United States Coast Guard
Office of Investigations and Analysis

Analysis of Fishing Vessel Casualties

A Review of Lost Fishing Vessels and Crew Fatalities, 1992 - 2010

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EXECUTIVE SUMMARY

During a three-week period in the winter of 1998/1999 four clam/conch vessels were lost in Mid-Atlantic waters, which resulted in the deaths of 11 fishermen. After this cluster of accidents, a task force of government and industry representatives was chartered to study trends in fishing vessel (F/V) safety and to make recommendations for reducing loss of life and property. The Task Force's report of March 1999 provided a series of short-term and long-term recommendations.[1] The report also included a high-level review of casualty data for calendar years 1994 – 1998.

Shortly after the Task Force report was released, industry and senior Coast Guard managers requested more details about fishing vessel casualties. The Compliance Analysis Division collaborated with the Fishing Vessel Safety program manager and prepared a follow-on review to provide information about why and how such incidents occurred. That report was distributed in October of 1999. This document is the fifth edition of the casualty study with newly added data for calendar years 2008 - 2010.[2] The resulting updated data set includes such factors as:

- Operation of the vessel at the time of the incident.
- Geographic or location information of the incident.
- Participation of the vessel in the voluntary exam program and its decal status.
- Causal information about vessel loss, (what went wrong).
- Causal information about deaths and missing persons.
- Assistance by Good Samaritan vessels, and;
- Availability and use of lifesaving equipment.

Analysis of the casualty data is presented in two parts: vessel losses, and crew fatalities. Each part begins with overall summaries and descriptive statistics, and then a more detailed "drill down" analysis is provided on the data. For each of the two groupings, the broad based information was examined in increasing detail, in order to focus on the most significant factors involved in these fishing vessel incidents.

For the nineteen-year period from 1992 through 2010, there were 2,072 lost vessels and 1,055 fatalities. Of those fatalities, 564 occurred at the same time a vessel was lost. Overall, this is an average of 109 lost vessels and 56 fatalities per year.[3]

For both vessel losses and personnel casualties, ***it was found that a majority of these incidents were not directly related to fishing operations, but to other activities, such as traveling to or from port. Most often, fishermen are dying because their vessel sank and***

[1] U.S. Coast Guard, *Living To Fish, Dying To Fish*, Fishing Vessel Casualty Task Force Report, Washington, DC, March 1999. This report is available on the Coast Guard internet portal: http://homeport.uscg.mil, in the "Investigations" section.

[2] A description of the data sources used in this report, along with a discussion of applicable assumptions and constraints, is presented in Appendix B.

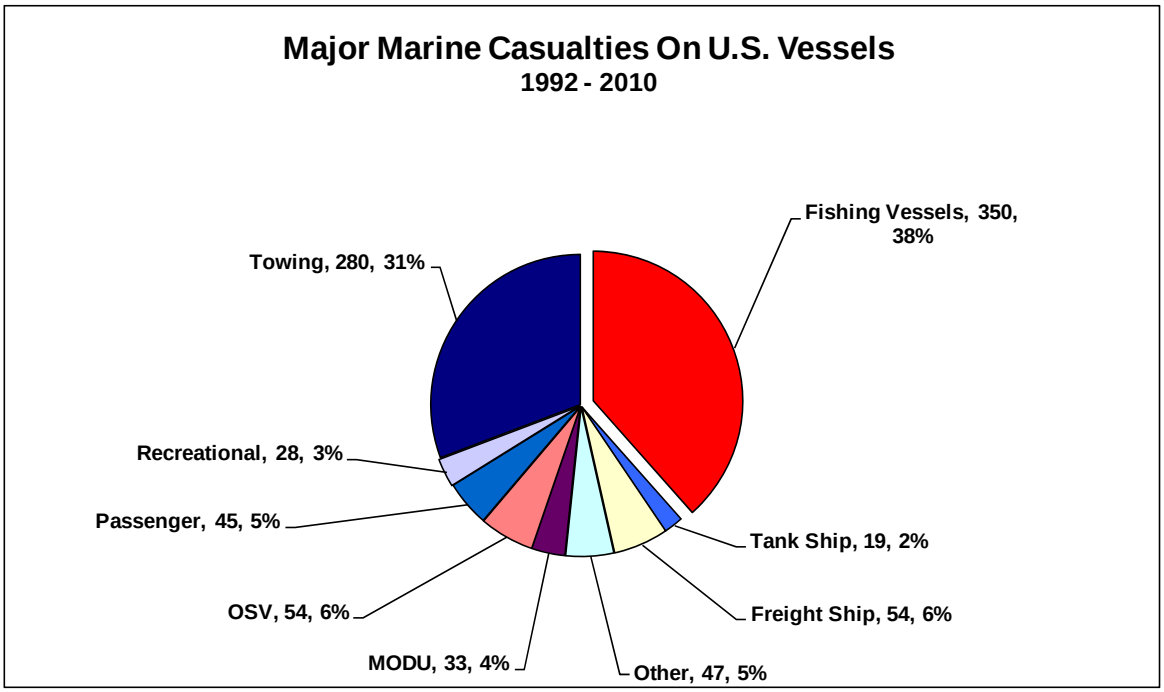
[3] Except where noted, this data is not normalized because reliable vessel and workforce population data is not available for the fishing fleet. With this in mind, fleet size is assumed to be essentially uniform for the period of this study, as will be explained in more detail, later in this document.

they entered the water. Further, the analysis of personnel casualties indicates links between water conditions and the use of lifesaving equipment, especially survival suits. In particular, most of the water exposure deaths were along the West and Northeast coasts, where the water is coldest. Use of survival suits was infrequent in such incidents. However, ***fishermen survive more than twice as often when survival suits are properly used***

Given the Coast Guard's limited authority over fishing vessel design and maintenance, analysis of this data illustrates that when vessels have the safety equipment prescribed by Federal Regulations, and fishermen use the equipment properly, their chances of survival increase significantly.

The Magnitude of Fishing Industry Casualties

Before proceeding with the details of fishing vessel losses and fatalities, it may be useful to place those incidents in the context of the U.S. commercial fleet, overall. Coast Guard records show that fishing vessel casualties account for a large percentage of the most serious incidents. From calendar year 1992 through 2010, fishing vessels were involved in 38% of all major marine casualties, (shown below).[4]



[4] Title 46, Code of Federal Regulations, Paragraph 4.40-5(d), defines a major marine casualty as "a casualty involving a vessel, other than a public vessel, that results in: 1) The loss of six or more lives; 2) The loss of a mechanically propelled vessel of 100 or more gross tons; 3) Property damage initially estimated at $500,000 or more . . . "

A. MAIN POINTS

1. During this period 2,072 fishing vessels were lost. Of those vessels, 1,672 (just under 81%) had Certificates of Documentation, rather than state registration, (pg. 5).

2. Overall, the majority of vessel losses occurred in the 17th, 8th, and 1st Coast Guard Districts, (p. 7).

3. There was a statistically significant drop in vessel losses starting in 2006. Given the lack of regulations and the complexity of the industry, the drop is most likely due to a combination of economic, environmental, fisheries management and other regulatory factors, (pp. 8-10).

4. A comparison of vessel losses and safety exams showed limited correlation (about 34%). Few of the current regulations focus on preventing vessel loss, (pg 11).

5. When shown as a rate (losses/1000 vessels), losses occurred more frequently with longer vessels, (pg 12).

6. Fishing vessels between 11 and 30 years of age, with a valid Certificate of Documentation, sustained the greatest loss. Also, most vessels lost were constructed of wood (47%), steel (24), or FRP (25%), (pg 13).

7. Most fishing vessel losses (62%) occurred while engaged in non-fishing operations, (pg. 14).

8. Together, flooding and fire were the initiating events in 56% the fishing vessel losses, (pg. 14).

9. In the 19 year period of this study there were 1,055 crewmember fatalities, or an average of 56 per year. For the most recent 5 years there were 196 fatalities, or an average of 39 per year, (pg. 17).

10. The U.S. fishing industry suffered its worst casualty in 50 years with the loss of the *ARCTIC ROSE*. The vessel disappeared in the Bering Sea the night of 1 April 2001, resulting in 1 deceased and 14 missing crewmembers, (pg 17).

11. Overall, the majority of deaths (58%) occurred in the 17th, 8th, and 1st Coast Guard Districts, (pg. 17).

12. Most incidents (91%) result in either one or two fatalities, indicating that multiple-fatality incidents are relatively rare. Thus, it would be necessary to address a relatively large number of incidents in order to reduce the fatality counts significantly, (pg. 17).

13. Examination of the events leading to death confirmed that water exposure was, by far, the most significant factor – 77% of all fatalities, (pg. 18).

14. Deaths from water exposure were higher along the West and Northeast coasts than in any other region because of more severe environmental conditions, (pg. 19).

15. Vessel-related fatalities tend to be higher in the months of October through January, (pp. 20).

16. When presented as a rate (fatalities per vessel lost), vessel-related fatalities were the lowest in the warmer waters of the Gulf of Mexico and along the Southeast U.S. coast, (pps. 21 - 22).

17. Inadequate training contributed to at least 3 fatalities, (pg.22).

18. Forty four percent of all vessel-related fatalities occurred on steel hulled vessels. Population data showed that steel vessels are generally larger than vessels of other hull materials. Consequently, they are able to operate farther offshore, with larger crews. Given the higher risk factors of crew size and distance from shore, it may be appropriate to focus preventive efforts on steel vessels, (pg. 23).

19. Beginning in calendar year 2000, there was a significant downward shift in the number of fatalities per year, with a record low in 2010, (pg. 24).

20. Overall, the correlation between vessel losses and fatalities was found to be quite low. Again, current regulations focus more on preventing fatalities than preventing vessel loss, (pg. 25).

21. In cold waters, fishermen survive more than twice as often when lifesaving equipment is used, (pg. 26).

22. Loss of lives was much lower on those vessels that received a safety decal. When deaths did occur, the vessel was lost suddenly with little time to respond, (pg. 27).

23. A significant number of crewmember fatalities may have been prevented because Good Samaritan vessels were present for nearly 30% of vessels lost. Because of quick rescue, as many as 1,200 fatalities may have been prevented. Given that such vessels have prevented a large number of persons from entering the water, they may be hiding the true risk from vessel losses. (pp. 28-29).

24. With 24% of the total deaths (251 of 1,055), falls overboard were the second largest group of fatalities. PFD/survival suit usage was reported with only two of those fatalities, (pg. 30).

25. The highest number of falls overboard fatalities occurred in the 8th District, accounting for 35% of their total (87 of 251). Given that the 8th District has the warmest waters with the longest survival times, it is likely that many of the fatalities were preventable with PFD's. This appears to be a region where continued emphasis on safety equipment, drills and training would be beneficial, (pg. 30).

26. To eliminate some fatalities, such as those that occur while the crew is asleep, it will be necessary to prevent vessel losses, (various).

B. LOST VESSELS

Overview

After extracting and examining the casualty data as described in Appendix B, the Coast Guard databases showed 2,072 fishing vessels (documented and state registered) were lost during calendar years 1992 through 2010 (Figure 1). Overall, the average number of vessels lost per year was 109. For the most recent 5 years, the rate was 61 vessels lost per year. The maximum and minimum number of vessels lost was 166 in calendar year 1996 and 55 in 2008, (a record low). Of the 2,072 vessels, 1,672 or just under 81%, had certificates of documentation issued by the Coast Guard, instead of state registrations. According to the Coast Guard's MISLE database, the population of documented fishing vessels was 19,976 in 2010. Appendix F shows the data in Figure 1 by Coast Guard District.

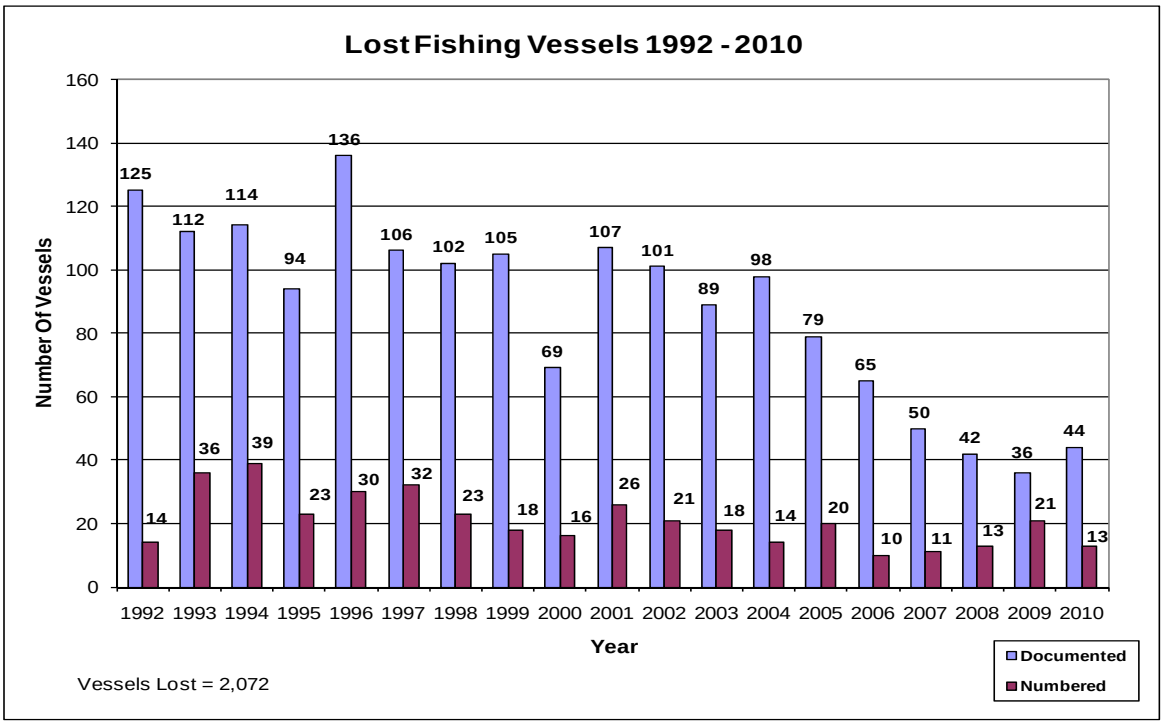


Figure 1

Fishing Vessels are Getting Older

Historic Coast Guard data indicates that the population of documented fishing vessels is getting older and smaller. Figure 2 compares the distribution of vessels in calendar years 1997 (the earliest available) and 2010. In 1997, there were 24,332 fishing vessels, versus 19,976 in 2010. Most fishing vessels (55.4%) were 20 years old or less in 1997, versus 22.9% of the population in 2010. More recently, 61.4% of all fishing vessels were between 21 and 40 years old. The shift in vessel age may represent an increased risk factor for vessel casualties.

