandic fishermen started to talk about a system they could use for reporting their whereabouts, sailings, and fishing in the matter of search and rescue if something went suddenly wrong and they were not able to send out any distress calls. At that time the fishing fleet consisted mostly of small fishing boats fishing on local banks but also as far as on the Newfoundland banks and banks of Jan Mayen.

Accidents at sea is the biggest factor in any progress to gain more safety as regulations are not an act that government makes unless it is necessary. It was not until 1967 that some government action took place, through the promotion efforts of the National Life-saving Association of Iceland, (NLAI) which had documented the need for ship surveillance systems for many years. Their efforts to effect a national system was aided by public sentiment during a maritime disaster. The Icelandic fishing vessel *Stígandi* sank August 19, 1967, on the fishing banks of Jan Mayen. The crew managed to launch a lifeboat and a life raft, but were not able to send out a distress call. They spent five days in the life rafts and life boats. This is the longest known period that Icelandic seafarers have been in life rafts. The crew told the media after the rescue that during their time in the lifeboats they saw several ships passing by in the fog but no one noticed them as none were looking for persons in distress.

This incident opened the eyes of the public, the government, and the seafarers for the need to establish a safety surveillance system for the fishing fleet. The Parliament put forward legislation establishing the Icelandic Ship Reporting System (ICE-REP) in May 1968 and the NLAI was contracted by the Póstur & Simi (Icelandic telecommunication network) to run and operate the system. ICE-REP has been in the hands of the NLAI ,which now has changed its name to ICE-SAR.

Ever since the requirements for staffing this project called for watch officers with extensive navigation and fishing experience. Newly hired staff were well aware of the behavior of the fishing fleet, through their own experiences.

The idea of this system was to let all vessels report their departure and arrival to port and while at sea to report by grid system their position every morning and evening. This was a manual system but it could be up to 14 hours between reports from a ship. Nevertheless, every ship could send as many reports between the actual reporting period as they thought would be necessary for their safety. The morning reporting period was from 10:00 to 13:30 and the evening period between 20:00 to 22:00. As soon as each period was over a list of missing vessels in reporting their whereabouts was sent to all coastal stations, which called them up. Within a reasonable time if nothing was heard from the vessel a rescue team was alerted.

In 1985, the operation center became the first MRCC station in Iceland with the call sign MRCC-Coastal and 24-hour watch.

The idea of making automatic reporting system for ships was put forward in connection with a project for the Icelandic Air Traffic control system in 1978. That was done by the University of Iceland, which, in cooperation with the National Life-saving Association of Iceland, started trials in 1988. Later on, the University was drawn back from the development of the system and a firm, Stefja, took over their part. Ten ships were used during the trial period, and in 1999 the system was finally ready for operation and vessel transmitters were ready for manufacture. The formal opening of the Automatic ICE-REP was in May 2000.

The system consists of three major parts described below.

NETWORK

The network has sites all around the coast that receive information from ships. Information from vessels is sent by VHF or Inmarsat depending on the position of vessel to coastal stations. Network controllers receive information from coastal stations and forward them to the communication server and on further to the ICE-REP operation center. Information can also be sent to the Internet as can be seen on http://www.tracscape.com/demo/

VESSEL TRANSMITTERS

The transmitter sends constant information about the vessel's position, course and speed. The transmitter is fully automatic and has indication lights that assures the crew the message is being transmitted. An emergency button is also on the transmitter and has to be pressed for five seconds in order to activate. Messages show up on the screen at the ICE-REP station instantly in the event of such emergencies. Vessels using Inmarsat send information twice every 24 hours.

INFORMATION SYSTEM

The systems display messages from ships on screen at the ICE-REP station - MRCC-Coastal. For vessels covered by the automatic ICE-REP system, information is received every 30 seconds, and if no message is received for 15 minutes or more then an alert is given. The message handler is the most vital part of this system. He or she reports to the officer on watch if a vessel is missing or sending distress call. The message is categorized by the vessel position, which means that the vessel not responding to the system but known to be in port is a minor alert, while those believed to be at sea comprise red alerts. Every Icelandic vessel is listed in the ICE-SAR information system with information of owner, operator and master including phone numbers, which gives the officer on watch the instant ability to contact needed personnel regarding the missed reports from the vessel.

ICE-SAR is now fully automatic and all ships 24 m and shorter are required to be equipped with ICE-REP transmitters, excluding pleasure craft. All ships longer than 24 m use INMARSAT for ICE-REP every 12 hours. By the end of August 2000, 1400 vessels were equipped with transmitters for ICE-REP and by the end of 2000, a total of 2700 vessels are expected to have transmitters sending their whereabouts to the system.

Photograph and caption by Earl Dotter

The crew of a sea urchin dragger unload their totes of urchins at the breakwater in Eastport, Maine, U.S.A. at low tide. The tides average 18 feet from high to low, a rate of over one inch a minute.

WORK PRACTICES, ENTANGLEMENT OF LOBSTERMEN, AND ENTANGLEMENT PREVENTION DEVICES IN THE MAINE LOBSTER FISHERY: A PRELIMINARY SURVEY

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BACKGROUND

Commercial fishing has been recognized as a hazardous occupation for centuries. Sir Walter Scott wrote in *The Antiquary* (1816), "It's no fish ye're buying, it's men's lives."[1] The working conditions for commercial fishermen are very hazardous and factors associated with commercial fishing deaths are complex. Gear type, fatigue, and environmental conditions contribute to the severity and frequency of these incidents.

By the mid-1980s, hazards in the commercial fishing industry captured the attention of Congress, which enacted the Commercial Fishing Industry Vessel Safety Act of 1988. During 1990-1995, the CFIVSA required fishing vessels to begin carrying specific safety and survival equipment and required certain crewmembers to have training in first aid and how to conduct emergency drills on fishing boats. However, deck safety was not addressed by these regulations.

According to data from the 1997 Census of Fatal Occupational Injuries (CFOI) published by the Bureau of Labor Statistics, the fishing industry ranked second to the logging industry for the highest occupational fatality rate. That year, timber cutters sustained 128.7 fatalities per 100,000 full time workers; the fishing industry sustained 123.4 fatalities per 100,000 full time fishermen.[2] With the 1997 United States national average for all industries at 4.8 fatalities per 100,000 full time workers[3] the fishing industry is on the order of 25 times more hazardous than all occupations combined.

In Maine, from 1993-1997, the average number of lobster licenses of all classes issued annually by the Department of Marine Resources was 5681.[4] The occupational fatality rate for lobstermen was 14 per 100,000 licensed lobstermen,[5] more than 2.5 times the national average for all industries (4.8 per 100,000) (Note the comparison is between licensed lobstermen both full and part time and full time workers. The figures for lobstermen are not normalized to full time lobstermen. Therefore, the actual rates would likely be higher.) From 1993-1999, seven lobstermen drowned after falling overboard.[6] Conditions on the boats suggested that trap rope entanglement was a likely cause.[7] Anecdotal reports indicate that the prevalence of the entanglement of lobstermen in trap rope is high. When they become entangled in trap rope, they can be pulled into the water and often are not able to free themselves from the rope.

Lobsters are fished by placing a baited, rectangular mesh trap (size: 0.5 m by 0.5 m by 1.0 m, and weighing 2-4 kg) on the sea bottom (5-20 meters deep) connected to a surface buoy by a rope, "trap rope". One to ten traps may be connected to the same rope. Traps are periodically (every one to three days) pulled up into a boat using a winch (pot hauler), the trapped lobsters are removed, and the trap is cleaned of debris and re-baited.

There are four basic activities associated with lobstering:

- Buoy pick-up - the buoy is gaffed, and the trap rope is placed in the pot-hauler (winch);
- Freeing snarls - gear caught on another set of traps is untangled;
- Setting gear - lobster traps are baited and thrown overboard; and,
- Shifting gear - a large number of lobster traps are hauled-up and transported to another fishing ground.

This study was undertaken to gather data on the prevalence of personal entanglement in trap rope, to understand the work practices associated with entanglement, and to learn from fishermen what work practices and engineering controls would 1) reduce the risk of entanglement, 2) help lobstermen escape from an entanglement, and 3) facilitate re-boarding in the event that a lobsterman was pulled overboard from an entanglement.

METHODS

An interview guide for this cross-sectional study was developed and piloted with lobstermen. The guide consisted of eight sections: background information, description of lobstering practice, description of vessel, entanglement likelihood and circumstances, interventions, other devices, personal entanglement accident history, and communications.

Five people were trained to use the interview guide and 103 lobstermen were interviewed at the wharves, in coffee shops, lobster co-ops, storage cabins, and hardware stores. Often this meant arriving at a coffee shop at 5:15 AM to talk with lobstermen before they headed out at daybreak. At other times, the interviews were conducted when the lobstermen were unloading at the wharves at the end of a fishing day. The interviews took place from October 1999 through September 2000. The interviewers obtained consent before proceeding with the interview; some lobstermen declined the interview but none terminated the interview midstream in spite of having been given the option. In most cases, the lobstermen were interviewed privately. Interviewers did not collect any information that could be used to identify participants. The data were entered into spreadsheet software.

RESULTS

Of the 103 lobstermen interviewed only one was female; 93 were captains and 10 were sternmen. Fifty-two percent reported "always" fishing with a sternman, while 25% reported "sometimes" and 22% reported "never" fishing with a sternman.

Of the 103 lobstermen interviewed, 75 (73%) answered "yes" to the question, "Have you even been caught in trap rope where you lost clothing, were pulled to the stern, or pulled overboard." Forty-five (44%) of the 103 lobstermen reported a total of 90 entanglements within the last five years.

Eighty-one percent of the lobstermen interviewed said that entanglement was either "likely" or "very likely" to happen when setting gear. Sixty-eight percent said entanglement was either "likely" or "very likely" while shifting gear. Freeing snarls and picking-up the buoy were described as "not likely" to be settings for an entanglement by 67% and 94%, respectively. (See Figure 1.)

Table 1. Number of lobstermen entanglement events in the last five years.