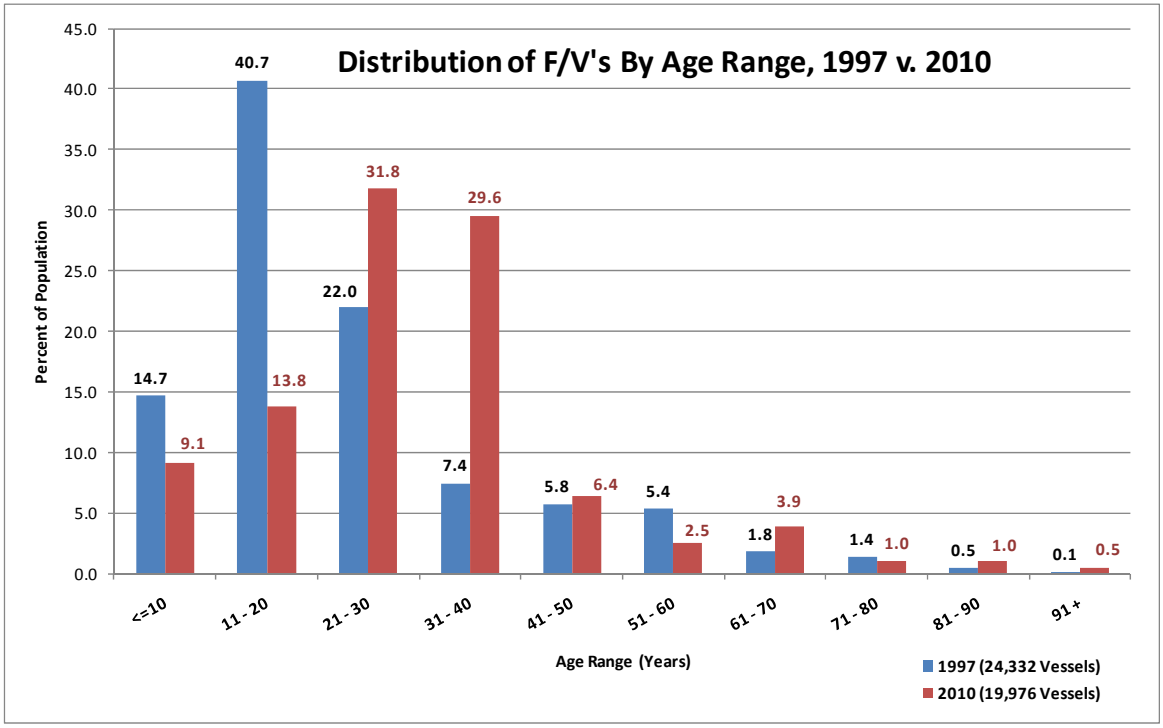


Figure 2

Lost F/Vs by Year and District

The table below displays vessel losses by District and Year. The three Districts with the highest number of fishing vessel losses were the 17th, 8th, and 1st Districts – for a total of 1,170 casualties (56% of the total). In the most recent five years, the First District reported the most vessel losses, while the 8th reported a dramatic reduction. A map of the Coast Guard Districts is shown in Figure 3, below.

Lost Fishing Vessels By Year and District, 1992 - 2007																					
District	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Last 5
17	46	25	42	26	47	38	31	43	22	29	22	22	14	14	17	19	7	8	7	**479**	**58**
8	20	34	25	23	29	25	21	19	14	28	25	26	27	18	5	4	6	8	8	**365**	**31**
1	22	30	28	17	17	15	6	10	14	15	24	13	20	31	16	11	18	11	8	**326**	**64**
7	13	21	21	13	20	23	20	17	14	17	20	18	16	8	9	11	7	7	12	**287**	**46**
11	13	19	24	13	24	20	14	16	9	16	12	7	13	8	10	6	4	3	7	**238**	**30**
13	12	9	9	15	13	11	13	8	4	19	10	6	13	9	8	4	4	5	6	**178**	**27**
5	9	5	2	7	11	4	13	6	7	7	8	10	6	7	8	6	7	14	7	**144**	**42**
14	4	5	2	3	4	2	6	3	1	2	1	5	2	3	2		2	1	2	**50**	**7**
9	0	0	0	0	1	0	1	1	0	0	0	0	1	1	0	0	0	0	0	**5**	**0**
Total	**139**	**148**	**153**	**117**	**166**	**138**	**125**	**123**	**85**	**133**	**122**	**107**	**112**	**99**	**75**	**61**	**55**	**57**	**57**	**2,072**	**305**

Table 1

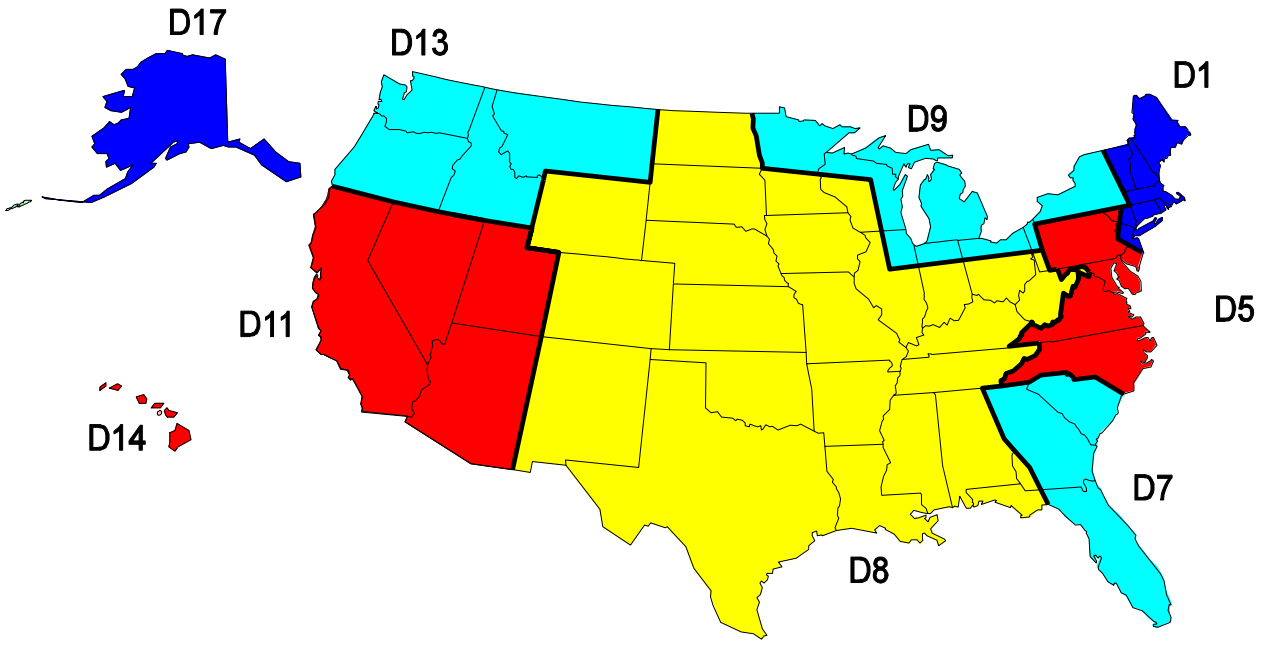


Figure 3

Vessel Loss Trend

Figure 4 shows the 19 year trend in fishing vessel losses. In order to evaluate this trend, a methodology known as control charting, is used.[5] The "base period" for this chart includes calendar years 1992 through 1999. That period was selected because additional emphasis was placed on fishing vessel safety after the 1999 Task Force. Consequently, that point in time may represent a "process improvement". The calculated upper and lower limits are 192.6 and 84.6, respectively. The resulting chart shows a downward trend, with statistically significant values for calendar years 2000, and 2006 through 2010. Those values are considered statistically significant, because they reached or fell below the expected limits of year-to-year variation. With five years below the lower limit, there appears to be a "level shift" downward in vessel losses.

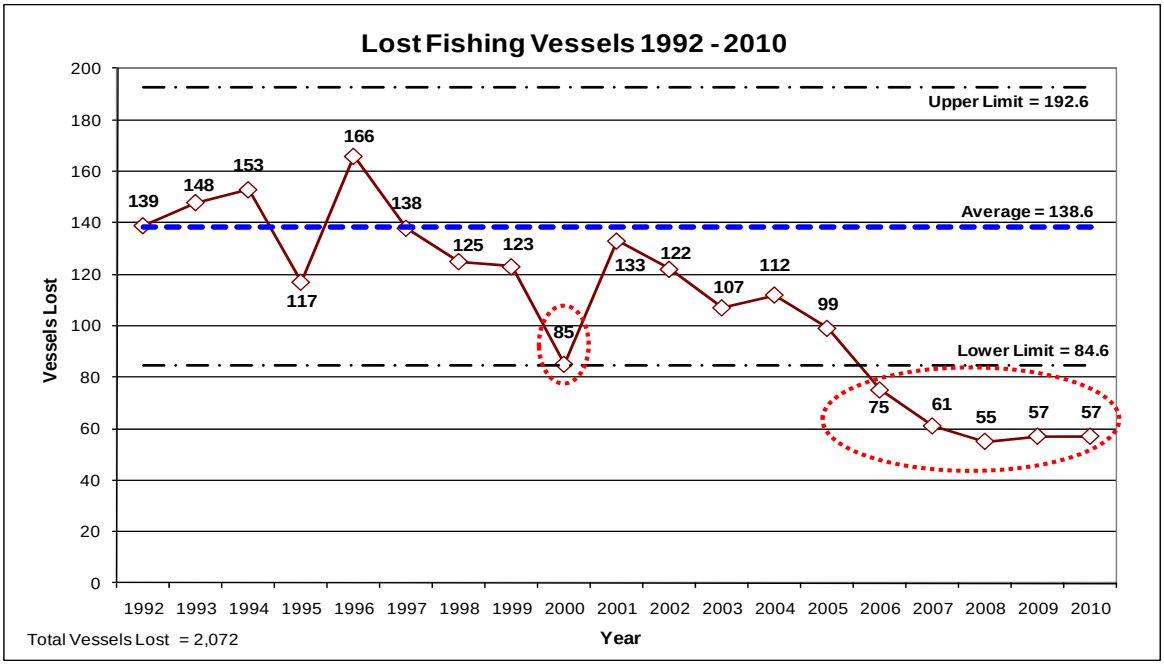


Figure 4

The reduction of vessel losses in 2000 might be explained by increased emphasis on fishing vessel safety after the 1999 Task Force report was released. Here are some highlights:

- On April 28, 1999 the Assistant Commandant for Operations and the Assistant Commandant for Marine Safety & Environmental Protection, after consultation with the Commercial Fishing Industry Vessel Safety Advisory Committee, released an official message describing a series of short term and long-term actions to enhance safety. Based on the Task Force report, the short-term actions included increased emphasis on safety items during at-sea boardings, additional training for boarding officers and stepped up outreach activities.
- During the fall and winter of 1999, each of the Coast Guard Area Commanders announced their own initiatives to reduce fishing vessel casualties – "Operation Safe

[5] Wheeler, Donald J., *Understanding Variation: The Key to Managing Chaos*, SPC Press, Inc., Knoxville, TN, 1993, pg. 134. This methodology is described in Appendix C.

Catch" in Atlantic Area and "Operation Safe Return" in the Pacific Area. As suggested in the Commandant's message, these initiatives placed additional emphasis on safety items during at-sea boardings.

- In calendar years 1999 and 2000, there was also a sharp increase in the number of dockside exams.

The control chart also shows significantly lower casualty figures for calendar years 2006 through 2010, which appear to be the continuation of a downward trend that started in 2002. In fact, 2008 represents a record low.[6] While the recent reduction in vessel losses is statistically significant, there is no simple explanation, given that current regulations do not focus on preventing vessel loss. Thus, a number of other factors may have contributed to the apparent safety improvement, including:

- An increased Coast Guard presence along the coasts of the United States. After the terrorist attacks of 11 September 2001, the operating hours of Coast Guard ships and aircraft, for all mission areas, increased by a large percentage.[7] This increased presence could have at least two benefits to fishing vessel safety:

  Deterrence. Vessels are more likely to comply with safety regulations when the possibility of an underway boarding increases. In fact, the number of fishing vessel boardings did increase during this period. The MISLE database shows 3,883 boardings in calendar year 2000 and 5,429 for calendar year 2010, (40% more).

  Proximity to rescue. As the number of patrolling ships and aircraft in a given region increases, the time to respond to an emergency decreases, potentially reducing the number of vessel losses. In addition, the 17th District (Alaska) relocates ships and aircraft as certain fisheries open in order to improve response times and reduce the risk of fatalities.

- Return to prior emphasis on safety. – Shortly after the terrorist attacks of 11 September 2001, the Coast Guard increased the priority of homeland security missions. This change in emphasis very likely reduced the number of personnel available for fishing vessel safety activities. In fact, the number of dockside exams and issued decals dropped after 2001, then returned to prior levels, starting in 2004. In 2010, there were 8,729 dockside exams and 4,525 decals issued – more than any prior year.

- Hurricanes of 2005. – According to the National Marine Fisheries Service[8], "Hurricanes Katrina and Rita devastated the shoreside infrastructure and fishing fleet

[6] Historic casualty figures show an average of 207 fishing vessel losses for calendar years 1970 through 1991. During that period, the record low was 89 vessels lost in 1978. Appendix D contains a summary of the historic casualty data.

[7] U.S. Department of Homeland Security, Office of Inspector General, *Annual Review of Mission Performance, United States Coast Guard (FY 2009), pg 3*. Available at: www.oig.dhs.gov/assets/Mgmt/OIG_10-106_Aug10.pdf

[8] December 15, 2005. Testimony of Dr. William Hogarth, Assistant Administrator, National Marine Fisheries Service, National Oceanic & Atmospheric Administration, U.S. Department Of Commerce, on Effects of hurricanes Katrina and Rita on the fishing industry and fishing communities in the Gulf of Mexico, before the Subcommittee on Fisheries and Oceans, Committee on Resources, U.S. House of Representatives.

in a wide swath from Mississippi Sound through the Louisiana Delta, including parts of the Florida Keys, western Louisiana, and eastern Texas." In fact, casualty statistics suggest that fewer vessels were operating after the hurricanes of 2005. An average of 24 vessels per year were lost in the Gulf of Mexico from 1992 – 2004, compared to only 6 vessels per year between 2006 and 2010. (See Table 1.)

- High fuel prices. – As the price of fuel has increased in recent years, the number of fishing vessels in operation or the number of days at sea may have decreased, as indicated in Figure 2, above. According to the U. S. Department of Energy[9], the price of crude oil increased from approximately $18.68 per barrel in January of 2002 to about $90.61 in December of 2010. The price of refined products, such as diesel fuel and gasoline, varies in direct proportion to the price of crude oil.

- Changes in fishery management. – There are eight Regional Fishery Management Councils that regulate fishing in the Exclusive Economic Zone of the United States, (generally 3 to 200 miles from shore). The fishery regulations are complex and have changed over time. As the regulations change, the number of vessels that operate in a fishery and/or the number of days that vessels may operate will be affected, with a corresponding change in casualty risk or "exposure". For example, in recent years several fisheries in Alaska have been converted from "open access" to "individual fishing quota" (IFQ) management plans. IFQ's have reduced the number of vessels that may operate in those fisheries. Thus, the overall risk of vessel casualties is reduced.[10] In addition, a secondary justification for IFQ's was a belief that vessel and crew safety would improve, because vessel owners would have more control over their schedules and would be able to fish over a longer period of time. Research has confirmed that the IFQ management plan is safer than open access.[11]

[9] U.S. Department of Energy, Energy Information Administration. Published at: http://tonto.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WTOTWORLD&f=W

[10] Lincoln, J.M.; Mode, N.A.; Woodley, C.J.; November, 2007. *An Evaluation of Quota-based Management Systems in Alaska. North Pacific Research Board Final Report 533*, pp 10-11.

[11] IBID.

Comparison of Lost F/Vs to Dockside Exams

Table 2 summarizes the decal status of the 2,072 lost fishing vessels. Current decals, issued within the prior 2 years[12], were onboard 18% of all lost vessels, and 20% of the documented vessels. Statistically, a comparison of vessel losses and exams, by calendar year, shows very little correlation, (about 34%). In fact, other studies have concluded that additional measures are needed to prevent vessel loss, including crew training and licensing and requirements for design, watertight integrity, stability and periodic inspections of fishing vessels. The Fishing Vessel Casualty Task Force Report[13] covered this topic in detail.

Decal Status	Vessels Lost (All)	Documented Only
None	1,319	996
Current	368	334
Expired	373	336
Unknown	12	6
Total	2,072	1,672

Table 2

It is important to note that the Federal Regulations (46 CFR, Part 28) promulgated under the Commercial Fishing Industry Safety Act of 1988 (P.L. 100-424) primarily focus on emergency response, such as lifesaving and firefighting equipment. Thus, it would be difficult to show that strict compliance with the safety regulations would prevent vessel loss. However, the Coast Guard's voluntary dockside examination program includes an educational component, intended to raise awareness of vessel watertight integrity, stability, and maintenance problems that often lead to vessel loss. This is a possible benefit of dockside examinations that is not included in law or regulation. Of course, the voluntary nature of the program suggests a self-selection bias. In other words, the exams are not focused on vessels that need the most safety improvements, nor are the exams randomly distributed throughout the fishing fleet. Instead, vessel owners and operators that are already interested in safety improvement will request the exam.

There are occasions when dockside exams are mandatory. With increasing frequency, the National Marine Fisheries Service (NMFS) regulations require Coast Guard safety decals as a condition to fish. The purpose of these requirements is for the protection of the NMFS observers assigned to the vessels. Also, before certain fishery openings in Alaska, all vessels in port are visited and encouraged to complete a safety exam. When an exam is declined, the vessel's owner or master is informed that the vessel is more likely to be boarded while underway, because it may present a higher safety risk.

[12] At the time of this report dockside exams are a voluntary initiative. As such, there is no statute or regulation that specifies an expiration date for safety decals. The Coast Guard simply recommends a safety exam every two years, to verify that equipment is properly maintained and expendable items are up to date.

[13] U. S. Coast Guard. *Living to Fish, Dying To Fish*. Fishing Vessel Casualty Task Force, Washington, DC, March, 1999, Chapter 5 and Appendix E.

New Requirements for Vessel Safety

Section 604 of the Coast Guard Authorization Act of 2010[14] tasks the Coast Guard with conducting dockside exams of fishing vessels on a periodic basis. When this provision is implemented, all fishing vessels that operate outside of state waters will be subject to safety exams. In addition, the Act requires safety and operational training for each person "in charge of" a fishing vessel. After July of 2012, new vessels over 50 feet in length must be examined by a Classification Society, and vessels over 79 feet will require loadlines. In 2017, vessels over 25 years of age will require certification under an alternative safety program. Those changes are intended to reduce the risk of fishing vessel loss. Consequently, this report may serve as a baseline to compare accident rates after the new regulations are implemented.

F/Vs Loss Rate by Length

The fishing vessel loss rate by vessel length is shown in Figure 5, for documented vessels greater than 20 feet (1,672 vessels). A line has been added for each corresponding length range showing the annual rate of vessel loss per 1000 vessels, using the 2010 vessel population.[15] These "normalized" figures show that accident rates increase with vessel length, with a sharp spike in the 60 ft. to 70 ft. range. A variety of factors could influence this increase in accident rates. However, it is likely that larger vessels are capable of operating further from shore, with the potential for longer voyages and exposure to more severe environmental conditions.

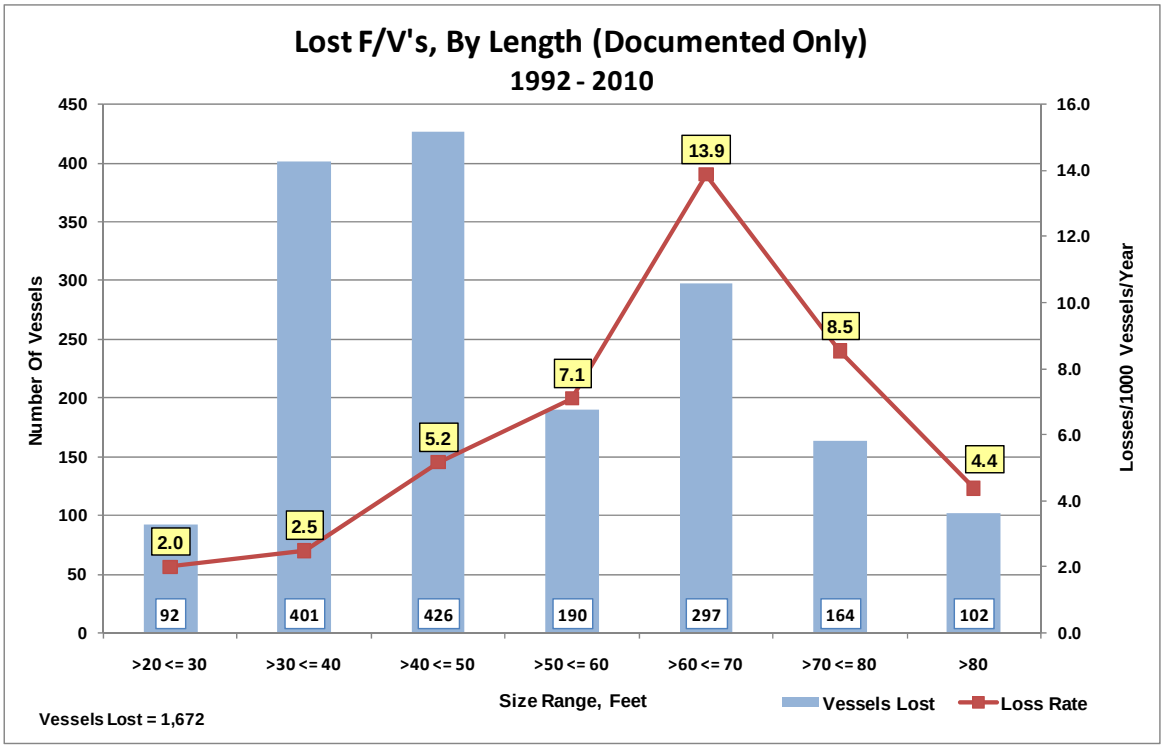


Figure 5

[14] Public Law 111-281, 15 October 2010, Section 604(f)(2).

[15] Lost F/Vs within each length category divided by the total number of F/Vs within these categories. (Total Documented F/V Population for 2010 = 19,976)

Lost Documented F/Vs by Age and Hull Material

Shown in Table 3 are the documented fishing vessel losses by age and hull material. Fishing vessel losses occurred predominately within the age range of 11 to 30 years. This age group accounted for 926 (55%) of the vessels. The breakdown of the hull material consists of the following: Wood - 789 (47%); Fiberglass Reinforced Plastic (FRP) 425 - (25%); Steel – 408 (24%); Aluminum – 21 (~1%); Concrete – 8 (.5%); and Unknown Material – 21 (~1%).

Lost Fishing Vessels (Documented), By Age And Hull Material, 1992 - 2010													
	<= 10	11<= 20	21 <= 30	31 <= 40	41 <= 50	51 <= 60	61 <= 70	71 <= 80	81 <= 90	91 <= 100	Unknown	Total	% Of Total
Aluminum	9	6	6									21	1.3
Concrete		4	4									8	0.5
FRP (Fiberglass)	72	185	125	38	3						2	425	25.4
Steel	41	119	152	61	20	10	1	1			3	408	24.4
Wood	10	112	198	124	128	94	66	35	20	1	1	789	47.2
Unknown	1	5	10	4			1					21	1.3
Grand Total	133	431	495	227	151	104	68	36	20	1	6	1,672	100.0

Table 3

The line diagram below (Figure 6) compares the vessel losses by age for the three main hull types, as shown in Table 3.

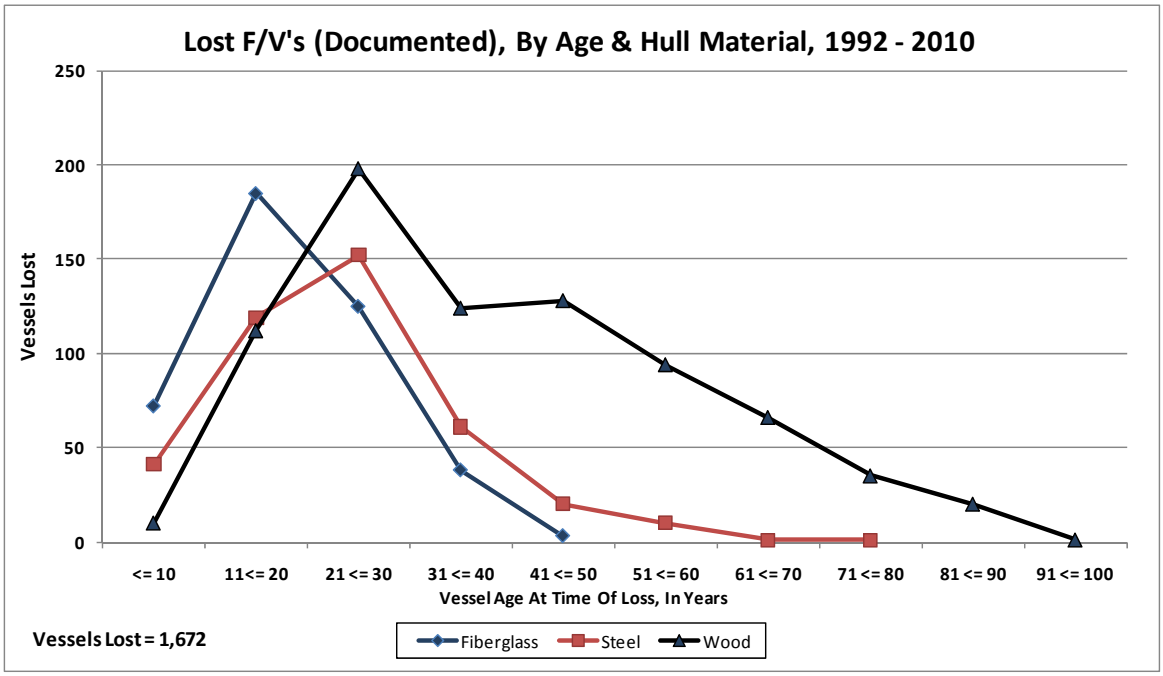


Figure 6

Pre-Casualty Operation

Figure 7 describes how the vessels were being operated prior to casualty occurrence. As displayed, 33% (676) of the losses occurred while the vessels were transiting (non-fishing mode). Other categories involving non-fishing modes were Moored, Inbound, Outbound, Towing, and Being Towed, for a total of 1,275 vessels (62%).

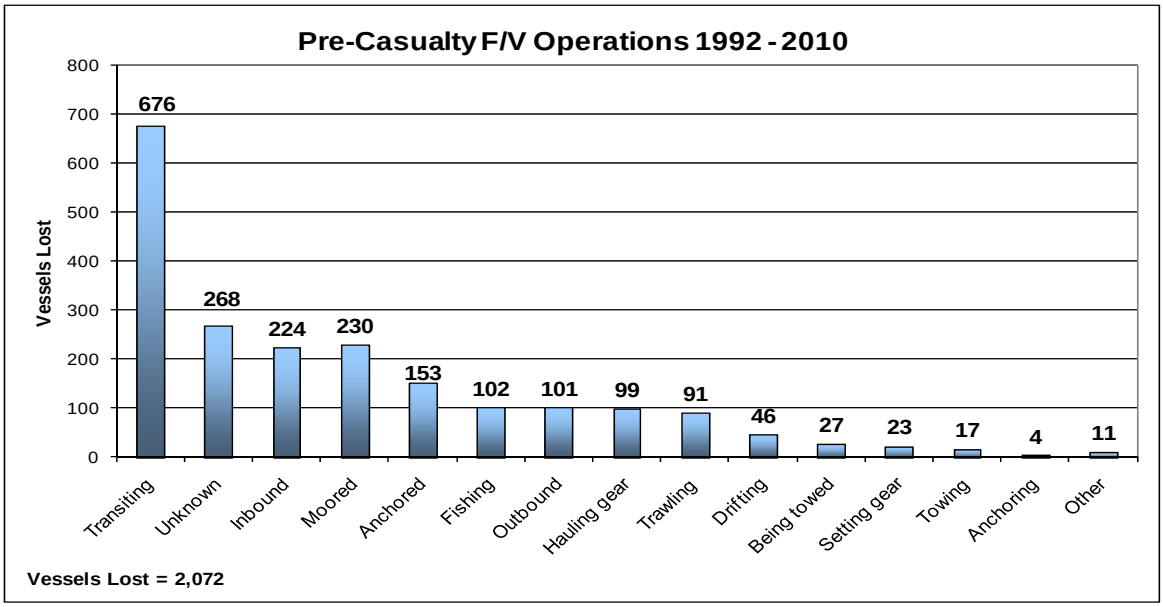


Figure 7

F/V Loss by Type of Incident

Most casualties can be described as a series of events that, in this study, lead to the loss of a vessel, (e.g., a hull failure, followed by flooding, then sinking). Figure 8 summarizes the incidents by the type of event most directly associated with the vessel loss. Vessel flooding contributed to 36% of the vessel losses during this period. Fires onboard vessels were the second leading type, having contributed to 20% of the losses.