Number of events	Number reporting	Total events
1	20	20
2	14	28
3	7	21
4	2	8
5	1	5
8	1	8
TOTALS	45	90

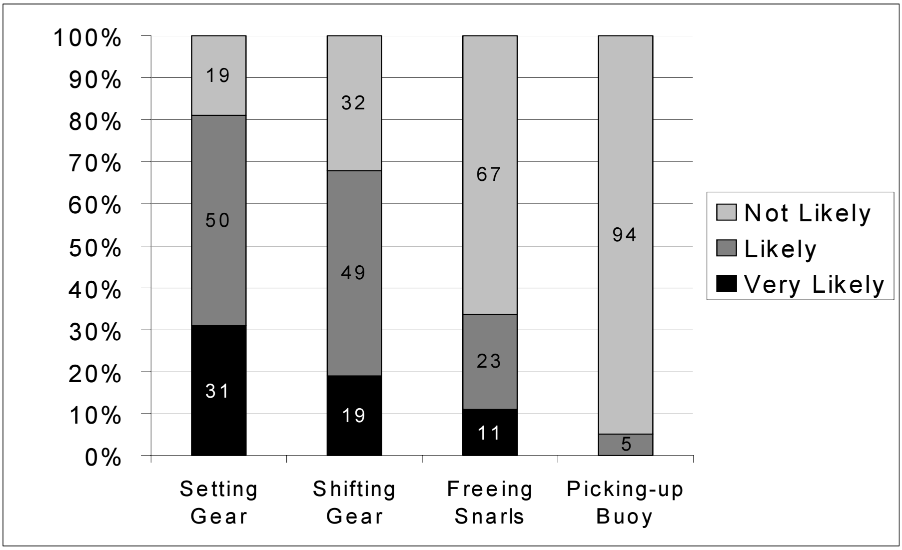

Figure 1: Likelihood of entanglement for each of the four lobstering activities.

Rope often accumulates at the feet of the lobsterman as he is setting traps. When he is ready to set the traps he pushes the first trap overboard and the remainder follow, with the rope paying out over the side or transom of the boat at considerable speed. The setting gear activity is generally more dangerous if the captain (as is the practice) has placed the boat in forward gear.

Interventions suggested by lobstermen that might reduce and presumably prevent entanglement included both work practices and engineering controls, the two categories of interventions typically found in industrial settings. Regarding their work practices, lobstermen mentioned "working slowly", paying close attention, knowing where the rope was at all times, using "common sense," keeping hands and feet away from rope as much as possible, and positioning people carefully during setting and shifting activities.

Table 2 shows the responses given when lobstermen were asked to determine whether eight engineering interventions we listed would be "not useful," "useful," or "very useful" in preventing entanglements or aiding in self-rescue from an entanglement.

Table 2. Percent of respondents specifying perceived usefulness of engineering controls to reduce entanglement risk

Intervention	Not Useful	Useful	Very Useful	Useful or Very Useful
Nonskid mats	5	53	42	95
Washrail above knee	5	38	57	95
High traction deck	15	58	27	85
Rope locker/bin	31	39	31	69
Bucket/pipe as fairlead	49	39	13	51
Temporary abrasive (salt)	61	33	6	39
Safety shut off cord for engine	65	26	9	35
Sensor mat for shutting off engine	70	27	3	30

As shown, lobstermen were clear and largely in agreement that non-skid mats, a washrail above the knee, a high-traction deck surface, and either a rope locker or a rope bin are engineering controls that would be useful in reducing the risk of entanglement.

When asked to make a choice among eight means of escaping from an entanglement, 95% of those interviewed said having a sternman would offer the best hope of escape. The second, third, and fourth choices were wearing a knife (25%), having a knife mounted in the stern (18%), and having a gag line (remote engine shut-off) (15%).

When asked to choose among four means of surviving an overboard incident and being able to re-board the boat, 98% ranked having a sternman as their top choice. Loose clothing (77%), a rope ladder or scuppers for footholds (76%), and a life jacket (60%) were ranked second, third, and fourth.

DISCUSSION

With 73% of the respondents reporting that they had experienced a serious entanglement in trap rope at some time in their fishing career, it is evident that this type of entanglement is common in the lobster fishery. When asked to explain the circumstances, lobstermen reported a variety of circumstances leading to entanglement. One lobsterman fishing alone had the trap rope wrapped around his left wrist and was pulled into the water. He was able to cut the rope, but had no flotation device and only because another lobsterman saw his aimlessly circling boat was he rescued from the water 45 minutes later. He fortunately survived without major injury. One lobsterman told of hailing a passing boat while lying prone on the deck of his boat. Others were fortunate enough to have had a sternman or a knife, or the strength to hold on to the wheel long enough to take the boat out of gear.

This study delineated four major components in the strategy to prevent entanglement and facilitate recovery from the event: 1.) control the environment including the ropes, 2.) stop the force including cutting the engine, 3.) rescue by untangling or cutting the rope, and 4.) re-enter the vessel if pulled overboard.

Rope control can be achieved through "engineering controls" such as installing an under-rail rope bin or an under-deck rope locker or by using a fairlead. Suggestions from lobstermen regarding work practices that can help reduce the risk of entanglement include "work slow," use "common sense," know where the rope is, keep hands and feet away from the rope, and choose positions on deck that reduce contact with rope. Another work practice promoted by some lobstermen was to set traps while drifting rather than while in forward gear.

More than two-thirds of the lobstermen indicated that a rope locker or rope bin would reduce the risk of entanglement. However, during this study, the interviewers only found two lobster boats with these devices. A rope locker (see Photo 1) is a water-tight compartment built under the flooring with openings under the pot-hauler and along the rail so that rope coming off the pot-hauler will drop into the compartment under where the lobsterman stands and will be completely out of his/her way. These lockers are particularly useful for lobstermen who fish ten trap trawls (ten traps on a length of rope between two lobster buoys) because these trawls involve the use of much more rope than fishing a single or double (pair of traps) per set.

Photo by Ann Backus

Photo One: Rope locker (deck platform open) shows rope collecting under the deck away from the fisherman's feet.

Nonskid mats reduce the chance of slipping into the rope pile and increase the chance of retaining or regaining balance when caught in the rope. The deck surface tends not only to become wet, but also slimy when seaweed and algae arrive on board with the rope and traps. For similar reasons, a high traction deck surface is useful. Some lobstermen improve the traction on their entire deck surface by having their decks painted with an abrasive-containing paint. Nonskid mats are often used along with high-traction deck paint.

The rope bin is a simple hinged door device that allows the rope to fall into a compartment under the washrail, but above the deck. The door, as simple as a plywood panel hinged along the deck-side edge, keeps the rope away from the feet of the lobsterman.

A fairlead in the form of a bucket or pipe, set on or mounted through the washrail, was deemed "useful" or "very useful" by 51% of those interviewed.

Illustration by Mediastream.

Figure 3. Rope bin made of plywood with a piano hinge that allows it to drop open and accept trap rope from the pot hauler.

This device controls the rope by guiding it back into the water before it has a chance to run to the stern, and thereby reduces the floor space occupied by rope to a small corner near the pot-hauler. The fairleads in use were in some cases buckets filled with water, and in others were an iron or PVC pipe, or a spaghetti-like bundle of fiberglass rods mounted through the washrail. This last invention had the benefit of being flexible in the event that a person was thrown against it during a sudden shifting of the boat or an entanglement accident.

The importance of the washrail height as a means to reduce entanglement and especially lessen the potential of being pulled over board is well-understood by lobstermen. Ninety-five percent said that a washrail (washboard) above the knee was "useful" or "very useful" in reducing the risk of entanglement. While hauling and setting, lobstermen tend to lean on the washrail. A rail that is high, i.e., above the knee and almost at mid-thigh, provides significantly more support against the loss of balance and provides a better barrier to being pulled overboard.

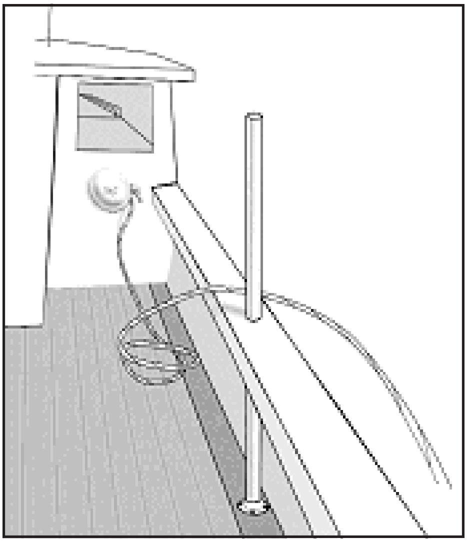

Illustration by Mediastream.

Figure 4. A fairlead made of a steel pipe or a collection of fiberglass rods mounted into the deck that "leads" rope out of the boat and minimizes the area where rope could be a hazard.

Once entangled, either a lobsterman loses a glove or boot, has to struggle to loosen the rope, or has to cut himself free. If there is a second person on board, the situation can usually be resolved quickly; if not, wearing a dive knife in an accessible location, preferably secured upside down on suspenders, is extremely important. A dive knife is made of 100% stainless steel and should have a hard molded sheath that clips the knife in for safety. Of the lobstermen interviewed, 25% answered that wearing a knife was their top choice for escaping from entanglement; 18% thought taping a knife at the stern would be their preference. In actuality, having knives both on person and taped to the transom would provide the best opportunities to escape.

Ability to cut free of the rope is dependent on the access to a very sharp knife, not one that has rusted in its holster on suspenders, or in its leather holder at the stern. Some lobstermen issue new knives after each heavy use; some have a small jack knife in their pants pocket which, even if reachable in an emergency, could not be opened with one hand if the other hand were caught in rope. The suggested placement of a knife is handle down on suspenders such that it is reachable by either hand in one stroke.

Rick Kelly

Photo 2. Wearing a dive knife in an accessible location, preferably secured upside down on suspenders, is extremely important.

Cutting the engine can be done by a competent sternman, but without the presence of a second competent person onboard, an engine gag line or kill switch is essential to get free from an entanglement.

Although only 35% of the lobstermen noted that a safety cord or gag line/kill switch that would provide remote engine shut off would be useful in reducing the risk of entanglement, a means of shutting off the engine is critical to surviving many entanglement accidents. Many lobstermen either don't think it would come to needing to shut down the engine remotely because the sternman would be available to manage the helm, or they think such a device would be a nuisance at non-critical times. For lobstermen fishing alone, it may be the only lifeline in a serious situation. A gag line run under the washrail and across the stern, reachable from two sides of the boat, would in fact be out of the way of normal operations but available to pull-on in the event the lobsterman were pulled to the deck or caught at the transom. Given that most lobstermen set their traps while in forward gear, a means to stop the engine is the only way to gain slack in the rope. The traps are fast sinking and their weight creates a force on the rope that is too great for the average lobsterman to overcome unless he can cut the rope. [8]

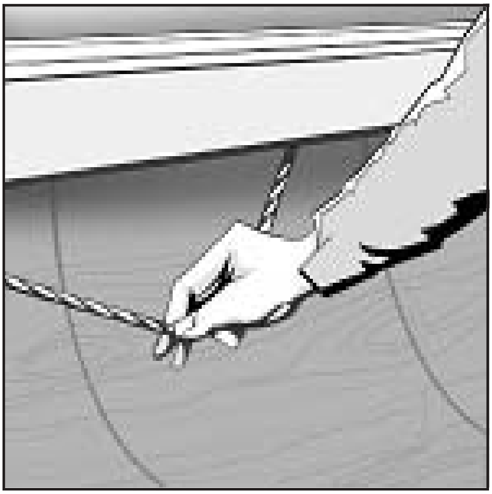

Illustration by Mediastream

Figure 5. Gag line or kill switch for remote engine shut-off.

Captains have the option of taking a sternman with them, and they do so for various reasons. Probably the most frequent reasons given are productivity and efficiency. Many captains would also cite the safety benefit of having an additional person on board. Choosing to fish with a sternman has significant positive safety implications. It reduces considerably the risk of a fatal injury because a second person is available to help. However, the risk is not negligible because some sternmen lack knowledge about the throttle and gears of a boat and could make a mistake that had a fatal outcome if he/she throttled up or didn't take the boat out of forward gear, for example. Although this survey did not contain questions regarding how well sternmen knew the boat and would be able to respond in an emergency, sternmen should be prepared to step to the helm.

In addition, the interviews associated with this study revealed that few lobstermen wear life jackets, inflatable vests, or suspenders. Thus, staying afloat in the water for a length of time is problematic. Observation of lobster boats shows clearly that few boats have fittings that would enable a lobsterman to re-board if thrown overboard. Some boats have steps, knotted ropes, or rope ladders and some have scuppers that are large enough for the toe of a boot, but generally the hand and foot holds on these boats are noticeably absent. It would be simple for lobstermen to make rope ladders to hang off the non-working side, to install a ladder or steps, or to install scuppers that are large enough to serve as footholds and mount handles for easy re-boarding.

CONCLUSIONS

Personal entanglement in trap rope is an experience most lobstermen have had. Setting gear and shifting gear are the lobstering activities that are most likely to result in entanglement. Only a few lobstermen, however, have a planned strategy for reducing the risk of entanglement. The four components any strategy needs are to be able to 1.) control the environment, including the ropes, 2.) stop the pulling force, including cutting the engine, 3.) rescue oneself by untangling or cutting the rope, and 4.) re-enter the vessel if pulled overboard. Careful, intentional work practices, combined with a variety of engineering controls including nonskid mats, high washrails, and rope lockers or bins may reduce the risk of being caught in rope. A remote engine shut-off, strategically placed knives, personal flotation devices, and a means of re-boarding the boat are all approaches that may improve the chances for surviving an entanglement. Additionally, having two people on the boat, each with a thorough knowledge of the operations of the boat, could also improve the ability to survive an entanglement.

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FOOTNOTES

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DEVELOPING THE FOUNDATION FOR AN INTERDISCIPLINARY APPROACH TO IMPROVING FISHING VESSEL SAFETY

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Dr. Johnson taught courses and has done research in many fields including fluid mechanics, hydrodynamics, naval architecture, ocean wave mechanics, and engineering economic analysis. He is the co-author with Prof. Thomas Gillmer of Introduction to Naval Architecture, published by the U.S. Naval Institute, and the co-author with Donald Newnan of Engineering Economic Analysis (5th Edition).

PURPOSE

The purpose of this paper is to report on the initial results of an interdisciplinary program concerned with identifying fishing boat design parameters related to commercial fishing safety and health. The paper will address (1) improving vessel stability and hull integrity, (2) hazards associated with small fishing vessels and (3) relationship between fishery management and safety including better ways to communicate the importance of following stability guidelines. The goal is to improve survivability for fishermen, and profitability for vessel owners.

METHOD

We used an extensive literature search on fishing vessel regulations and documented capsizing events, interviewed owners and captains (including two co-authors), studied various fishing vessel classes and identified hazardous operational procedures.

RESULTS

The paper addresses ways to improve existing and new fishing boat designs with special emphasis on those vessel classes known to have safety problems. We discuss various areas of concern that have had an impact on vessel safety. These areas include: creating and maintaining a watertight envelope including the deckhouse and holds; suggestions on developing an integrated set of intact and damaged stability criteria for fishing vessels of all sizes; methods for more effectively communicating to the crews the safe loading conditions for their vessels; and an improved format for the stability letter. The paper also outlines various conflicts between fishery management practices and vessel safety.

FUTURE WORK

The long-range goal is to create a fishing vessel research program to develop a new set of scalable non-dimensional parameters for designing and building safer fishing vessels.

INTRODUCTION

The IMO voluntary fishing boat safety regulations for vessels under 79 feet (24 m) in length are based on one-size-fits-all criteria derived from computer generated static stability righting-arm curves. The current version is known as the 1993 Torremolinos Protocol and can be found on the IMO web site. [For technical and historical details on its development see USCG NVIC 5-86 (1986), Bird (1986), Cleary (1993), USCG 'Living to Fish, Dying to Fish' (1999), Dyer (2000) and Kobylinski (1994 and 2000)].

The Torremolinos Protocol has been criticized: (1) for lacking "rational criteria" [Kobylinski 1994 and 2000, Umeda 1994, Dahle 1995]; and (2) for promoting capsize resistance at the expense of operational safety conditions on board [Boccadamo 1994 , 2000, Umeda 1999, 2000]. Requiring a relatively large transverse metacentric height (GM_T) to handle various loading conditions frequently causes rapid rolling during fishing operations since the undamped roll period varies inversely with the square root of GM_T [Gillmer 1982]. This in turn increases the frequency of Motion Induced Interruptions (MII) [Boccadamo 2000] which can cause serious injuries to crew members working on deck. Fishermen attempt to compensate for snappy rolling motions by using roll dampening devices such as paravanes, rolling chocks, anti-roll flume tanks, and other similar devices that only change the stability problems a fisherman faces [Bass 1994, 1998, Helmore 2000].

LESSONS LEARNED: STABILITY LETTERS

Implementation of the Torremolinos Protocol generally involves producing a "stability letter" for each fishing vessel, which seems to be of greater interest to insurance companies than to the fishermen themselves. To most captains, the determination of a vessel's stability letter is a lot of black magic by the naval architect/surveyor. After moving some weights on the deck (the only part the crew sees), the naval architect mysteriously determines how large a catch a boat can safely carry. Problems occur when some stability requirements run counter to a captain's "feel" or traditional beliefs on how a vessel should be loaded. For example, some captains prefer to fill ballast tanks under fish holds to stiffen a vessel's ride. While this increases the vessel's initial stability, it may give a false sense of security to the captain and crew because the vessel's freeboard and downflooding angle have been significantly diminished. Crew members will likely not realized this dangerous situation because all they can "feel" onboard is the initial stability. Only complex mathematical calculations or model experiments can show the dangerous effect on overall stability at large angles of heel. This same false and dangerous sense of security occurs with the use of paravanes (flopper stoppers). Paravanes are roll-reducing devices suspended from long outriggers off the vessel's sides. These outriggers, which are longer than the vessel's beam, are lowered to a position just above horizontal when in use. The stability problems they create are twofold. First, by reducing the vessel's rolling motion, the paravanes create a misleading increase in the vessel's stability as felt by the crew, i.e. the vessel appears "stiffer". And secondly, when seas roughen the outriggers can roll into the waves causing the vessel to veer off course (tripping). Unfortunately, the outriggers should not be stowed in the vertical position because that action would raise the vessel's center of gravity, and further reduce the vessel's overall stability at the very time when the vessel needs maximum stability to survive the storm.

An additional problem with crew members understanding of stability is the fact that the stability standards are intended to protect the vessel and its crew in major storms but not necessarily to survive a direct hit by extreme waves, as in the movie *The Perfect Storm*. The rules don't seem to apply to normal weather operations, which can create the false impression that the vessel's stability letter is overly conservative and the vessel can actually carry more cargo. For example, during a fair weather trip, the captain hits the jackpot and fills the hold. The fishing is still good, bills are due, the weather fair, and the vessel feels "safe", so understandably they continue to fish. They do this several times and then start to doubt the catch limits imposed by the stability letter. If their luck changes on a given trip and the weather storms up before they can return to port, the vessel may lack sufficient stability characteristics to survive [USCG 1999].

LESSONS LEARNED: COMMUNICATING FISHING VESSEL STABILITY CONCEPTS TO CREWS

To resolve these conflicts, a simple method of directly showing a captain and crew the effects of such things as cargo loading, tank loading, and use of paravanes (deployed vs. retracted) needs to be developed. Existing booklets and stability trainers have significant negatives that inhibit effective training use in many situations. For example, the USCG's Fishing Vessel Stability Trainer is a sizable, cumbersome unit that requires a trailer for transport and a large tank of water. It is demonstrated primarily at USCG stations, meetings, trade shows and the like. Because it is a generic model of a specific type of fishing vessel (northwest seiner), two additional negatives are present. First, the effect of an individual stability characteristic cannot be easily explored. Second, because the trainer's arrangements may be significantly different than the captain's vessel, the captain and crew will likely believe the demonstration does not apply to their situation.

The training device envisioned by this research is a series of relatively inexpensive, simple 3-D interactive models that captains and crews can literally play with, to visually see the effects of their loading actions on the model's stability. The models (Figures1-3) would be short watertight sections of typical hull forms set in a clear tank that allows the models to heel freely. Hull sections would include fish holds and side and belly tanks. By filling tanks or placing increasing amounts of weights on different models, the effects of deck loading, adding weights high, or free surface in tanks/holds, can be demonstrated for different classes of fishing vessels. And by using side-by-side models, the negative stability effects can be visually demonstrated in a dramatic manner when the training model with the stability defect takes water on deck or capsizes quickly.