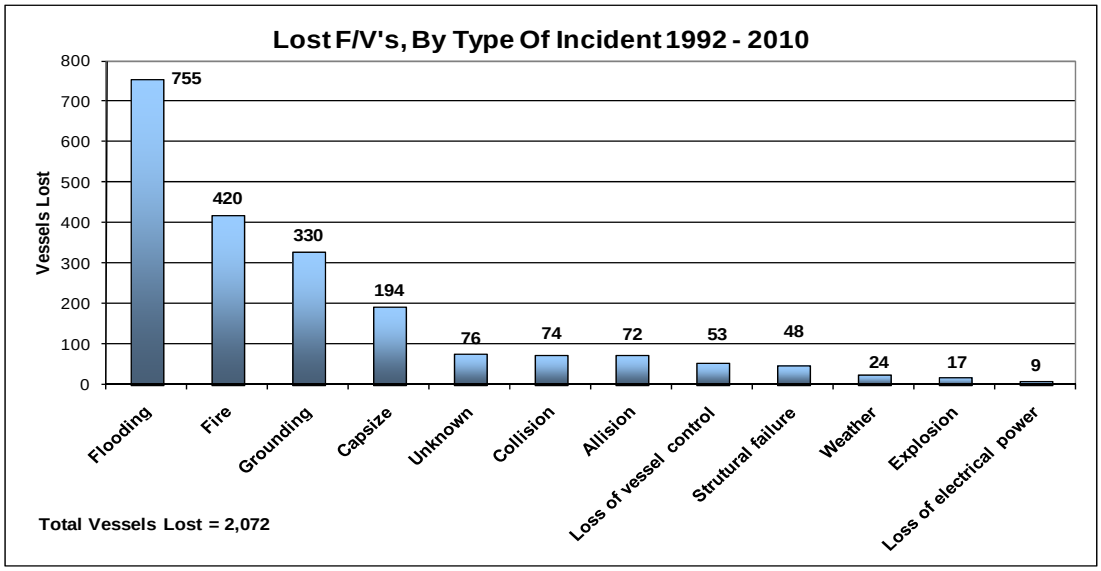


Figure 8

Causes of F/V Flooding

The leading type of vessel loss, as indicated by Figure 8, was flooding. The major causes leading to flooding were subdivided into five categories in Figure 9, consisting of Hull/Machinery Failure, Weather, Human Factors, External Fault, and Unknown. The area that contributed most to vessel flooding was Hull/Machinery Failure, accounting for 67% of the flooding losses and 25% of the casualties, overall. The Hull/Machinery Failures included: damage from casualties (i.e. grounding & allisions), Failure of hull material (i.e. wood planking, steel wastage), Failure of propulsion equipment, etc.

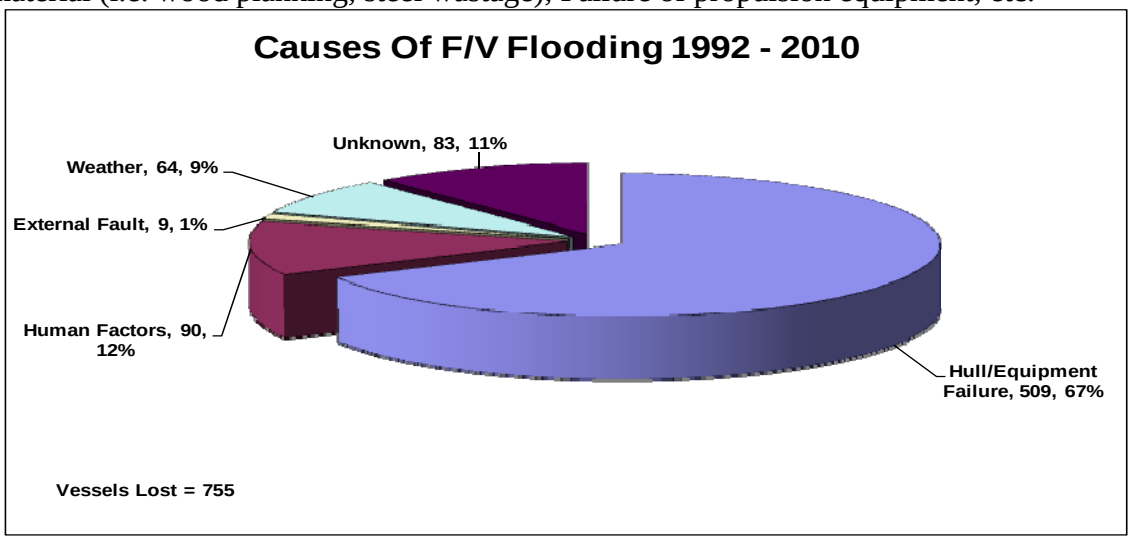


Figure 9

F/V Fire Locations

The second leading type of vessel loss was fire. In evaluating the casualty reports, it was difficult to determine the cause of most fires, because of the damage. However the location was easily retrieved. As indicated below, 73% of the fire locations occurred within the vessel's engine room. Further analysis was not feasible beyond this point due to the level of detail in many of the investigation reports.

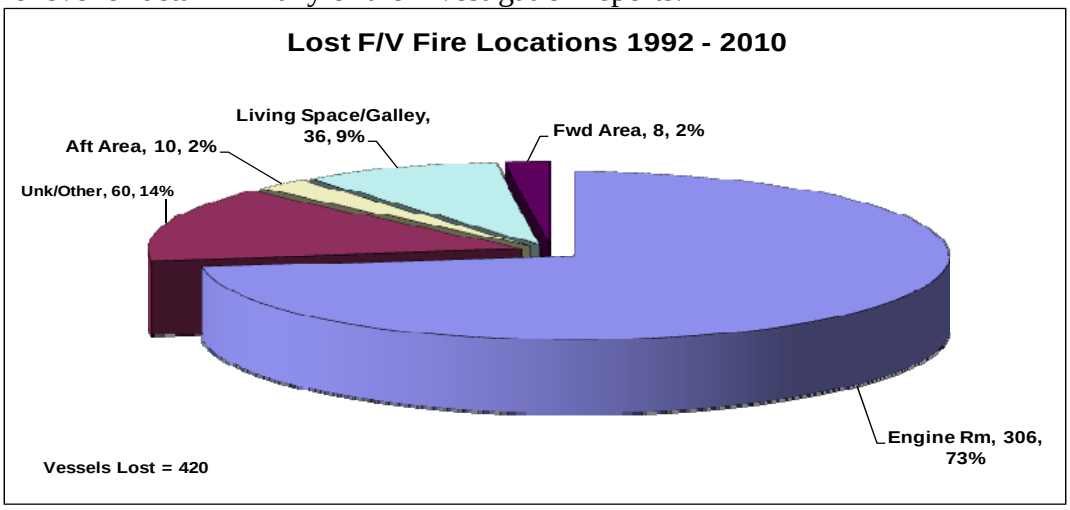


Figure 10

Summary of Lost Fishing Vessel Information

During the 19 year period of this report, 2,072 fishing vessels were lost, for an average of 109 per year. Most vessel losses (56%) occurred in the 17th (Alaska), 8th (Gulf Of Mexico), and 1st (Northeast) Coast Guard Districts. For the most recent 5 years, the average was 61 vessels lost per year.

Coast Guard documented vessels accounted for 1,672 (81%) of the vessel losses. Among the documented vessel population, accident rates increased with vessel length, with a sharp spike for vessels 60 – 70 feet in length. More than half (55%) of the lost vessels were between 11 and 30 years of age. Since 1997, the documented fishing vessel population has gotten smaller and older, which may present a greater casualty risk. The most recent data shows that 61% of all documented vessels are between 21 and 40 years of age.

A methodology known as control charting was used to examine the trend in vessel losses. The chart showed a statistically significant drop, starting in 2006. Additionally, there was a new record low in 2008, (57 vessels). Given the complexity of the fishing industry, the drop is most likely due to a combination of factors, including economics (e.g., fuel prices, changes in fishery management plans), environment (e.g., hurricanes Rita and Katrina), and regulatory activities (e.g., increased Coast Guard boardings and examinations).

It is difficult to show that strict compliance with the fishing vessel safety regulations would prevent vessel losses. The Federal Regulations (46 CFR, Part 28) promulgated under the Commercial Fishing Industry Safety Act of 1988 (P.L. 100-424) primarily focus on emergency response, such as lifesaving and firefighting. The data presented on the preceding pages shows that most losses are due to flooding and fires - problems that are largely not covered nor can be substantially prevented by the current regulations.

The Coast Guard Authorization Act of 2010 (Public Law 111-281), included several new requirements for fishing vessel safety, including periodic dockside examinations. Those changes are intended to reduce the risk of fishing vessel loss. Consequently, this report may serve as a baseline to compare accident rates after the new regulations are implemented.

C. DEATHS AND MISSING PERSONS

Overview

The casualty data for calendar years 1992 through 2010 included 757 reports involving loss of life. Those incidents resulted in 1,055 deaths, or an average of 56 fatalities per year. More than 1/3 of all fatalities (489) occurred at the same time a fishing vessel was lost, involving 249 of the lost vessels described in the preceding section. Significant among the vessel losses was the sinking of the *ARCTIC ROSE* on or about 1 April 2001, with 1 deceased and 14 missing crewmembers. The *ARCTIC ROSE* sinking resulted in the highest number of fatalities since the *GUDRUN* disappeared off the Atlantic coast on 1 January 1951, with the same fatality count.[16]

Fatalities By Coast Guard District

Fatalities by Coast Guard District are shown in Table 4. Like vessel losses, the highest number of fatalities occurred in the 17th (Alaska), 8th (Gulf of Mexico) and 1st (Northeast) Districts, for 57% of the total. Also, the most recent 5 years are shown in the last column. The 17th District reported the most fatalities for that period.

Fishing Vessel Fatalities, By Year And District

District	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Grand Total	Last 5
17	26	18	18	17	22	3	13	19	5	23	12	7	6	14	9	4	17	4	2	**239**	**36**
08	16	18	6	16	17	13	11	16	4	11	12	10	9	8	6	5	7	8	7	**200**	**33**
01	17	10	14	5	8	11	8	6	11	10	2	13	9	6	6	9	3	11	5	**164**	**34**
11	5	12	17	5	11	11	12	12	3		4	2	6		3	3	3	4	3	**116**	**16**
13	7	10	10	9	6	10	7	5	5	8	2	3	1	1	7	5	6	4	4	**110**	**26**
07	5	17	7	2	3	8	7	7	5	1	4	5	3	9	3	3	2	0	2	**93**	**10**
05	5	3	3	4	7	4	6	12	3	4	1	3	3	3	8	3	3	12	4	**91**	**30**
14	4	4		4	8	1	3		1	1				1		1	2	3	5	**38**	**11**
09							4													**4**	**0**
Grand Total	**85**	**92**	**75**	**62**	**82**	**61**	**71**	**77**	**37**	**58**	**37**	**43**	**37**	**42**	**42**	**33**	**43**	**46**	**32**	**1055**	**196**

Table 4

Distribution Of Fatalities

The number of fatalities per incident is summarized by the histogram in Figure 11. Together, incidents with either one or two fatalities are 91% of the cases and 75% of the fatalities.

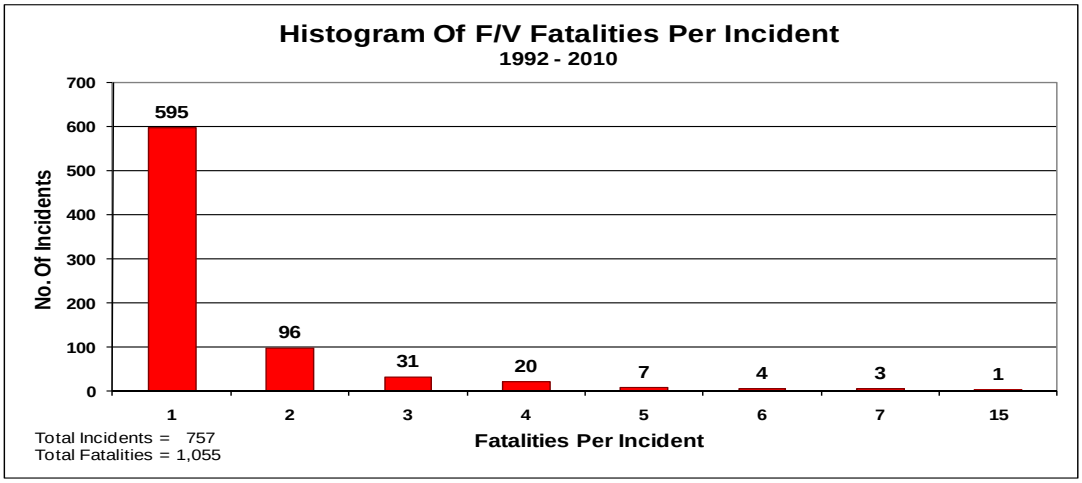


Figure 11

[16] The *ARCTIC ROSE* and *GUDRUN* casualties were both subjects of Marine Boards of Investigation, which can be viewed a the Coast Guard's Homeport web portal (http://homeport.uscg.mil) in the following folder: Missions > Investigations > Marine Casualty Reports.

Fatalities By Casualty Type

Table 5 summarizes the fatalities by casualty type. As shown in both Table 5 and Figure 12, just over half (53%) of all fishing vessel deaths are attributed to flooding, sinking, or capsizing of the vessel. Another 24% of the fatalities were falls overboard. ***With three-quarters of all fatalities, water exposure is by far the most significant factor in personnel loss***. The next largest group of accident types includes fishermen that were struck by or caught in lines or other equipment, for 7% of the total.