Because of the model's simplicity, the participants can perform the tests themselves, thus intuitively learning stability without tedious lectures and theory. It must be remembered, the point of this training activity is not to teach crews how to calculate stability. It is to allow the crews to explore various aspects of stability intuitively, especially those that occur at the severe heel angles the

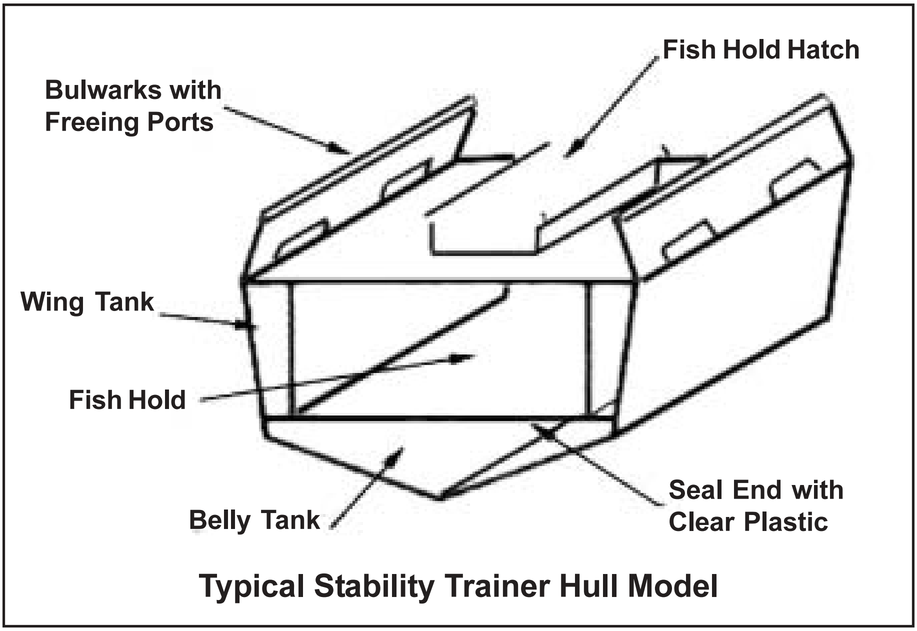

Figure 1: Base model section shown. Additional features such as fish hold pen boards, tank and void vents, outriggers with paravanes, and net reels will be added to individual sets of models to illustrate specific stablity characteristics.

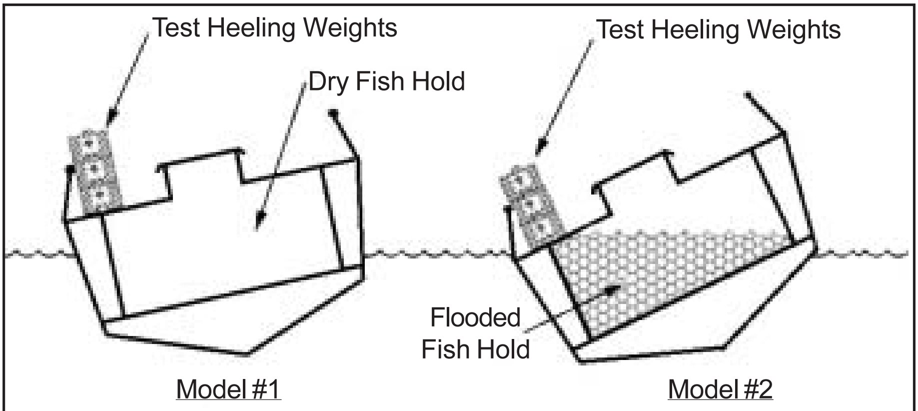

Figure 2: A set of two models are used to illustrate the effect of free surface from partiallly flooed fish hold on stability. Test heeling weights are added one at a time to show each model's relative level of stability. The training model with the stability defect, in this example model 2, will capsize well before the other model.

crews do not regularly experience onboard. This will allow crewmembers to better respect the stability information provided by the naval architect, and to understand the ramifications of their actions on their vessel's stability. The proposed training model achieves this goal by being inexpensive to build, easy to transport, and by its interactive nature effective in demonstrating the mystery of stability. In fact, small versions could be taken dockside for individual training and larger versions can be used at meetings such as fishery mananagment councils.

LESSONS LEARNED: VESSEL OPERATIONS

The next lesson learned deals with another aspect of vessel operations. With the many years of design and operational experience in the U.S. fishing fleet, there exists a vast knowledge of practical tips and areas of concern in vessel design and operation. However, because of the nature of the industry, this information is not readily shared. Current methods such as USCG NIVCs do

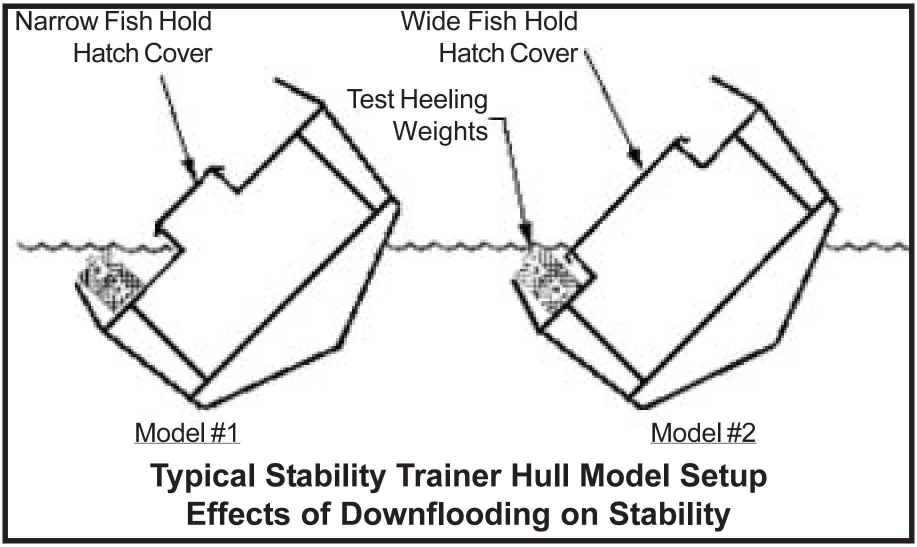

Figure 3: Set of two models are used to illustrate the effect of downflooding from fish hold hatches on stability. Test heeling weights are added one at a time to demonstrate the model's relative level of stability. The training model with the stability effect, in this case model 2, will capsize well before the other one.

not allow for a wide enough a distribution of information and concepts in language understandable to all parties in the fishing fleet. The USCG recently developed booklet, *Best Practices Guide to Vessel Stability*, while written in terms more understandable to the fishermen, uses stability illustrations more akin to a kid's cartoon character. These illustrations with unrealistic hull forms simply erode a crew's ability to believe the lessons given in the booklet. (The USCG has agreed to update this booklet with more realistic illustrations.)

The most important lesson learned is "Keeping the water out"; i.e. creating and maintaining the vessel's watertight envelope and adequate reserve buoyancy. The sea has proven to be merciless and will find a vessel's weak point. Past history has shown the following general areas of major concern: watertight hatches, windows, and doors; rudder and propeller stuffing boxes; sea-cocks and sea connections; ventilation and tank vents; and vessel freeboard and arrangements. The failure modes of these areas are of two types; catastrophic sudden failure and slow progressive flooding.

Slow progressive flooding is generally caused by a small, unnoticed break in the vessel's watertight envelope such as a worn rudder packing gland, cracking in a sea connection, or improperly designed or sealed watertight hatches. Items such as the rudder or shaft packing glands and sea connections are generally located in unmanned compartments or under deck plates in the bilges, making inspection and maintenance difficult and easily forgotten. The watertight hatches, while usually easily inspected, have large sealing surfaces prone to damage when in the open position. Bilge alarms have been installed in some instances to warn the crew of impending flooding, but they suffer the same inspection and maintenance problems because they too are located in hard-to-reach bilge locations [Dyer 2000].

As an example, the Atlantic coast surf clam and ocean quahog fishery lands large volumes of raw shell stock which dictate large fish holds, easily as much as 50 percent of a vessel's hull volume. Because the vessels load the heavy shell stock directly into large containers (cages) that cannot be readily moved by the ship's crew when fully loaded, the top of the fish holds must be able to be completely opened during clamming operations. The majority of the hatch covers currently used cannot be dogged watertight or even held closed and are considered little more than a sun cover by the fishermen [USCG 1999].

The greatest danger arises when vessels return to port fully loaded and have minimal aft freeboard. The hatch covers gradually leak water into the holds, which results in a progressive degradation of the vessel's stability. Because this occurs over a long period of time, it is likely to be undetected by a crew that is tired after a fishing trip or distracted by other problems. Generally, in past sinkings, by the time the crew does realize there is a problem, the vessel's stability has been reduced to the point of being ready to capsize on any boarding wave. The crew, if lucky, only has time to radio a quick mayday and hastily abandon ship [USCG 1999, Dyer 2000]. This situation is another area in which the envisioned stability-training model can be used to impress upon the crew the real dangers of this situation and the need to quickly discover and rectify the flooding problem.

Catastrophic flooding is just as serious, if not more so, than slow flooding [Dyer 2000]. In catastrophic flooding, crew members will very likely have little time to react either to save the ship or themselves. Such flooding generally occurs through the sudden failure of large hatches or the breakage of pilothouse windows under heavy seas. Of all areas onboard a fishing vessel, pilothouse windows are generally the weakest portion in the vessel's watertight envelope. Because they protect the main control station of the vessel, they are also the most important part of the watertight envelope. Loss of the pilothouse windows endangers a vessel's survivability by destroying its stability and restricting the crew's ability to control the vessel and make emergency communications.

One recommendation is to focus on turning fishing vessel pilothouse design from a liability to a stability asset. By the inherent location of a fishing vessel's pilothouse, its enclosed volume can generate a very large righting force at the time of the last chance to save the boat in a capsizing situation. For example, on the USCG's new 47-foot rescue surfboat, the design of the pilot house actually creates a greater righting moment when the vessel is upside down than when floating upright. While this is an extreme example, to integrate this concept into current fishing vessel design would not be costly. The major changes required would be simply upgrading the windows and doors while providing provisions for escape when capsized, and performing some additional stability calculations to obtain credit for the additional reserve buoyancy.

The last lesson learned in "Keeping the Water Out" is in the crew's access to the vessel's internal compartments and bilge systems. Vessel arrangements must allow a crew access throughout the vessel in bad weather to allow the crew to respond to flooding. For example, again we will look at a type of vessel arrangement prevalent in the Atlantic coast surf clam and ocean quahog fishery. Many of these vessels are converted from gulf shrimpers by modifying the fish hold and adding a large pump and engine in the lazarette. This pump primarily supplies high-pressure water to the harvesting dredge, but is also used to flood and pump dry the fish holds. The problem occurs when flooding through the non-tight fish hold hatches discussed above occurs in rough seas. The only access to the fish hold pump is outside across the deck and through a relatively exposed hatchway. Several vessels have been lost when the crew could not access the critical pumps because by the time the problem was discovered, the seas boarding the vessel prevented access aft across the deck [USCG 1999].

LESSONS LEARNED: FISHERIES MANAGEMENT

All parties involved in the fisheries management process must address the potentially negative impact on vessel safety caused by fishing regulations. Unfortunately, with many management schemes in place today, this has not happened. For example, in derby style management with its fixed short openings, the fisherman must go to sea in spite of the weather or the vessel's condition. They simply cannot afford to miss days at sea (lost income) that cannot be made up later. Even with the best boats available, when the weather is bad, vessels simply should not leave the dock. To do so is an unnecessary risk to the crew's safety.

FUTURE WORK

The long range goal is to create a fishing vessel research program to develop a new set of scalable non-dimensional parameters for designing and building safer fishing vessels [Blume 1993, Boccadamo 1994, Buckley 1994]. In order to experimentally determine fishing vessel design parameters that improve survivability in a severe seaway, a new "free-to-broach" towing rig will be developed for the Naval Academy towing tanks. This rig will allow models of a series of existing and proposed new fishing boat designs to be investigated for capsizing resistance while towed under computer control to a region of the tank where computer-generated irregular waves are combined with deterministic steep waves produced by wave energy concentration [Duncan 1987, Takaishi 1994, Buckley 1994, Kriebel 2000]. This technique avoids using radio-controlled models which are difficult to position in capsizing wave conditions, as the book *Lost at Sea: An American Tragedy* [Dillon 1998] discusses. This technique should also be useful for validating attempts to mathematically model the surf-riding phenomenon [Vassalos 1994]. Towing models in quartering seas with and without paravanes extended should shed light on the dynamic stability characteristics of several classes of fishing boats, improving on the zero-speed beam-sea capsize testing previously done at the Naval Academy on sailing yachts [Zseleczky 1988] and the USCG 44-ft and 47-ft Motor Life Boats.

It is expected that the effects of variations in length, beam, draft, freeboard, sheer line, bulwark and deckhouse arrangements, and loading conditions can be correlated with a new set of design parameters for increasing fishing boat safety in a variety of situations [Boccadamo 1994].

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Photograph and caption by Earl Dotter

The four to five-hour “haul back” cycle goes night and day. After preparing the fish and storing it in the fish hold, there’s about an hour and a half to two hours down time before the cycle begins again.

SAFETY MANAGEMENT ON BOARD ICELANDIC FISHING VESSELS

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The number of accidents on board Icelandic ships and boats during the period 1984 through 1997 shows that that accidents vary from about 400 per year to about 630 per year. It is fair to say that annually one out of every ten Icelandic seamen at work becomes the victim of an accident.

The number of work-related accidents and other accidents decreases very slowly in Iceland. Research indicates that by far most of the events occur as a result of human error, and the result of the adoption of new technology is frequently a new wave of accidents. This is why there exists a great need for carefully planned internal control in respect of the seamen's safety measures and a need for greatly increased education among seamen on injury prevention measures and safety.

Every year the society's costs from accidents at sea amount to millions of Icelandic crowns. A reduction in the number of accidents is, of course, a matter of great interest, not only to the seamen and their immediate families, but also to the fishing companies and the whole Icelandic population, which shoulders a vast part of the high costs resulting from these events.

This decade has seen great efforts in terms of the collection and registration of data on accidents at sea, their number, causes and consequences. But, more needs to be done. If we want to decrease the number of accidents at sea it is more essential than ever to make good use of such data.

The Icelandic Association for Search and Rescue (ICE-SAR) has proposed the use of a coordinated safety control system on board the Icelandic fishing vessels in order to decrease the number of accidents. We have introduced this concept to the national authorities. Together with ICE-SAR, the organizations of fishing vessel owners and seamen have sent a resolution to the authorities to the effect that they are prepared to cooperate with the authorities on the establishment of a safety control system. Additionally, ICE-SAR has obtained cooperation with the Marine Research Institute of the University of Iceland in formulating such a safety system for seamen. The concept has been well received by everyone. The Ministry of Transport and the National Research Council have agreed to provide financial support for the project.

The objective of the safety system is to set up a certain arrangement regarding security procedures and strategies on board the fishing vessels and boats. This system is intended to meet all provisions of Icelandic laws and regulations pertaining to the safety of seamen, as well as meeting international standards, which the Icelandic authorities have acknowledged. The system is to be based on international safety systems and to increase the internal safety control of the crews and the fishing companies. This is to be a coordinated system with all the same principal rules of procedure applying on board all ships and boats in respect of responsibilities and the division of duties. This facilitates the seamen knowing that even though they change ships, the same safety system applies to it as the previous one. The safety system is to contain descriptions of the procedures of all the main work factors on board every ship and boat, and it will ensure regular and well-organized education and registration within the framework of the safety control measures. The system is also to entail confirmation of the safety rules being honored and that improvements are made when needed. The system will be tried onboard 10-20 ships and boats of different sizes and make. The main objective is, of course, to make seamanship safer and to prevent injuries to the men and damage to property.

This year and last year, a young university student, Ingimundur Valgeirsson, who is studying civil engineering at the University of Iceland, has worked on this project on behalf of ICE-SAR and the University's Marine Research Institute. His Master's thesis will be on safety control systems for seamen. Valgeirsson has collaborated with the crews and owners of a large modern freezer trawler, on the one hand, and a smaller line vessel, on the other hand. Three more vessels have already entered into this cooperation for research purposes.

A decision was made from the very beginning to carry out hazard analysis according to Hazard Analysis Critical Control Points (HACCAP). HACCAP is used for monitoring the quality, hygiene and health of the fish products on board ships; hence the seamen are quite familiar with the system. The seamen write descriptions of all work factors on board, including when a vessel leaves port, procedures during its voyage, during the fishing, which in turn, includes trawl, net, seine and line fishing, fish processing, the arrangement of the catch on board, work in the hold, arrival in port, loading and unloading, etc. A joint assessment is then made of the control points, control frequency and the desirable guidelines.

A detailed study will be made of the high-risk accident points on board the ships. A registration of all work procedures in co-operation with trained researchers and experienced seamen should reveal which points, work procedures and circumstances are hazardous. Accident statistics will also be used in this respect. In addition to finding the hazardous locations on board, other conditions must be studied, including the effects of weather, light, freezing, etc., the objective being to reduce the risk of accidents. A study must also be made of the effects of fatigue, long working hours and even cold weather in regard to the causes of accidents. What is the effect of human relations in this respect? Do misunderstood instructions cause accidents? Under what circumstances? What improvements can be made? What is the impact of the equipment used on board in terms of injury risks? What is the impact of work procedures? This list of questions could easily be extended. Collaboration has taken place with the Icelandic Maritime Administration, the Occupational Safety and Health Administration, and classification societies on the various control factors, control frequency and guidelines. These institutions have already contributed to the preparation of descriptions and guidelines for the control points. According to law, the captain is fully responsible for the safety on board his ship and this does not change, although the implementation of the safety system will systematically distribute the responsibility among all crewmembers, the fishing company and the service parties.

Safety committees will be appointed on board the ships. Their role is to ensure that the system is indeed used and that it works. The safety committee of each ship will receive suggestions by the crew, for example, on risks and control points. The committee will decide who shall carry out the control, when and how frequently. The captain may request the committee to receive a newly recruited crewmember and, in turn, the committee may appoint a special representative, an orientation supervisor, to act in a capacity as the recruit's personal temporary instructor and consultant. The representative will show the new crewmember the ship, the locations of safety equipment and introduce the safety rules on board the ship. The new crewmember will receive a booklet showing the details of the ship, as well as containing work descriptions, information on the safety system and highlighting the main hazards on board. It is highly important that the safety committee enjoys the trust and support of the ship's management. The safety committee will hold meetings with the crew and the owners as often as deemed necessary to discuss the main safety factors on board and to dispatch requests regarding repairs and improvements of the ship. The relevant fishing company and the ship's service parties ashore must take active part in the ship's safety system, which is something the safety committee must follow up on.

The efforts currently taking place are essential basic work, which will certainly be useful to all ships and boats deciding to carry out the safety system. It is quite likely, however, that the system will have to be adjusted to every single vessel. Additionally, it is necessary to computerize the system in order to facilitate improved control and accumulation of data.

The accident statistics of seamen cover a large number of events taking place at harbors in Iceland. ICE-SAR strongly urges for rules being implemented on harbor safety and, needless to say, the safety control system for seamen should apply to all harbors in Iceland.

As previously stated, the objective of this project is for the safety system being adopted and carried out by the entire Icelandic fishing fleet. The IMO already requires commercial vessels to abide by the International Safety Management Code and experience shows that the requirements made of commercial vessels today will sooner or later be made of the fishing vessels. Today, our objective is to structure and implement a safety system for fishing vessels. The system must not only meet all the requirements made of commercial vessels. It must also include a detailed safety control system on board the fishing vessels. Additionally, the safety system will be laid out in such a fashion that it can easily be translated into foreign languages and adjusted for use onboard foreign fishing vessels.

READY FOR SEA: THE SEVENTEENTH COAST GUARD DISTRICT'S SAFETY PROGRAM

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Captain Ed Page is a 1972 graduate of the Coast Guard Academy located in New London, Connecticut. After sailing as a deck officer on the 378 foot Coast Guard Cutter Boutwell out of Boston and later Seattle on Ocean Station and Alaska patrols, he subsequently had assignments in Port Operations and Investigations branches at marine safety offices in Concord, California, San Francisco, California, and Anchorage, Alaska. He also served as Commanding Officer of LORAN Station Iwo Jima, Japan, as deputy Group Commander of Group Ketchikan involved in Search and Rescue and as Chief of Marine Environmental Protection for the 17th Coast Guard District during the Exxon Valdez oil spill response. He served as Commanding Officer of Marine Safety Office/Group Los Angeles-Long Beach from 1994-1997 and as Chief of Marine Safety for the 11th Coast Guard District and Pacific Area in Alameda, California from 1997-1999. During his 28 years as a commissioned Coast Guard officer he has been involved in the coordination of rescues and investigation of numerous fishing vessel accidents on the West Coast of the U.S. As Chief of Marine Safety for the Seventeenth District he led the development and implementation of the "Ready for Sea" program in Alaska. An avid kayaker and outdoorsman, he presently lives in Juneau, Alaska with his wife Barbara and daughters Jessica and Brittany.