Casualty Type	Fatalities
Vsl. Flooding/sinking/capsize	564
Fall into water	251
Pulled overboard by equipment	45
Diving Accident	42
Caught in winch	23
Dangerous Atmosphere	20
Struck by Moving Object - Other	20
Unknown Injury Type	17
Crushed by equipment	13
Struck by/Caught in lines	13
Smoke Inhalation - Vsl. Fire	11
Drowned - Entered water voluntarily	7
Electrical shock	5
Drowned while attempting to unfoul propeller	4
Fall onto surface	4
Struck a Fixed Object	4
Vessel Collision/Grounding	4
Blown Overboard By Explosion	3
Exposure - Other	3
Fell overboard, crushed between dock and vessel	1
Burns	1
Total	**1055**

Table 5

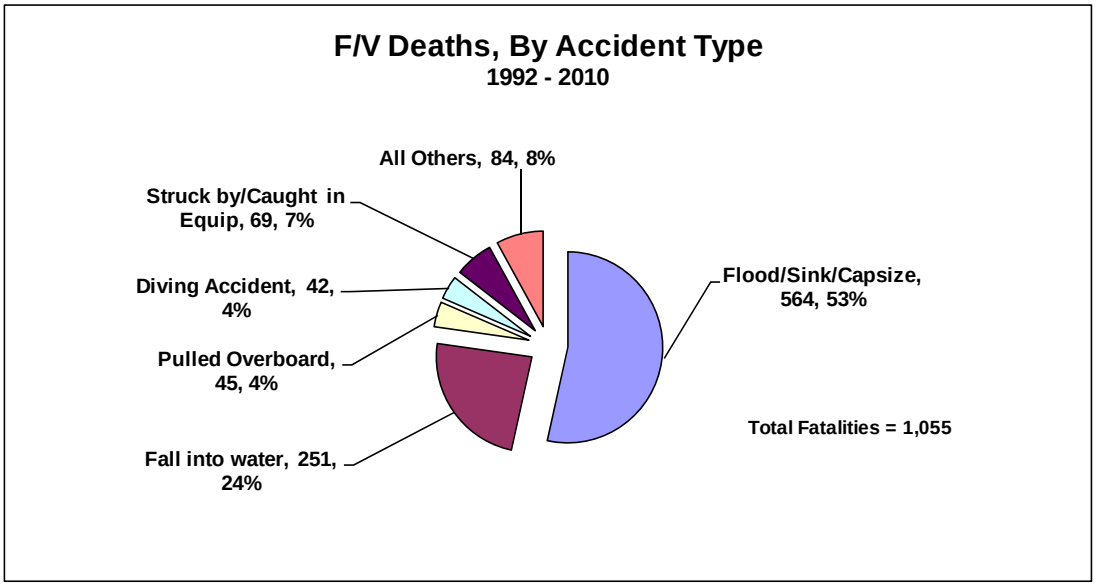


Figure 12

Deaths With Vessel Flooding, Sinking Or Capsize

Since half of all personnel casualties are associated with the flooding, sinking or capsizing of a vessel (564 of 1,055), it is useful to look at them separately. Figure 13 shows this group, arranged by Coast Guard District. (A map of the Coast Guard Districts is shown in Figure 3.) The four highest counts are along the West and Northeast coasts of the U.S., accounting for nearly three-fourths (69%) of the vessel-related deaths.

The distribution of fatalities along the U.S. coastline is even more significant when one considers the figures for the 8th Coast Guard District, along the Gulf of Mexico. Overall, the 8th District had the second highest number of fatalities behind the 17th District (Alaska), with 239 and 200, respectively. Conversely, vessel-related fatalities in the warmer Gulf of Mexico waters ranked 5th among the 9 Coast Guard Districts. The large percentage of casualties on the West and Northeast coasts can be attributed to more severe conditions, especially cold-water exposure.[17] It is well known that survival times decrease rapidly as water temperature decreases.[18] Thus, the availability and use of survival equipment becomes more critical as the water becomes colder.

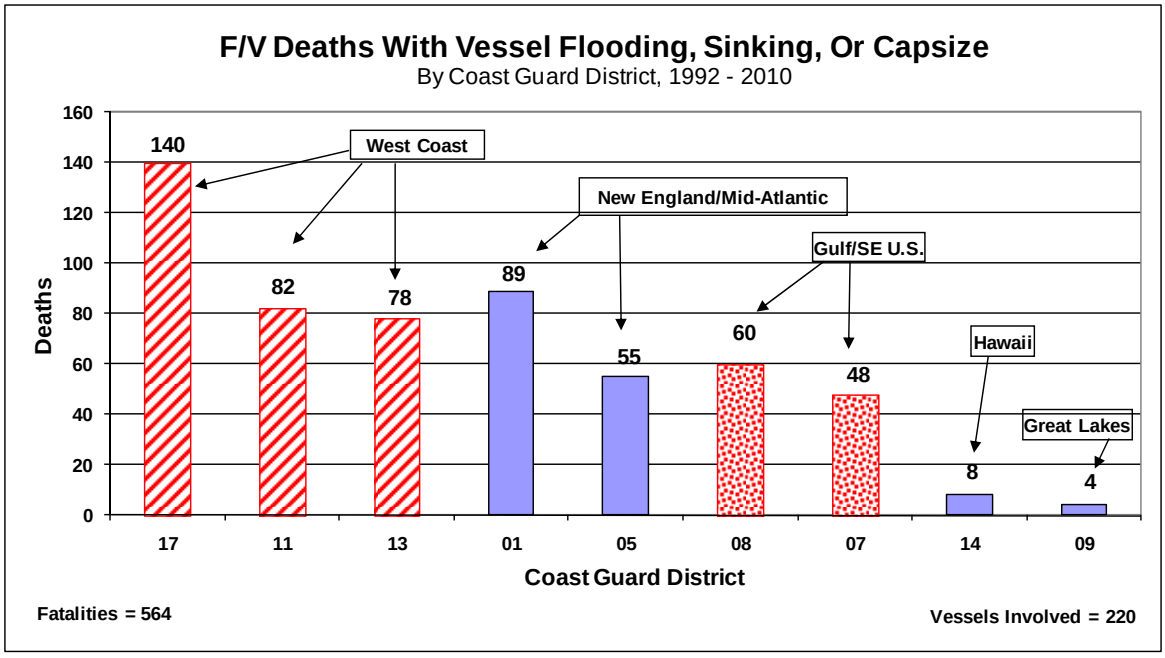


Figure 13

[17] Cold water conditions exist year round along the West Coast because of the Aleutian, California, and Davidson currents, which run parallel to shore.

[18] An overview of this topic is provided in the internet version of *The Ships Medicine Chest and Medical Aid at Sea*, U.S. Department of Health & Human Services: http://www.operationalmedicine.org/TextbookFiles/ShipsMedicineChest.htm

Cold Water Fatalities

As noted, most vessel-related fatalities (69%) occurred in the more severe conditions off the West and Northeast coasts. Given this apparent relationship to environmental conditions, time of year may be a factor as well. The chart in Figure 14 shows the vessel-related fatalities by month, along with a best-fit trend line. The chart shows that fatality counts tend to be higher in the months of October through January. The trend was examined with the *ARCTIC ROSE* incident included and excluded. The incident made only a slight change in the overall trend. The monthly distribution for West and Northeast coast incidents was, also, examined separately. The trend was essentially the same as the nationwide pattern. However, the difference between the months of October through January and the other months was a bit greater.

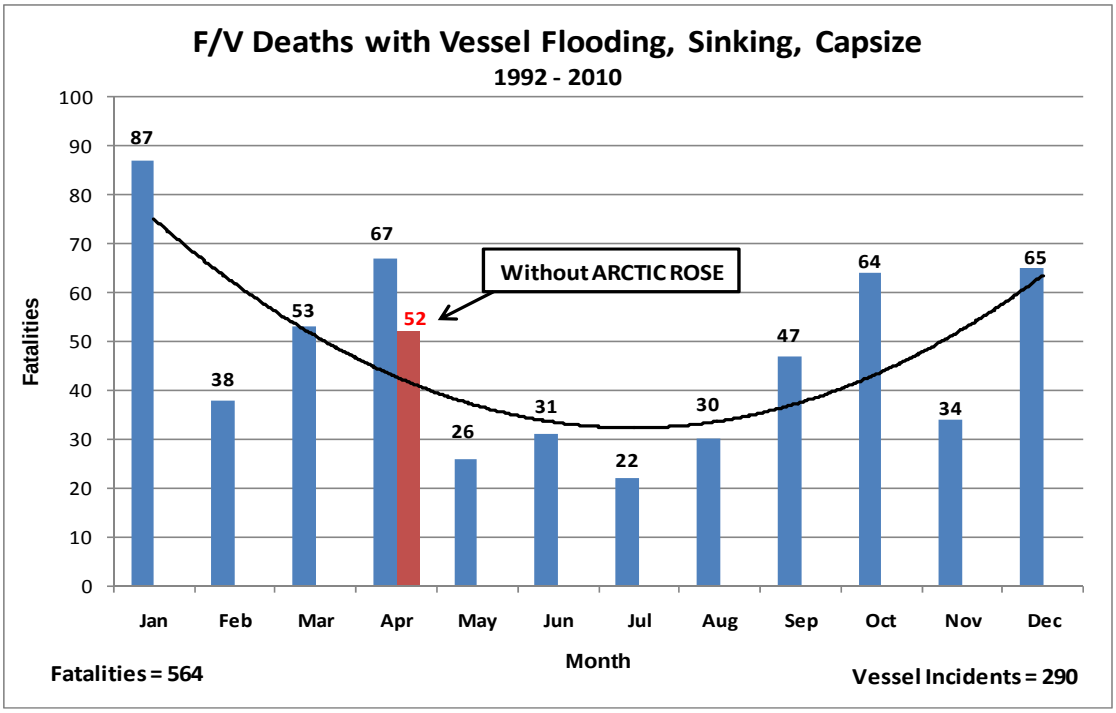


Figure 14

Fatalities In Warmer Waters

To provide a direct comparison between districts, a fatality rate can be calculated by comparing the number of vessel-related fatalities to all vessels lost due to flooding, sinking or capsizing. Using this comparison, the difference between regions is more distinct. The lowest fatality rates (for fatalities associated with vessel loss) were along the Gulf of Mexico and Southeast U.S. coast, (the 8th & 7th Coast Guard Districts), as shown in Table 6. As expected, the highest vessel-related fatality rates occurred in the colder waters along the West and Northeast Coasts. The West Coast fatality rates are about double that of the 7th and 8th Districts.

Coastal Area	District	Vessels Lost	Fatalities	Fatalities Per Lost Vessel
New England/Mid-Atlantic	1	168	89	0.53
	5	70	55	0.79
Gulf/Southeast U.S.	7	133	48	0.36
	8	159	60	0.38
West Coast	11	128	82	0.64
	13	96	78	0.81
	17	177	140	0.79

Table 6

Casualty reports showed that vessel-related fatalities in the 7th and 8th Districts involved a number of factors, in addition to water temperature. Many of the vessels were lost suddenly, often in severe weather conditions. The 108 "warm water" fatalities occurred in 67 incidents. Of those 67 incidents, 29 vessels capsized. At least 19 of the capsizings occurred during severe weather, and 3 more resulted from fishing gear that snagged an obstruction. Of 19 vessels that sank, 3 occurred during severe weather and 5 began with flooding that was discovered too late for corrective action. Seven vessels disappeared with their crews. Thus, it is known that nearly half of the incidents occurred too quickly for the use of lifesaving equipment. It is likely that this percentage is understated, given the number of vessels that disappeared due to unknown causes.

Also, 12 incidents involved other initiating events. While each of those incidents ultimately led to a flooding, sinking or capsizing, they are not considered applicable, for the purposes of this comparison.

Of the 108 warm water fatalities, it is known that 21 persons were trapped in their vessel or its rigging. Again, it is not likely that these fatalities could have been prevented by the use of lifesaving equipment. Forty-nine persons entered the water and died from drowning or hypothermia. Seventeen persons died from unknown causes when their vessel disappeared. The remaining 19 fatalities resulted from the non-applicable incidents described above.

The incident reports confirmed that persons can survive much longer in warmer waters – but not indefinitely. Survival times in the warmer waters were measured in hours, instead of minutes for cold waters such as Alaska. For example, two crewmembers held onto a life ring after their vessel sank in the Gulf of Mexico. One of them was rescued by a Coast Guard aircraft approximately 18 hours after entering the water. The other crewmember succumbed

to hypothermia less than an hour before the aircraft arrived. In six other incidents, it was reported that crew members remained in the water up to eight hours before rescue.

Even in warmer waters, the use of lifesaving equipment is important. Most survivors were recovered in either a Personal Flotation Device (life jacket) or a life raft. Conversely, most of the deceased crewmembers entered the water with no lifesaving equipment. The use of a life raft was reported 5 times. On two occasions, crewmembers had been in a raft for 2 days or more, until they were discovered by a passing vessel.

Finally, there are at least two incidents that show the importance of training. On 11 December 1997, the *GULF KING 15* burned and sank in the Gulf of Mexico, approximately 60 miles south of Freeport, Texas. All three crewmembers were able to abandon the vessel. However, none of the crew knew how to properly deploy the life raft. Instead of launching the raft correctly, the crew removed the raft from its container and threw it overboard, uninflated. The three crewmembers clung to the undeployed raft for several hours. Eventually, one of the crew drowned after letting go of the raft. The vessel's master, in a weakened condition, drowned while being rescued by a Good Samaritan fishing vessel.

The above scenario was repeated on 2 December 2010 when the *MARIO ARTURO II* sank in the Gulf of Mexico, just 8 miles offshore from Galveston, Texas. As the vessel was sinking, crewmembers disconnected a line between the vessel and the life raft's release/inflation mechanism and threw the raft overboard. This allowed the raft to drift away from the vessel, uninflated. Shortly thereafter, the four crewmembers entered the water with no personal flotation. Three of the crewmembers were able to locate and cling onto floating debris from the vessel. The fourth crewmember drowned. Less than one hour after entering the water, the three survivors were rescued by a Coast Guard helicopter. The investigating officer for this incident concluded that a lack of training in the use of lifesaving equipment contributed to the loss of life.

In summary, the review of warmer water incidents highlighted the following:

- ***Some incidents happened too quickly for effective use of lifesaving equipment, or trapped crewmembers on board. To eliminate fatalities from such incidents, it would be necessary to prevent the vessel losses.***
- ***Even with longer survival times in warmer waters, lifesaving equipment is essential.***
- ***At least three fatalities could have been prevented by training in the use of lifesaving equipment.***

Fatalities v. Hull Material

In Table 7, vessel-related fatalities are compared to all vessels lost to flooding, sinking or capsizing. The last 2 columns of the table show the vessel losses and fatalities as a percentage of their respective totals. For vessel losses, the highest percentages involved wood and steel hulls, respectively. However, those percentages are reversed for fatalities, with steel-hulled vessels accounting for 44% of the vessel-related fatalities.

It appears that the high percentage of fatalities on steel vessels is due to their size and area of operation. Using the 2010 documented vessel population; the average length for steel vessels was 73.7 feet. The average wood vessel was 45.8 feet in length. Thus, steel vessels would be capable of operating farther from land, with larger crews – two factors of increased risk.

Comparison of Vessel-Related Fatalities To Vessels Lost, by Hull Material				
Hull Material	**Vessels Lost**	**Vessel-Related Fatalities**	**% Vessels Lost**	**% Fatalities**
Wood	369	99	38.88	17.55
Steel	241	248	25.40	43.97
FRP	184	111	19.39	19.68
Aluminum	11	11	1.16	1.95
Other	4	1	0.42	0.18
Unknown	140	94	14.75	16.67
Totals	**949**	**564**		

Table 7

Vessel-Related Fatality Trend

Beginning in calendar year 2000, there is an apparent downward shift in vessel-related fatalities, as shown in Figure 15. (For comparison purposes, the *ARCTIC ROSE* casualty is shown separately, as indicated by the dotted line.) The control charting methodology described earlier can be used to further evaluate this trend. Calendar years 1992 – 1999 were used to calculate the average, upper and lower control limits, (i.e., the "base period"). Using this methodology, the reduction in fatalities that began in 2000 can be considered statistically significant. In other words, the reduction signals an improvement in vessel-related fatalities that is not explained by the normal year-to-year variation. According to *Wheeler*, either of the following two criteria may be used to support this conclusion. The fatality trend meets both of them;[19]

1. One or more values (2002, 2007 & 2010) dropped below the lower control limit, **OR**;
2. Three of the four most recent values were closer to the lower limit than to the average. This criterion is exceeded, since all of the values after 1999 are closer the lower limit.

Thus, there has been a real, measurable reduction in fatalities, with a new record low for 2010. If this trend continues, one can expect an average of 19 vessel-related fatalities per year, instead of the previous 42. Actual counts can be expected to fluctuate between 5 and 34, (i.e. the new trend limits). Fatality trends, by District, are provided in Appendix E.

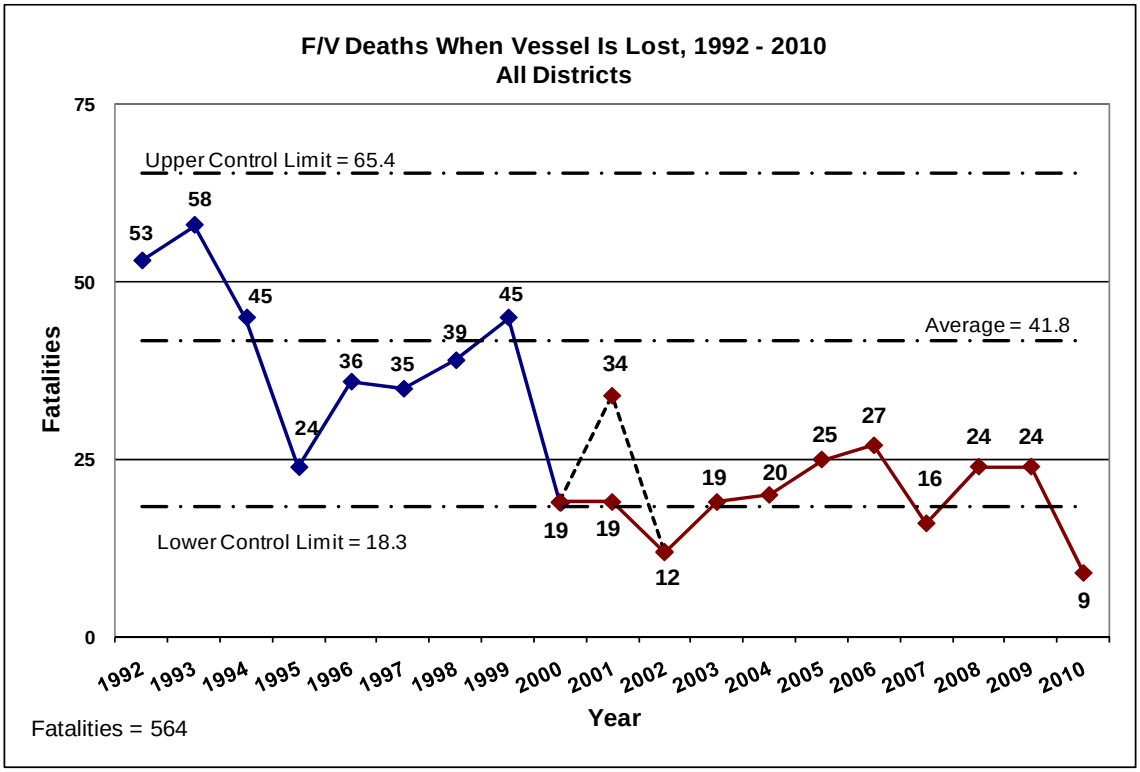


Figure 15

[19] Wheeler, Donald J., *Understanding Variation: The Key to Managing Chaos*, SPC Press, Inc., Knoxville, TN, 1993, pg. 57.

Comparison To Vessel Losses

The correlation between vessel-related fatalities and vessel losses was examined and found to be quite low. This is understandable, given that:

- Most of the current safety regulations focus largely on saving lives and not on preventing vessel loss. In fact, the intent is to eliminate fatalities, regardless of vessel losses. The use of lifesaving equipment is described further on the following pages.
- Not all of the vessel-related fatalities occurred on vessels that were total losses. Some of the vessels returned to service after flooding, sinking or capsizing incidents.
- Between incidents, there is some variation in crew size, (i.e., the number of persons at risk, per vessel, is not constant).
- Some incidents result in no fatalities, especially when crew members are rescued by other vessels in the vicinity of the incident, (i.e., Good Samaritan vessels.)

Use Of Safety Equipment

The summary data presented earlier shows that nearly 8 of 10 (77%) fatalities resulted from water exposure. The Commercial Fishing Industry Vessel Safety Act of 1988 and associated Federal Regulations, implemented in the Fall of 1991, address water exposure through emergency equipment, training and drills. Thus, one would expect a reduction in fatalities among the fishing vessels that have on board, and when crewmembers properly use, the required emergency equipment. Overall, there has been some apparent improvement. During the 10 years prior to the implementing regulations of the Fishing Vessel Safety Act, 1982 through 1991, there were 1045 fatalities, or an average of 105 per year. For the most recent 10 years, from 2001 through 2010, there were 413 fatalities, or 41 per year (61% lower).[20] This high-level comparison suggests that the collective safety efforts have had the intended effect.[21] However, this comparison includes other fatality types, such as on-deck accidents. To get more details on the usage and benefits of emergency equipment, each of the casualty reports was reviewed individually, and the results are presented below.

From 1992 through 2010, the primary event leading to water exposure fatalities was vessel loss, followed by falling overboard. Of the 564 fatalities resulting from vessel loss, the usage rates of survival equipment, shown in Table 8, were very low. For PFDs (Personal Flotation Devices)/Survival Suits, the reported usage rate was 10%. The usage rates for rescue boats, EPIRB's, and radios were 18%, 34%, and 30% respectively. Thus, it is reasonable to assume that many of these fatalities could have been prevented with use of the required emergency equipment. It is notable, however, that 149 of the 564 fatalities, or 26%, showed "available, no time for use" for PFD/Survival Suit utilization. Generally, these fatalities occurred when the vessel was lost suddenly, such as capsizing, or when a problem, such as engine room flooding, was not discovered in a timely manner. ***As noted previously, to eliminate such fatalities it would be necessary to prevent or delay vessel losses.***

[20] The fatality figures for 1982 – 1991 were extracted from the Coast Guard's *CASMAIN* database, which predates the MSIS system.
[21] These figures are not "normalized" or referenced to the number of persons working on fishing vessels, fishing activity, economic changes or other factors, such as weather. Thus, the population is assumed to be constant throughout the period. Indeed, there would have to be a dramatic drop in the worker employment to negate the 61% reduction in fatalities.

	Used (%Used)	Not Used	Not Applicable[22]	Unknown
PFD/Survival Suit	56 (10%)	292	2	214
Rescue Boat	100 (18%)	243	31	190
EPIRB	194 (34%)	125	46	199
Radio	169 (30%)	110	10	275

Table 8

Survival Rates In Cold Waters

A survival rate can be calculated by comparing the number of persons on lost fishing vessels to the number of survivors. From Figure 13 we know the greatest number of deaths from vessel flooding, sinking or capsizing occurred along the West and Northeast coasts (389 deaths and 186 lost vessels), apparently the result of more severe water conditions. Because of the more severe conditions, we also know that the use of lifesaving equipment is more crucial along the West and Northeast coasts. Thus, survival rates were prepared for the vessel-related fatalities in those cold water areas as shown on Table 9.

For incidents where survival suit/PFD usage is known, the results indicate that ***fishermen survive more than twice as often when survival equipment is properly used***.

This is considered to be a significant finding.

In fact, this result is understated. Of the 77 survivors that did not use a survival suit in cold waters, 27 of them were saved by using a life raft. Conversely, the fatalities among persons who used survival suits are explained in the investigation reports. Those 64 fatalities involved suits that were damaged, did not fit, or were not completely donned. ***This highlights the importance of maintaining lifesaving equipment and practicing its use.*** It is likely that emergency drills would have detected the damaged and inadequate survival suits before they were needed, thereby preventing as many as 64 fatalities.

SURVIVAL RATE COMPARISON			
West And Northeast Coasts of the U.S., 1994 - 2010			
Survival Suit Usage	**All Persons At Risk**	**Survivors**	**Survival Rate**
Used	184	120	65%
Not Used	271	77	28%
Unknown	146	15	N.A.
Overall	**601**	**212**	**35%**

Table 9

[22] The "Not Applicable" values represent incidents where survivors were able to step directly onto another vessel without first entering the water, or other circumstances where the equipment was not required or not needed.

Voluntary Dockside Examinations

Data from the Coast Guard's voluntary dockside exam program provides another indicator of safety. Since the program began in 1992, exam results were recorded in the marine safety databases. Vessels meeting all requirements were issued decals to display onboard. Of the 564 fatalities resulting from a vessel loss, 73% occurred on vessels with no decal or with a decal over 2 years old (unofficially "expired") as summarized in Table 10. This is another indication that safety equipment, and the increased awareness gained through interaction with crewmembers during dockside exams, is saving lives.

Since 27% of the fatalities (150) occurred on vessels with decals, each of the investigation reports was reviewed for additional details. The reports showed that nearly all of the vessel losses occurred suddenly, with little time to respond. The fatalities occurred on 56 vessels that were lost by capsizing (24), flooding (26), collision (5), and fire (1). In nearly all of these casualties crewmembers either could not get to the survival equipment or, in a few cases, could not fully don a survival suit before entering the water. In fifteen of the incidents, the first indication of distress was an EPIRB alert. ***In the incidents just described, it would be necessary to prevent the vessel losses in order to eliminate the fatalities.***

Deaths When Vessel Is Lost	
Decal Status	**Dead/Missing**
None	340
Current	150
Expired	70
Unknown	4
Total	**564**

Table 10

Good Samaritan Rescues

The casualty reports often mention that crewmembers were rescued by nearby vessels. However, this information was not captured in the Coast Guard databases in a way that could be electronically searched and analyzed. Therefore, the narrative information in each case report was read to determine how often crewmembers were rescued by Good Samaritan vessels.

The reports showed that Good Samaritan vessels rescued one or more crewmembers in 604 of the 2,072 vessel losses, or 29% of all incidents. The distribution of these cases, by year, is proportional to and parallels the overall vessel losses very closely, as shown in Figure 16. Throughout the 19 year period, between 23% and 46% of all lost vessels received Good Samaritan assistance.

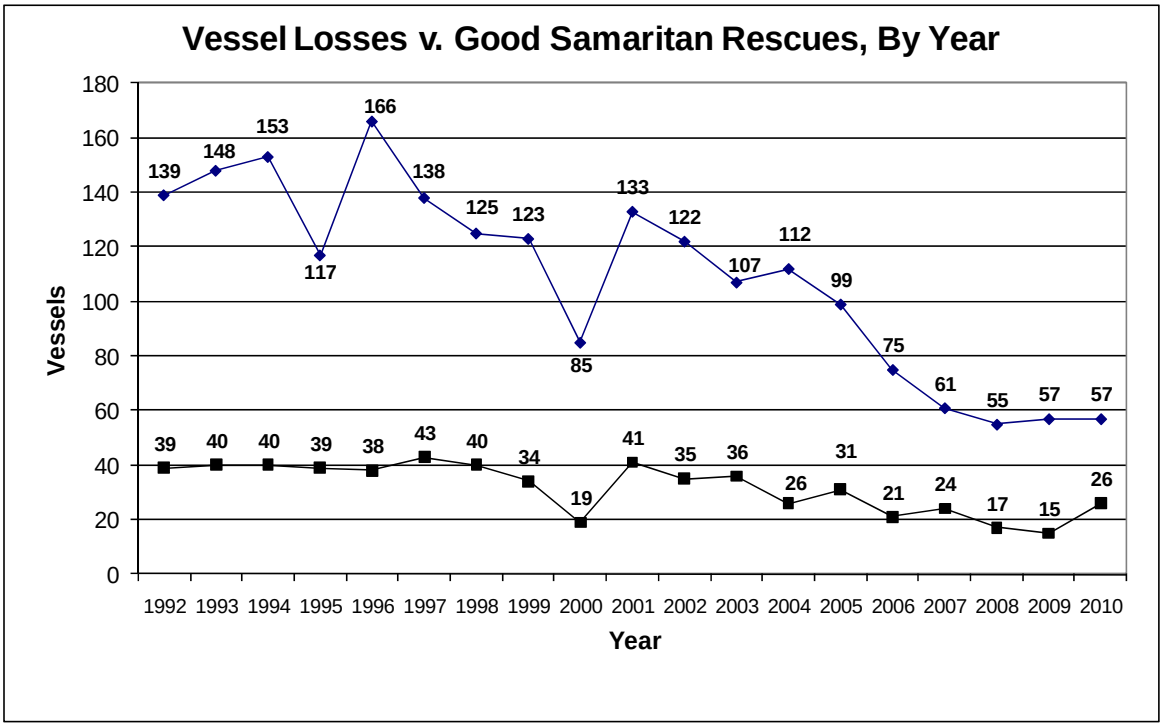


Figure 16

The significance of Good Samaritan rescues becomes apparent when compared to vessels where no assistance was available, as summarized on Table 11.

Of the 604 vessels that received Good Samaritan assistance, only 41 of them resulted in one or more fatalities for a total of 56 persons (0.10 fatalities per vessel). Conversely, there were 208 vessels lost with fatalities but no Good Samaritan assistance. Those incidents resulted in 433 fatalities, or 2.08 fatalities per vessel.

	Lost Vessels With Good Samaritan Assistance	Lost Vessels With Fatalities, But No Good Samaritan Assistance	All Lost Vessels With Fatalities
Vessels	604	208	249
Persons At Risk	1,764	627	805
Fatalities	56	433	489
Fatalities/Vessel Lost	**0.10**	**2.08**	**1.96**
% Of Persons At Risk	**3.2%**	**69%**	**61%**

Table 11

Of the 41 vessels with fatalities during Good Samaritan assistance, the case reports showed that most of the vessels were lost suddenly. Twenty-two of the vessels capsized; fourteen sank quickly; three vessels were involved in collisions, and; two vessels suffered an engine room explosion or fire. There was at least one survivor in each of these incidents making it possible to get some details about the deaths.

Of the 56 fatalities in this group, twenty-six persons died when they were either trapped inside their vessel or were entangled in fishing gear. Twenty-one persons died after entering the water, with no time to don a survival suit or PFD. Two more persons died in survival suits that were not fully closed. Five persons are missing, one was crushed between vessels during rescue, and one person died of hypothermia while in a life raft.