Alaska is notorious for its rich and active fisheries as well as for its harsh waters and climate. The extreme weather conditions have led to the sinkings of hundreds of vessels with their crews over the last decade. As reflected in Figures 1 and 2, the added safety equipment required by the Commercial Fishing Industry Vessel Safety Act of 1988 have been effective in reducing the number of lives lost. Despite the improved safety record, fishing continues to be the most dangerous profession in the U.S. and numerous fishermen continue to be lost to Alaska’s unforgiving sea each year. At the same time some vessels and their crews are lost at sea, other vessels and crews survive. The difference is the ones that return safely to port ensured their vessel and crew were “Ready for Sea” before getting underway.

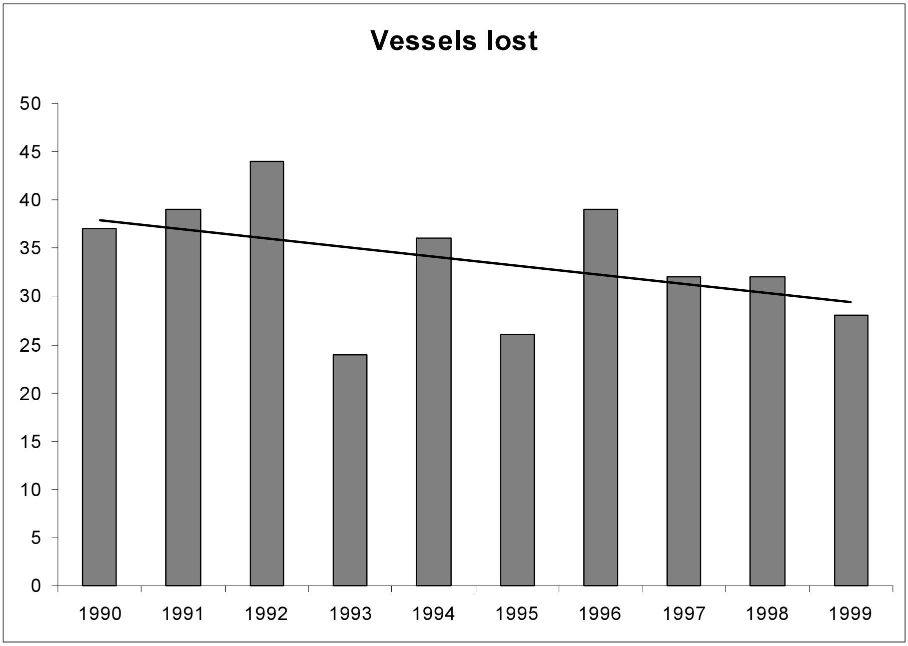

Figure 1: Vessels Lost in Alaska

Figure 2: Lives Lost in Alaska

In an effort to develop and implement a non-regulatory approach to improve fishing vessel safety, the Chief of Marine Safety for the Seventeenth Coast Guard District established a work group comprised of the Coast Guard's fishing vessel examiners, to evaluate past casualties, to identify safety trends and to develop a new approach towards improving fishing vessel safety. Upon reviewing past casualities, the work group identified the factors that made a difference in keeping vessels afloat, and in cases where vessels foundered, the survival and rescue of the crew. This analysis led to development of the Seventeenth District's "Ready for Sea" safety initiative. In developing this program, the work group applied the following Coast Guard "Prevention Through People" principles.

1. Seek Non-Regulatory Solutions: The "Ready for Sea" initiative highlights and communicates "Standards of Care" which prudent mariners practice. It does not add new regulations and in fact, many of the items on the Top 10 safety list are not required by law. It is envisioned a greater awareness of safety issues and adherence to the factors that make a crew and their vessel "Ready for Sea" will significantly reduce the number of casualties.

2. Shared Commitment: The group sought the input of the fishing community and safety associations that share the same goals of improving safety in identifying actions that would improve the safety culture of fishermen.

3. Lessons Learned: Sharing "Lessons Learned" from marine casualties helps fishermen learn from others' accidents as well as safe practices that have prevented the loss of vessels and their crews. These "Lessons Learned" are in many cases success stories where good practices have led to successful rescues. By rapidly identifying the "Lessons Learned" from fishing vessel accidents and sharing them through the timely issuance of flyers distributed via newsletters, mail, postings at harbors and on the Internet, fishermen can become more informed about the risks.

4. Manage Risk: The "Ready for Sea" program focused on managing the risks of fishing in Alaska. The Top 10 safety list reminds fishermen to assess the weather, the skills of their crew, the maintenance of safety equipment, the stability of the vessel and other safety factors to minimize the risks of going to sea.

THE TOP 10 SAFETY LIST FOCUSES ON THE FOLLOWING ISSUES

Weather: Many vessels sink because their crews fail to properly assess the weather conditions as well as the vessel's ability to safely go to sea in the forecasted weather conditions. Evaluating the weather is a risk assessment all mariners should make before setting sail and periodically re-evaluate the weather while at sea.

Crew: An unskilled and/or fatigued crew is a major factor in most fishing vessel casualties. Crews trained in safety practices including the proper deployment and use of lifesaving equipment have a much greater chance of preventing a marine casualty and in cases where the vessel sinks, of surviving.

Stability/Overloading: Loss of stability dramatically reduces a vessel's seaworthiness and has led to numerous sinkings and loss of life in Alaska. Greater awareness of the factors that lead to instability and taking action to preserve stability can reduce vessel capsizings.

EPIRBs/Comms Equipment: A crew's ability to seek help when in distress depends on reliable emergency communications. Properly installed, serviced and operable EPIRBs, VHF and HF communications have saved many lives.

Immersion Suits: Hypothermia has killed many fishermen in Alaska. Many others have survived emergencies because they've carried serviceable and accessible immersion suits and knew how to don them.

Survival Craft: Properly installed and serviced life rafts have saved many lives in Alaska!

PFDs Worn on Deck: Fifty-six fishermen were lost overboard in Alaska during the last ten years. The practice of wearing Personal Floatation Devices (PFDs) while working on deck would have saved many of those mariners, and is a "Standard of Care" vessel crews should adopt.

Damage Control: Quick and effective repair of a vessel can prevent a vessel's loss and the need to abandon ship. Crew training in how to use damage control tools can ensure a crew's safe return.

Fire Fighting: Uncontrolled fire at sea has led to the loss of many vessels. Carrying proper firefighting equipment on board and ensuring the crew is trained in its use can prevent a vessel's loss.

Third Party Exam of Vessel: A third party safety audit by a marine surveyor, classification society or by a Coast Guard fishing vessel safety examiner can identify potentially unsafe conditions.

A Top 10 "Ready for Sea" check off list was developed to address these issues and is provided as an appendix to this report.

As mentioned earlier, another element of the "Ready for Sea" program is the sharing of "Lessons Learned" from other maritime casualties. The communication of these "Lessons Learned" can be an effective way of raising the safety awareness of fishermen and prevent them from making the same mistakes or taking similar actions that have led to the safe rescue of other mariners in distress. A copy of a "Lessons Learned" is attached as an appendis to this report.

Lastly, the Coast Guard's fishing vessel safety program in Alaska modified the Coast Guard's vessel at-sea boarding program to focus on the safety factors that make a vessel "Ready for Sea". Emphasis of Coast Guard boardings was shifted from law enforcement to increasing the safety awareness and culture of a fishing vessel's crew during the course of the boarding.

In summary, the Coast Guard's "Ready for Sea" program is a new approach towards improving fishing vessel safety. The program outlines the factors that help fishermen ensure their vessel and crew are "Ready for Sea" before casting off all lines.

APPENDIX A: COAST GUARD READY FOR SEA SAMPLE CHECKLIST

READY FOR SEA

- [ ] Weather: Evaluated weather forecast. Vessel and crew can handle safely! Can monitor weather reports at sea.
- [ ] Crew: Trained and drilled in operation of vessel and safety equipment.
- [ ] Work schedule minimizes fatigue.
- [ ] Stability: Scuppers and freeing ports clear. Gear, catch and hatches secured. Limit accumulation of ice.
- [ ] EPIRB and Communications: Equipment tested. EPIRB armed and stowed properly. Carry back-up comms.
- [ ] Immersion Suits: Crew donned suits. Ensured proper fit and good condition. Suits accessible and lights attached.
- [ ] Survival Craft: Capacity for entire crew. Serviced, properly installed and crew trained to launch.
- [ ] PFDs Worn on Deck: PFDs/flotation worn on deck by crew. Operable lights attached.
- [ ] Damage Control: Bilge pumps work. Damage control equipment on board and crew trained in use.
- [ ] Fire Fighting: Adequate number of serviced fire extinguishers on board and crew trained in fire fighting.
- [ ] Safety Exam: I conducted "Ready for Sea" deck walk/safety inspection and determined vessel safe to sail.

APPENDIX TWO: SAFETY ALERT SAMPLE

SAFETY ALERT 02-99

SINKING OF FISHING VESSEL WITH ONE LIFE LOST

FAIRWEATHER GROUNDS, SOUTHEAST ALASKA

Background: The Seventeenth Coast Guard District Fishing Vessel Safety Alert program provides timely safety-related information to fishermen of "Lessons Learned" from marine casualties.

Incident: A 54-ft longliner capsized and sank approximately 50 miles offshore off the Fairweather Grounds just before midnight on November 12. The vessel was fishing for halibut in heavy weather and while sailing for port was hit broadside by 20 ft waves, shifting the halibut catch and deck gear, and causing the vessel to list 30 degrees and take on water. The operator tried calling the Coast Guard (CG) on VHF Channel 16 with no response (too far offshore) but did not call on SSB radio that is monitored for offshore emergencies. The operator also activated the EPIRB and threw it over the side as the crew donned immersion suits then tried to reach the life raft that washed overboard. As the life raft painter was not secured to the vessel it did not inflate. A crewmember tied off a rope to his waist and then to the vessel and dove in after the raft. The vessel sank a short time later and he was not seen again. The CG received the registered 406 EPIRB alert and contacted the vessel owner to gather information and verify the alert. Although weather conditions were beyond safe parameters to launch the CG helicopter, the aircraft deployed due to the high confidence of the vessel's distress. The crew was found less than an hour later within 100 yards of the EPIRB. When the helicopter arrived on scene one crewmember turned on the light on his immersion suit and the helicopter crew was able to spot them immediately. Three crewmembers were rescued.