The accident reports showed that lack of lifesaving equipment was a critical factor in 15 of the 56 fatalities. Conversely, nearly all of the survivors were recovered in either survival suits or life rafts. Thus, it is concluded that:

- ***A significant, but unknown, number of crewmember fatalities were prevented, since Good Samaritan vessels were present for nearly 30% of the vessels that were lost. Hypothetically, 1,200 lives may have been saved, if one assumes the same death rate as the vessels with no Good Samaritan assistance:***
  433 deaths/208 incidents = 2.08 deaths per incident.
  (604 assisted vessels x 2.08) - 56 actual fatalities = 1,200 fatalities prevented.
- ***While it is fortuitous that Good Samaritan vessels were present to rescue crewmembers, the true risk from vessel losses may be hidden, because crew members do not enter the water or are only exposed for a short period of time. Thus, Good Samaritans may be serving as a substitute for properly maintained lifesaving equipment. Yet, it would not be prudent to expect Good Samaritan vessels to be nearby when needed.***
- ***Even when a Good Samaritan vessel is nearby, lifesaving equipment is essential.***

Falls Overboard

Overall, falls overboard resulted in the second largest number of fatalities, with 24% of the total, (251 of 1,055.) PFD/survival suit usage was reported for only two of the 251 fatalities, although "unknown" was reported for 111 persons. Also, investigating officers noted the use of alcohol in 31 of the fatalities and drug use four times.

Table 12 shows falls overboard fatalities, by District and year. By far, the highest number of fatalities occurred in the 8th District, accounting for 35% of the total. In fact, more than 43% of all 8th District fatalities were falls overboard, (87 of 200). Further, this is the only District that recorded falls overboard fatalities every year. Given that the 8th District has the warmest waters and, thus, the longest survival times, the number of falls overboard fatalities appear to be abnormally high. The data provides no reasons for this high number of fatalities. There were statistically significant improvement in 2004 and 2006, followed by a return to previous levels. Thus, this appears to be a region where continued emphasis on safety equipment, drills and training would be beneficial.

Falls Overboard Fatalities, By Year and District																				
District	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Totals
01	5	1	3	1	2	4	3	2	2		1	3	1			3		3	1	35
05	1			1	1	1	1	3		2	1	1	1		3		1		3	20
07	1	1	3		3	1	2	2	1	1	1			2		2			1	21
08	5	7	3	7	10	5	9	7	3	5	4	6	2	1	2	1	3	3	4	87
11	2	1		1	1	3		1	1		1						3	1	1	16
13	2	3	1	2	1		2	1	2		1	1		1		2	1	1		21
14	1	1		1	1		1							1		1	1	2	2	12
17	3	4	2	4	3		1	4	2	4	2		1	4		2	1	2		39
Totals	20	18	12	17	22	14	19	20	11	12	11	11	5	9	5	11	10	12	12	251

Table 12

The falls overboard fatality trend is shown in Figure 17, along with control limits. Similar to vessel-related fatalities, the number of falls overboard fatalities shifted downward after the 1999 Fishing Vessel Safety Task Force initiatives. Assuming a "level shift" in 2000, one can expect an average of 10 fatalities per year, instead of the previous 18. Actual counts can be expected to fluctuate between 3 and 17, (i.e. the new process limits.)

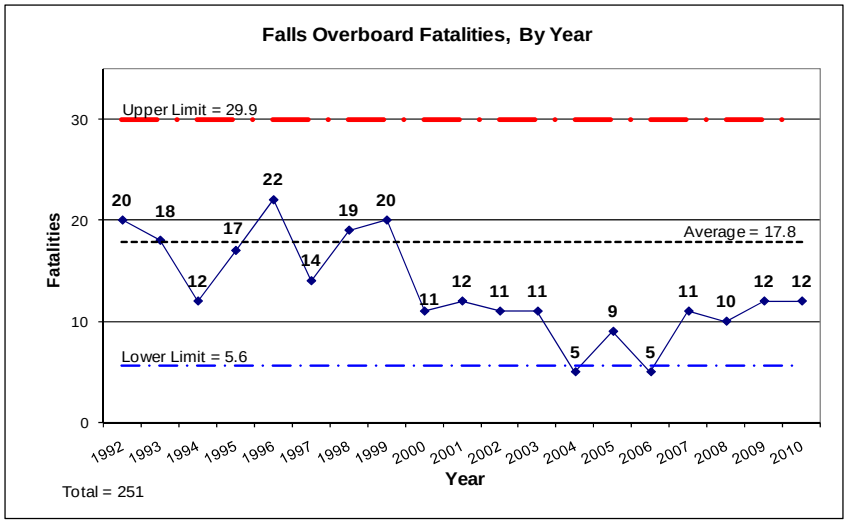


Figure 17

Data Interpretation

In this section, the most important factors leading to loss of life on fishing vessels were sought. The findings and conclusions are summarized as follows:

- **Descriptive Statistics** – For the nineteen year period of this report, there were 753 incidents that resulted in 1,055fatalities, or an average of 56 fatalities per year. Those incidents included 249 of the lost vessels described earlier. The largest number of fatalities occurred in the 17th (Alaska), 8th (Gulf of Mexico), and 1st (Northeast U.S.) Coast Guard Districts, for 57% of the total. Incidents with one or two fatalities accounted for 91% of the cases and 75% of the fatalities. Consequently, it will be necessary to address a relatively large number of incidents in order to reduce fatality counts significantly.

- **Casualty Type -** When the incidents were grouped by casualty type, water exposure was the most prevalent factor. Vessels that flooded, sank, or capsized accounted for 53% of the deaths and missing persons. Another 24% of the fatalities were falls overboard. The next highest category, deaths from being struck by or caught in moving equipment, was 7% of the overall total.

- **Deaths From Vessel Loss –** For this sub-group of fatalities, loss of life was dramatically higher on the U. S. West and Northeast coasts than in other regions (69% of the total). The most likely reason for this is more severe conditions, especially cold water. Also, fatalities were higher during the months of October through January.

- **Fatalities In Warm Waters –** When presented as a rate (fatalities per vessel lost), the vessel-related fatalities were the lowest in the warmer waters of the Gulf of Mexico and along the Southeast U.S. coast. However, the number of incidents in that region was high enough to warrant further review. It was concluded that:

  Some incidents happened too quickly for effective use of lifesaving equipment, or trapped crewmembers on board. To eliminate fatalities from such incidents, it would be necessary to prevent the vessel losses.

  Even with longer survival times in warmer waters, lifesaving equipment is essential.

  At least three fatalities could have been prevented by training in the use of lifesaving equipment.

- **Hull Material** – Forty four percent of all vessel-related fatalities occurred on steel vessels. Vessel population data showed that steel vessels are generally larger than vessels of other hull materials. Consequently, they are able to operate farther offshore, with larger crews.

- **Fatality Trends -** Beginning in calendar year 2000, there was a downward shift in the number of vessel-related fatalities, with a record low in 2010. A control chart was used to confirm that the drop in fatalities was statistically significant, (i.e., more than normal year-to-year variation.) If the trend continues, one can expect an average of 19 vessel-related fatalities per year, instead of the previous 42.

  Further, it was found that the drop in fatalities was independent of vessel losses. This is understandable, given that current safety regulations focus on saving lives and not on preventing vessel loss.

- **Use of Lifesaving Equipment –** For fatalities related to vessel loss, the use of lifesaving equipment was very low. Also, for the West and Northeast coast incidents, survival rates were calculated based on lifesaving equipment usage. ***Survival rates more than doubled when the equipment was used.***

  Of the 564 fatalities resulting from vessel loss, only 27% of the vessels had participated in the voluntary dockside exam program and received a safety decal. Conversely, when fatalities occurred on vessels with decals, the vessels were lost suddenly, with little or no time to respond. In those casualties crewmembers were unable to use survival equipment or, in a few cases, could not fully don a survival suit. ***In such incidents, it would be necessary to prevent the vessel losses in order to eliminate the fatalities.***

- **Good Samaritan Rescues –** When fishing vessels were lost, Good Samaritan vessels were on hand to rescue crewmembers for over 29% of the incidents. There were very few fatalities during such incidents, and when fatalities did occur, the vessels were lost quickly due to flooding, capsizing, collision or fire. Further, the small number of fatalities showed that lifesaving equipment is important, even when help is nearby. It was concluded that:

  Fatalities would have been significantly higher without the assistance from Good Samaritan vessels. Hypothetically, as many as 1,200 deaths may have been prevented.

  Because crew members have minimal or no water exposure in such incidents, Good Samaritans may be serving as a substitute for properly maintained lifesaving equipment. Thus, the true risk from vessel losses may be hidden.

- **Falls Overboard –** Overall, falls overboard resulted in the second largest number of fatalities, with 23% of the total. PFD/survival suit usage was reported for only two of the fatalities. It was learned that 35% of these fatalities occurred in the 8th District, (Gulf of Mexico.) Given that the 8th District has the warmest waters and, thus, the longest survival times, it is likely that many of the fatalities were preventable with PFD's. This appears to be a region where continued emphasis on safety equipment, drills and training would be beneficial. Overall, there was a significant downward shift in falls overboard, beginning in calendar year 2000.

Taken together, the above findings indicate the following:

- ***Deaths can be avoided when lifesaving equipment is available and properly used, as required by Title 46 of the Code of Federal Regulations, part 28***.

- ***Factors leading to vessel loss will have to be addressed in order to reduce some fatalities below current levels, especially for incidents that occur suddenly, such as sinkings and capsizings.***

APPENDIX A: SELECTED CASUALTIES

Described below is a sampling of fishing vessel casualties that occurred in recent years.

Sinking of the ***ARCTIC ROSE.***

Between 10:00 pm on 1 April 2001 and 3:35 am on 2 April 2001, the F/V *ARCTIC ROSE* sank in the Bering Sea. The first indication of distress was an EPIRB alert that was received by the 17th Coast Guard District command center at 3:35 am on 2 April. A Search and Rescue case was initiated and USCG aircraft were sent to the EPIRB location. At 0840, a Coast Guard C-130 arrived and located the vessel's EPIRB at 58°56.9'N, 175°56.3'W. A large debris field and oil sheen was found in the vicinity. Shortly after arriving on-scene, the F/V *ALASKAN ROSE* recovered the body one crew member from the water. A subsequent search by Coast Guard aircraft, two cutters and two Good Samaritan fishing vessels in the immediate area failed to recover additional personnel. Fourteen persons are missing at sea and presumed dead.

The *ARCTIC ROSE* casualty was the subject of a Marine Board of Investigation. The board's report is available on the Coast Guard's "Homeport" internet portal, http://homeport.uscg.mil. Follow the folders to: Investigations -> Marine Casualty Reports.

Engine room fire and explosion.

October 20, 2002 – While en route to retrieve longline fishing gear in the Bering Sea, a fire erupted in the engine room of the fish processing vessel *GALAXY*. At the time, there were 26 persons on board. Believing that the ship's fixed CO_2 firefighting system had extinguished the fire, crewmembers began ventilating the engine room. Moments later a violent backdraft explosion ejected three crewmembers overboard. Two of the three crewmembers were quickly recovered. The third slipped away from the grasp of the ship's designated rescue swimmer and disappeared. At about the same time, the master transmitted a MAYDAY call to a nearby Coast Guard LORAN station and began evacuating the vessel. The remaining 25 crewmembers assembled in two groups on the vessel; 21 on the aft top deck and 4 on the main deck forward. The crew members on the aft top deck evacuated the vessel in the following manner:

- 12 crew members (three in survival suits and nine without) successfully abandoned the vessel by jumping into the life raft. An unknown crew member cut the raft's sea painter with a knife and the raft floated free from the vessel. The F/V *GLACIER BAY* recovered the raft without incident approximately 1.5 - 2 hours later.
- Two crew members unsuccessfully attempted to abandon ship into the raft. One crewmember (wearing a survival suit) attempted to jump into the life raft, but fell into the water and was not recovered. Another, with no survival suit unsuccessfully attempted to lower himself down the side of the vessel into the raft. The F/V *CLIPPER EXPRESS* recovered the latter person approximately 1.5 - 2 hours later without a pulse.

One crewmember (wearing a survival suit) and a National Marine Fisheries Service observer, (no survival suit) jumped into the water and were recovered alive approximately 1.5 - 2 hours later by the F/V *CLIPPER EXPRESS*.

- Three crew members (none wearing survival suits) on aft top deck were rescued by U.S. Coast Guard helicopter CG6021.

The remaining four crew members on the forward main deck, all wearing survival suits, were rescued as follows:

- One abandoned the vessel by jumping into the life raft as it floated past the bow of the FPV *GALAXY*.
- One abandoned the vessel into the water and was recovered by the F/V *BLUE PACIFIC* within approximately five minutes of entering the water.
- Two were rescued by U.S. Coast Guard helicopter CG6021

Of the 26 persons on board, two are deceased and one is missing and presumed dead.

Good Samaritan vessel loses a crewmember.

On October 22, 2002, while underway in the Bering Sea, a crewmember was swept overboard while securing a life raft on the vessel's main deck. Subject was hit by a large unexpected wave.

F/V *CLIPPER EXPRESS* was returning to Dutch Harbor after assisting with rescue and search of survivors from the F/V *GALAXY*. The *CLIPPER EXPRESS* had picked up personnel of the F/V *GALAXY* and a life raft that had been dropped by a CG aircraft. While en-route back to port, the raft came loose and was being tossed around by the wind on the vessel's fwd deck. Three men went out on deck to secure the raft. One of the men went back up to the wheel house while the other two worked to secure the raft. None of them were wearing any sort of PFD.

One crewmember was under the ladder going up to upper deck and working to secure the raft. A large wave approx. 35-45' came from the port side unexpectedly and washed him overboard. A search was immediately initiated by the vessel and Coast Guard Aircraft. However, the crewmember was not located.

Poor maintenance and outdated lifesaving equipment.

June 6, 2000 – While returning from a 3-day fishing trip, the *INFINITY* began taking on water and sank quickly by the stern. The vessel was lost approximately 17 miles southeast of Cape Elizabeth, along the coast of Maine. One of the three crewmembers was rescued and the other two were recovered deceased. Among the many findings, the investigating officer's report included the following:

- An inexperienced helmsman did not notice the vessel losing freeboard by the stern. When the flooding was discovered by another crewmember, the vessel's stern was nearly under water.
- Water entered the vessels aft compartment through a leaking rudder post. There was no functioning bilge pump in that space.
- All of the crewmembers donned survival suits. However, all of the suits were well beyond their service lives. Significant amounts of water were found in the suits of the two deceased crewmen, because they did not fit properly. One of the two suits was too small. A zipper jammed on the other.
- The vessel's life raft did not release.
- The vessel's EPIRB floated free, functioned properly and facilitated a quick response and recovery by Coast Guard aircraft.