Lessons Learned: While the cause of the casualty is unknown, there are several lessons learned.

1. Before getting underway mariners should assess the current and forecast weather and assess the vessel's condition to determine if the voyage can be safely conducted or should be delayed.

2. The proper securing of cargo and deck gear is critical for maintaining stability during heavy weather conditions. The shifting of fish or gear can quickly lead to disaster. The best time to ensure a vessel is properly "secured for sea" is before encountering heavy weather.

3. As evidenced by this case, a properly serviced and installed EPIRB and properly fitting and serviced immersion suits save lives. The crew attributed their AMSEA safety training with their familiarity with this equipment and their survival. Positive action to activate and deploy an EPIRB better ensures it sends a distress signal and is not caught up in the vessel's rigging.

4. Operable personal marker lights on immersion suits greatly aid night searches.

5. Life rafts should be properly attached to a secure point on the vessel in accordance with manufacturer's directions.

6. The vessel did not have a current CG dockside exam. The last exam was performed more than three years ago. These free exams, performed at the dock, help identify safety deficiencies that can lead to loss of vessels and/ or the crew.

USING DOCKSIDE ENFORCEMENT TO COMPEL COMPLIANCE AND IMPROVE SAFETY

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INTRODUCTION

Effective enforcement is a key component in any regulatory regime. "Enforcement problems arise in virtually every arena of human interaction. Such rules usually provide little or no social benefit unless they are effectively enforced. If deliberate violation of a rule can rarely be detected under an enforcement scheme, or if the punishment for violation is negligible, the rule no longer serves its purpose. Effective enforcement is therefore as important as the rule itself." [Burke et al 1975].

The U.S. Coast Guard is the primary agency responsible for the enforcement of commercial fishing vessel safety in the State of Alaska. Traditionally, the Coast Guard has used a two pronged approach to ensure commercial fishing vessels are in compliance with existing safety regulations: a voluntary dockside examination (VDE) program, and at-sea boarding enforcement program. Despite significant efforts aimed at improving compliance with commercial fishing vessel safety regulations, the existing programs have suffered from many impediments to their success. This paper will evaluate the existing enforcement regime for commercial fishing vessels in the State of Alaska, identify areas of improvement, and explore how developing dockside enforcement can effectively compel compliance and improve safety in the Alaskan fishing fleet.

VOLUNTARY DOCKSIDE EXAM PROGRAM

The major focus of the Coast Guard's fishing vessel safety efforts is the VDE program. Law or regulation does not require VDEs. Under the Commercial Fishing Industry Vessel Safety Act of 1988, fishing vessels do not require inspection by the Coast Guard. During a VDE, vessels are examined for compliance with all applicable federal regulations. VDEs are designed to be educational in nature and provide fishermen an opportunity to bring their vessels into compliance without the threat of civil penalties. Those vessels, which are found to be in compliance, receive a Commercial Fishing Industry Vessel Dockside Exam Decal.

There are several problems with the existing VDE program: vessels that have undergone a VDE may not get into or stay in compliance, relatively few vessels participate in the program, and those vessels that do participate are often not in high risk fisheries. The first problem is that a vessel can have a current exam decal, but slip out of compliance after the decal is issued. Decals are issued for a period of two years. During this two-year period equipment can be removed, fail or expire, and the vessel becomes noncompliant. Consequently, a vessel can have a VDE decal and still be out of compliance. Another area of concern is that because it is a voluntary program, vessels may have numerous safety violations, and there is no established policy to bring them into compliance. Enforcement action resulting from a VDE is forbidden under current Coast Guard policy.

Examining the results of a large number of dockside exams highlights a second problem. In 1999 USCG Marine Safety Office Anchorage analyzed 100 randomly selected fishing vessels that were voluntarily examined at the dock. Discrepancies were grouped as follows:

Big Five: primary life saving equipment and required drills and training;

Navigation Safety: Charts, publications, running lights, ground tackle, sound producing devices, communication equipment;

Administration: CG licenses vessel documentation, EPIRB registration, certificates, and proof of first aid and CPR training, logs;

Pollution: Spills, containment, fixed piping for waste oil, response equipment, oily waste book; and

Marpol: Logs, and marine sanitation devices.

Several concerns are raised from these exam results. The first is that one-third of the vessels examined were not in compliance with primary lifesaving equipment requirements. The second is that the data shows 51 percent of vessels getting exams don't complete the process or don't bring their vessels into compliance. Based upon this random analysis, one can assume that less than half of the vessels participating in the VDE program actually bring their vessels into compliance with safety regulations.

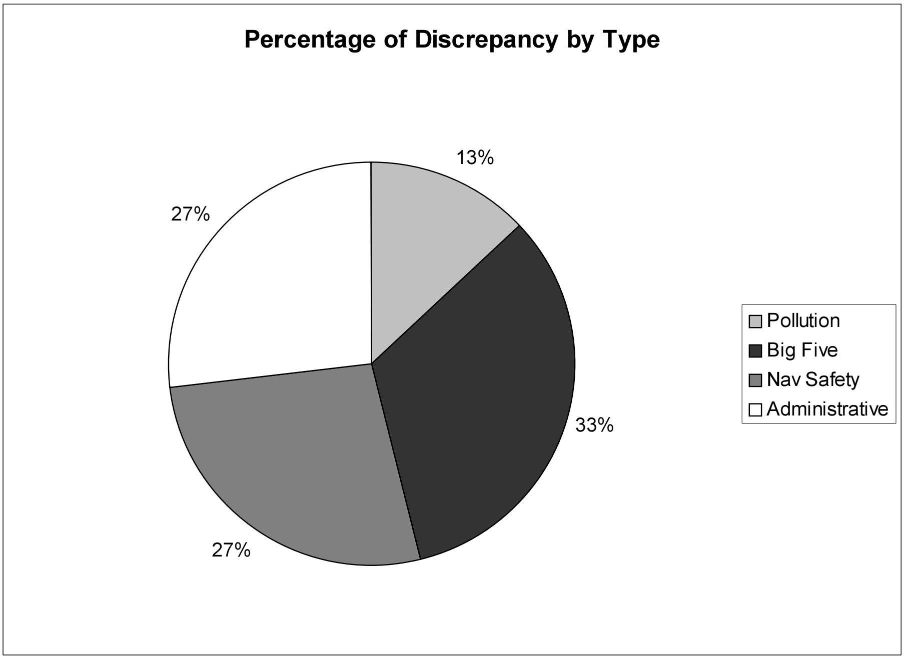

Figure 1: Fishing Vessel Safety Regulation Discrepancies on 100 Vessels receiving Dock-Side Exams in Alaska in 1999.

The second major problem with the voluntary dockside exam program is that very few vessel operators participate with the program. (See Table 1.) Based upon national statistics collected over a six-year period, only seven percent to eight percent of commercial fishing vessels nationwide have participated in the VDE program. In Alaska, the number of vessels participating has ranged from 5 to 9.5 percent and is probably closer to 12 percent. The percentage of the fleet encountered in the exam program is not significant enough to have an effect on overall compliance.

Table 1: VDEs conducted in Alaska

YEAR	1993	1994	1995	1996	1997	1998	1999
Total Vsls in Alaska	n/a	13500	13500	11559	13744	11968	11913
# VDE's	n/a	1243	1177	1093	769	1064	955
% Examined	n/a	9.2%	8.7%	9.4%	5.5%	8.89%	8%

The final problem with the voluntary dockside exam program is that units have tended to target fishing fleets where participation is high and exams are relatively easy to obtain. These fleets tend to have common gear types, are comprised of vessels that have above average material condition, and have a good overall safety record [USCG 1998b]. Marine Safety Office Anchorage, as an example, targets the Bristol Bay fleet heavily for the large number of examinations that can be attained. Coast Guard headquarters still equates program success with the amount of VDEs conducted. In 1999, 62 percent of the unit’s 565 total dockside exams came from this single fishing fleet, and the cost of the activity consumed 43 percent of the unit’s total fishing vessel safety budget. This effort occurs despite the fact that the fleet historically has an extremely low number of fatalities and the nature of the fishery is such that a vessel with an at-sea emergency could be assisted in a matter of minutes due to a tremendous concentration of fishing vessels.

Conversely, marine safety offices in various regions of the country have observed that vessels appearing to be most in need of safety education outreach are not willing to participate in the dockside exam program [NRC 1991, USCG 1998b]. Due to the difficulties and costs associated with promoting a voluntary dockside exam program to vessel owners and operators who are not very interested, it is not effective, in terms of maximizing exams, to expend the effort to reach these fleets. This strategy has led to an accident prevention paradox [USCG 1998b], where the fleets with higher levels of compliance tend to receive most dockside exam effort, and fleets with low levels of compliance receive less effort.

AT SEA BOARDING PROGRAM

The U. S. Coast Guard (17th District) uses at sea boardings of commercial fishing vessels to enforce federal fisheries regulations. While at sea enforcement is traditionally an effective way of compelling compliance, there are many obstacles in place, which currently limit the effectiveness of the Coast Guard's at-sea enforcement of fishing vessel safety regulations. At sea exams are limited in scope. The fleets are not targeted based upon risk, but based upon availability. The number of boardings has been declining for years, thus reducing transparency, and finally, when and if violations are even detected. (See Figure 2.)

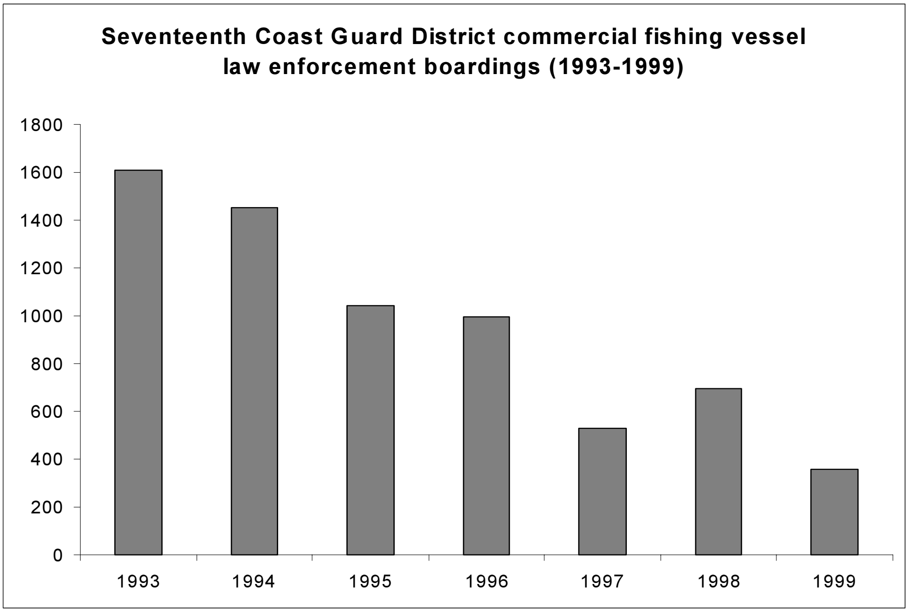

Figure 2: Seventeenth Coast Guard Unit Commercial Fishing Vessel Law Enforcment Boardings

Current Coast Guard policy places heavy limitations upon the degree that commercial fishing vessels can be examined for compliance with commercial fishing industry vessel safety regulations. Coast Guard boarding teams are limited by the following policies:

"The safety equipment examination on a vessel which displays a current decal will normally consist of no more than a spot check…" [COMDTINST 16711.13b].

"Fishing vessel safety boardings are normally conducted in conjunction with Search and Rescue (SAR) and Law Enforcement (LE). No planned patrols/ sorties are permitted for the sole purpose of safety equipment enforcement." [COMDTINST 16711.13b].

While the first policy limits the scope of an at sea boarding to mere spot checks of safety equipment, the second limitation creates more significant problems because it essentially limits safety examinations to only those fisheries that the Coast Guard enforces fishery management regulations on (such as halibut, pollock, and other groundfish): and does not allow the Coast Guard to board what are considered to be high risk fisheries (such as crab, herring, and salmon fisheries). A result of these policies is that the same low risk fleets are often targeted for boardings, and the high-risk fleets are never boarded at all. Compounding this problem is that the at sea boardings for the past ten years have declined in Alaska due to mandated multi-mission requirements, budget constraints, and lack of surface assets.

The limited number of boardings reduces transparency with in the fleet, therefore, it is extremely important that when violations are detected that the Coast Guard use its leverage to compel compliance. In the past, at sea boardings where violations were discovered typically resulted in very small fines or "warnings" in lieu of fines. This practice does not compel compliance nor modify behavior. In response to this problem many Coast Guard districts have established a "fix it" program. The "fix it" program relies on sending the violator a letter stating that maximum penalty will be assessed unless the operator contacts their local Marine Safety Office (usually within thirty days) and arranges to complete a CFVS exam. In Alaska, 90 percent of the operators (found in violation) receiving a "fix it" letter successfully complete the exam process. It's cheaper to comply than pay the fines, because the maximum fines are large. This approach has significant potential to address the non-compliance problem. Conceptually the "fix it" program is a good idea, but ways to make it apply to more vessels should be pursued. However, due to the limited contact the Coast Guard has with the Alaskan fishing fleet, the percentage of vessel operators brought into compliance via this method is insignificant when compared to the total size of the Alaskan fleet.

Given the scope of the compliance problem the Coast Guard faces with both the VDE program and at-sea law enforcement, new approaches need to be developed to improve compliance with fishing vessel safety regulations. Under the current practices, the Coast Guard is missing an opportunity to effect prevention, as well as compel compliance *before* fishing vessels put to sea.

AUTHORITY FOR DOCKSIDE ENFORCEMENT

Dockside enforcement solves most problems the Coast Guard faces with compelling compliance in the U.S. fishing fleet. High-risk fisheries and vessels can be targeted, sanctions are immediate, more vessels can be boarded safely, effectively, and economically than can be boarded at sea. Under the Ports and Waterway Safety Act, the designated Coast Guard Captain of the Port (COTP) has authority, delegated by the Secretary of Transportation, to control the movement of any vessel in his/her zone that is a risk to the environment, impedes commerce or poses a threat to human life and safety. The threat to human life and safety is, of course, the Coast Guard Marine Safety program's highest priority.

The tool used to carry out this authority is the Captain of the Port Order (COTP). Once a vessel has been identified with a clear safety problem, a COTP order is issued requiring the vessel to remain in port until the safety problem is resolved to the COTP satisfaction. This has two immediate effects: strong incentive to bring the vessel into compliance through the instant economic sanction of not being allowed to sail, and intervention prior to the vessel sailing, which is a great preventative action.

Traditionally the Coast Guard has not exercised its authority to enforce safety regulations at the dock as fishing vessels prepare to go fishing. Marine Safety Office Anchorage's efforts in Dutch Harbor are the first comprehensive dockside enforcement efforts aimed at a high risk fishing fleet.

IMPLEMENTATION

Beginning October 1999, the 13th and 17th Coast Guard District fishing vessel safety staff developed a comprehensive at the dock boarding program to identify and correct safety hazards known to exist in the Bering Sea crab fisheries. These fisheries were chosen because the National Institute of Occupational Safety and Health ranks them near the top of the most hazardous occupations in the United States. Economic factors as well fishery resource management issues all combine to create an unsafe environment for these types of vessels [Woodley 1999]. It has been established that the leading cause of fatalities in these winter crab fisheries is the sudden loss of a vessel due to stability problems, followed by man overboard events (MOB). (See Figure 3.)

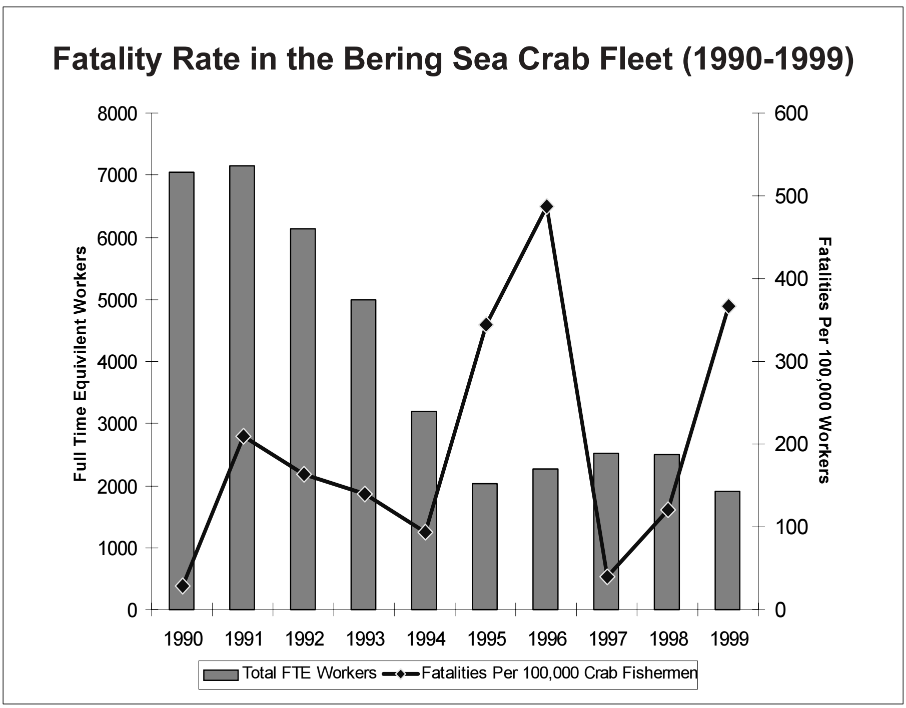

Figure 3: Summary of BSAI Crab Fishery Fatalities

The goal of this at-the-dock-boarding program was to examine a large number of vessels within the fleet prior to the fishery opening. The at-the-dock boarding used qualified marine safety enforcement personnel to board vessels and examine stability instructions, and to ensure vessels were loaded in accordance with the onboard stability criteria. During the examination of the vessels loading practices, enforcement personnel also examined other aspects of the vessels safety system, such as adherence to requirements for drills and instruction, primary life saving equipment, and observed overall material condition of the vessel. Because these boardings were not VDEs, enforcement was possible in the form of a COTP order detaining the vessel until the discrepancy is corrected. What works so well in the Alaskan crab fisheries is that the consequences of the COTP order (not be able to fish) is widely understood, so simply the threat of issuance is enough to compel immediate compliance. Only six COTP orders were actually issued in 1999-2000 and compliance with stability criteria in all cases was immediate.

The following is a brief summary of the three dockside enforcement efforts in 1999-2000:

- Boarded 70 percent of the crab fleet in three four day periods.
- Discussed stability and fishery related issues with over 210 vessel masters.
- Had vessel masters demonstrate knowledge of stability reports.
- Gathered large amount of safety data on fleet regarding MOB and prevention.
- Detected six overloaded vessels, intervened and compelled them to come into compliance.
- Accomplished all of the above with minimal use of personnel, resources and tax dollars.
- Identified problems with primary lifesaving equipment on one-third of vessels boarded.
- Corrected all deficiencies prior to any vessels leaving port.

A total of eight marine safety personnel were utilized and the cost of this enforcement effort totaled less than U.S. $20,000. Compared to what it would have cost to conduct a similar enforcement effort while at sea, this activity gives an extreme “bang” for the buck, and has accomplished every thing the current Coast Guard Marine Safety Business Plan has directed.

SUMMARY

For law enforcement to be successful and compel compliance, an enforcement system must provide surveillance, detection, and credible sanctions. In addition, the population regulated should also expect the presence of law enforcement personnel on a regular basis. Under the existing two pronged approach of VDEs and at-sea boardings, this is not being successfully accomplished. With VDEs there is no method to compel compliance, an insufficient number of exams are conducted, and high-risk fleets are not targeted in order to maximize the effect of exams. With at sea enforcement boardings, the compliance checks are abbreviated, high-risk fleets are not boarded, and the overall number of boardings has declined substantially. Dockside enforcement efforts can accomplish all of the above four primary goals and more.

Currently there is wide spread support in the industry for the Coast Guard to better enforce existing laws and standards. Coast Guard Headquarters and the Commercial Fishing Industry Vessel Advisory Committee are working together in the development of several regulatory and policy initiatives. Many of these initiatives will require extensive time lines for implementation because of the need for additional legislative authority. The use of dockside enforcement efforts that target fishing vessels involved in high risk fisheries can be implemented now. Fishing Vessel Safety personnel in the Coast Guard can target and tailor variations of this approach to suit regional needs. No additional legislative authority is needed, no additional personnel or funding is needed.

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