Fatality while fishing alone.	March 28, 2002 - The F/V *DUSTIN SEA* was discovered beached on George Island, Alaska with no one on board. The vessel was found with the stabilizers set, the engine in gear and with the auto-pilot set. The vessel's only crewmember was found by another vessel, near the harbor entrance. The deceased was reported to have an abrasion near the hairline on his head. The subject had reported previously that he was having problems with his starboard stabilizer and may have been knocked/slipped overboard when setting it.
Overloading causes vessel to capsize.	December 13, 2003 - The F/V *ATLANTA* a 70 GT scalloper capsized and sank approximately 25 nm south of Chatham, MA with seven crewmen on board. Two crewmen died and one is missing. At the time of the incident the vessel was in the process of bringing the loaded port and starboard scallop dredges on board an already loaded deck. After placing the loaded starboard dredge on deck the crew proceeded to haul the port dredge on board when the vessel began to list to port, causing the deck cargo to also shift to port. Seeing this the captain accidentally grabbed the starboard dredge control by mistake, lifting the loaded dredge off the deck and causing it to swing to the portside. This caused the vessel to heel further and finally capsize. Five crewmen were able to launch and enter a life raft, where they fired off a flare which was seen by the nearby F/V *OCEAN REIGN*. At some point one of the crewmen in the raft died from hypothermia. All five were taken into port on the *OCEAN REIGN* arriving in New Bedford, MA on the morning of 14 December. The captain's body was later recovered from the water. One crewman is missing and presumed dead.
Master and mate drown while trying to save their vessel	October 7, 2000 – While heading to fishing grounds off the coast of Virginia, flooding was discovered in the engine room of the *CAROLINA BREEZE*. Attempts to dewater the vessel with onboard pumps and pumps supplied by Coast Guard helicopters were not successful. Five of the seven crewmembers were hoisted from the vessel. However, the master and mate remained onboard, attempting to save the vessel. When the helicopter returned the vessel was gone. The mate was found hours later floating in the water in his immersion suit. The master was recovered from the vessel five days later. He was found in the pilothouse with his immersion suit on. The mate stated that the vessel was struck by a large wave over the stern and sank in less than one minute.
Capsizing of the ***NORTHERN EDGE***.	December 20, 2004 - The F/V *NORTHERN EDGE*, a 75ft scalloper with a crew of six persons capsized and sank approximately 45 miles off the coast of Massachusetts. One of the crewmembers was able to enter the vessel's life raft, where he found the survival kit and used flares to hail other vessels working in the area. He was picked up by the F/V *DIANE MARIE* approximately 40 minutes after the sinking. The other 5 crewmembers are missing and presumed dead. The *NORTHERN EDGE* was towing two scallop dredges, when it suddenly listed to the starboard side, possibly because one of the dredges became entangled on an obstruction. At that time, five crewmembers were on deck and the captain was in the wheelhouse. Two crewmen cut the life raft loose and it fell in the water. Another crewman jumped in the water to retrieve the raft. Grabbing the life raft painter lanyard (line) the crewman swam back toward the vessel. The vessel then rolled further knocking him underwater before he could hand off the lanyard. Once the crewman resurfaced, he swam back to the life raft, popped it open and climbed

in. At that point there were three other crewmembers on the stern of the vessel and one in the water attempting to swim to towards the life raft. The vessel then capsized with none of the remaining crewmembers reaching the life raft. Among the many findings, the investigating officer's report included the following:

- When the vessel first heeled over, the main deck watertight doors were open, allowing water to enter the engine room and accommodation spaces.
- Most of the freeing ports on the main deck were closed, trapping sea water on deck.

No records or witnesses were discovered to indicate that the required training or safety orientation had been conducted. However, the sole survivor had received safety training elsewhere.

Overloaded crab vessel capsizes.

On 15 January 2005 the overloaded F/V BIG VALLEY lost stability and sank in the Bering Sea. The 17th District command center learned of the incident from an EPIRB alert. There were 6 crewmembers on board the vessel. Only one of the crewmembers made it to a life raft and was rescued by a Coast Guard helicopter. The bodies of two other crewmembers were recovered. The search was suspended on 18 January 2005. The Master of the F/V BIG VALLEY along with the other 2 crewmembers were never found and are presumed dead.

Training and effective use of lifesaving equipment.

16 March 2006. While inbound after four days of fishing, the *CELTIC PRIDE* experienced uncontrollable flooding. At the time, the vessel was approximately 80 miles southeast of Portland, Maine. After determining that the vessel could not be saved, crew members made a distress call, donned survival suits, launched a life raft and activated the EPIRB. The vessel sank within minutes of abandonment. Approximately two hours after transmitting the EPIRB alert, all crew members were rescued by a Coast Guard helicopter. During the investigation it was learned that all crew members participated in emergency drills on a regular basis, which is believed to be an important factor in the crew's survival.

Disappearance of the ***LADY LUCK.***

On the night of 31 January 2007 the fishing vessel *LADY LUCK* sank off the coast of Cape Elizabeth, ME. The vessel's EPIRB started transmitting early the next morning and a CG search effort ensued. There were no other indications of distress. A search revealed only a small debris field and oil slick. The two crewmembers who were on board at the time are missing and presumed deceased.

On 13 March 2007, a remotely operated submarine located the *LADY LUCK* in approximately 530 feet of water, resting upright, with no visible damage. The vessel's life raft was found fully inflated, but still attached to the vessel. In investigator's findings included the following:

- Because there were no survivors and the vessel was not recovered, the cause of the sinking is unknown. The most likely cause was either rapid flooding or sinking, leaving the crew members little time to abandon the vessel.
- The life raft may not have been properly installed, because it did not release from the vessel.

This casualty was the subject of a Formal Investigation. The investigator's report is available on the Coast Guard's "Homeport" internet portal, http://homeport.uscg.mil. Follow the folders to: Investigations -> Marine Casualty Reports.

Vessel grounds due to operator fatigue.

On 18 March 2007 the *EXODUS EXPLORER* ran aground while transiting into Adak Harbor, Alaska and sank in approximately 6 fathoms of water. It was learned that a helmsman, after a full day of fishing, fell asleep at the wheel while the vessel was underway at full throttle. Three crew members and one Fisheries Service observer donned survival suits and abandoned the vessel to a life raft. All survivors were rescued by a nearby fishing vessel.

Crew members credit their survival to training.

September 28, 2007. While fishing for scallops near Nantucket, RI, the fishing vessel *JACOB ALAN* experienced uncontrollable flooding. After transmitting a distress call, all five crew members and a Fisheries Service observer donned survival suits, deployed the inflatable life raft and EPRIB. The crew members were rescued by a nearby fishing vessel. All crew members attributed their survival to recent lifesaving and survival training that they received.

Loss of the fish processing vessels ***ALASKA RANGER*** and ***KATMAI***.

In 2008, the fish processing vessels *ALASKA RANGER* and *KATMAI* were lost in the Bering Sea, with multiple loss of life, as summarized below:

ALASKA RANGER - Around 0226 on 23 March, approximately 130 miles west of Dutch Harbor, the *ALASKA RANGER*'s high water alarm sounded. The engineer on watch discovered rapid flooding in the rudder room, resulting in progressive flooding of the engine room and adjacent spaces.

At approximately 0402 the vessel suddenly rolled to starboard, and the crew began to abandon ship. By approximately 0420 the vessel was listing approximately 45° list to starboard, and crew members were forced to jump into the 32°F water. Shortly after 0430, the ALASKA RANGER stood straight up on its stern with only its bow sticking out of the water and sank.

Of the 47 people aboard the ALASKA RANGER, 22 managed to board one of the vessel's liferafts and each of them survived. Of the 25 people who did not get into one of the vessel's liferafts, 20 were rescued, four died, and one remains missing and is presumed dead. The deceased include the Captain, Mate, Chief Engineer, Fish Master, and one Factory Worker.

Throughout the emergency and rescue efforts, many people aboard the ALASKA RANGER awakened shipmates, helped others don immersion suits, provided encouragement, and assisted each other with entry into liferafts and survival in the water. The exceptional performance of the officers and crew of the ALASKA WARRIOR, the first ship to arrive on scene, the USCG helicopter crews, and Coast Guard Cutter MUNRO personnel was vital to the rescue of the 42 survivors.

The cause of the casualty was a breach in the watertight envelope of the hull and progressive flooding in the engine room and other spaces at the stern of the vessel. The exact initiating event that created the source of flooding is unknown. However, it was likely related to the vessel's poor material condition and may have possibly been related to the kort nozzle struts, which were believed to have created excessive local stresses where they attached to a corroded area of the hull.

KATMAI – During the evening of October 21, 2008, the F/V *KATMAI* was making way towards Dutch Harbor, AK to offload approximately 120,000 pounds of Pacific Cod. About midnight local time on October 22, the Captain discovered the vessel had lost steering and ordered the Engineer to investigate the problem. The Engineer proceeded to the lazarette and found the space was flooded. After an initial dewatering effort, the flooding progressed and the vessel listed to starboard and down by the stern. The cause of the rapid flooding remains unknown.

Shortly after the vessel listed to starboard, the Captain ordered the crew to abandon ship. Ten of the 11 crewmembers abandoned the vessel to liferafts. The engineer was last seen entering the engine room.

At 0107 local time on 22 October 2008, the North Pacific SAR Coordinator (NPSC) received an alert from the EPIRB registered to the F/V *KATMAI*. At 0154 local time, the F/V *BLUE BALLARD* reported to the NPSC that the F/V *KATMAI* sent emails stating that the vessel had lost steering and had a flooded lazarette. An immediate response to the alert was ordered by the NPSC, which included two aircraft, a Coast Guard cutter, and two Good Samaritan fishing vessels.

Among the many findings, the investigating officers concluded that:

- The F/V *KATMAI* sank as a result of the amount of cargo on board, exposure to heavy wind and high seas, and failure to maintain watertight boundaries.

Of the 11 crew members on board F/V *KATMAI*, there were four survivors, 5 deceased and 2 missing.

Both of the above incidents were subjects of formal investigations. The investigator's reports are available on the Coast Guard's "Homeport" internet portal, http://homeport.uscg.mil. Follow the folders to: Investigations -> Marine Casualty Reports.

APPENDIX B: ABOUT THE DATA SOURCES

The data for this review was extracted from the Coast Guard's marine safety databases, known as MSIS (Marine Safety Information System) and MISLE (Marine Information for Safety and Law Enforcement). Casualty data was collected in MSIS from 1 January 1992 through 13 December 2001. Thereafter, MSIS was replaced by the MISLE system.

The following criteria were used to extract fishing vessel casualty data from the casualty databases:

- The service of the vessel, at the time of the casualty, was recorded as a fishing vessel.
- At least one crewmember was listed as dead or missing, OR;
- The vessel was reported as a total loss.

Quality Control - As part of the case review, described in more detail below, case reports not meeting the criteria for this study were eliminated. This included the following:

- Duplicate records.
- Vessels that were damaged, but not a total loss.
- Vessels that were misclassified or not being used for fishing.
- Fatalities from natural causes, (e.g., heart attack, stroke, etc.).

Also, to get the most complete data set possible, records of the Fishing Vessel Safety program office were used to crosscheck query results.

Assumptions and Constraints

Data Collection - It is important to note that policy does not specifically require all of the information needed for this study, although the information system was capable of recording most of the information in various locations. In fact, investigating officers have significant discretion in the amount of information collected based on the severity of the incident, reporting policy, and other factors.

Often, vessel casualties were only investigated because they resulted in pollution - not to determine the cause of the vessel loss. Thus, each case report, including the narrative entries, was reviewed in order to fill in missing data items, which provided additional details. Results were dependent upon the writing style and thoroughness of the investigating officer, which varied from a few brief sentences to many pages. Even with this extensive case review process, data elements often resulted in values being shown as "Unknown." Of course, more automated and easily repeatable methods of data analysis are preferred to the labor-intensive procedures used in this study. Policy, data reporting, and data quality procedures are regularly reviewed to support future data analysis requirements.

Missing Values - In many cases where a vessel was lost and all persons on board were rescued, few details were available about the vessel, the use of lifesaving equipment, or the persons on board. For these cases, the lifesaving information is recorded as "Unknown".

Population v. Sample Size - For purposes of this study, the data set is considered to be the entire population of lost fishing vessels and personnel casualties. Those are incidents with

serious consequences and it is assumed that such incidents will rarely escape the Coast Guard's attention. It is believed that any cases missing from the data, due to lack of notification, clerical, or other error, are few in number and will not affect the results of this study. Further, the number of records available for analysis is large – 2,072 for lost vessels and 1,055 for personnel loss, which would minimize the affect of any missing records. Of more concern to this study are the previously mentioned missing values that had to be recorded as "unknown."

Normalization - As noted in the Fishing Vessel Task Force report, demographics about the size and composition of the fishing industry, including the number of workers, the number of state numbered vessels, and vessel utilization rates, are not readily available. Further, recent attempts to estimate the worker population have resulted in widely varying estimates. Thus, most of the figures presented in this document are "as reported" to Coast Guard information systems without statistical normalization or leveling. (An exception to this is a review of the subset of documented vessel losses. The population of documented vessels is in the Coast Guard's information system.) No comparisons with other industries were made in this report.

Reviewer Interpretation/Bias - In the MSIS and MISLE systems, investigating officers can describe a casualty as a series of events, each with associated causes. The case reviewers for this study used the first reported event as the cause of vessel loss or fatality. For example, a vessel might suffer a hull failure, followed by flooding, then sinking. In this example, an investigator might report, given the best available information, the first event as flooding, without knowing of the hull failure event. If the investigator provides no events, a case reviewer may determine the cause of vessel loss as sinking, without knowing of the hull failure or the flooding. This, of course, may insert additional bias into the data. However, this method was preferred to leaving a large number of values as "unknown."

APPENDIX C: CONTROL CHARTING METHODOLOGY

The methodology for developing the control charts used in this document is summarized as follows:

- Use the average of the individual observations (**X**), for the central line.
- Calculate the average moving range, (m**R**). This is done by finding the difference in the individual observations, the moving ranges, (e.g., the difference between the 1994 vessel losses and the 1995 losses is 36), then averaging the moving ranges.
- Calculate the upper control limit, (UCL). UCL = **X** + (2.66 x m**R**).
- Calculate the lower control limit, (LCL). LCL = **X** - (2.66 x m**R**).
- Display the individual values, the central line, the upper control limit, and the lower control limit on a line chart.

The trend line of the individual observations is interpreted by comparing them to the upper and lower control limits. Values that are consistently close to or cross one of the limits are considered "out of control." In other words, the change cannot be explained by normal variation.

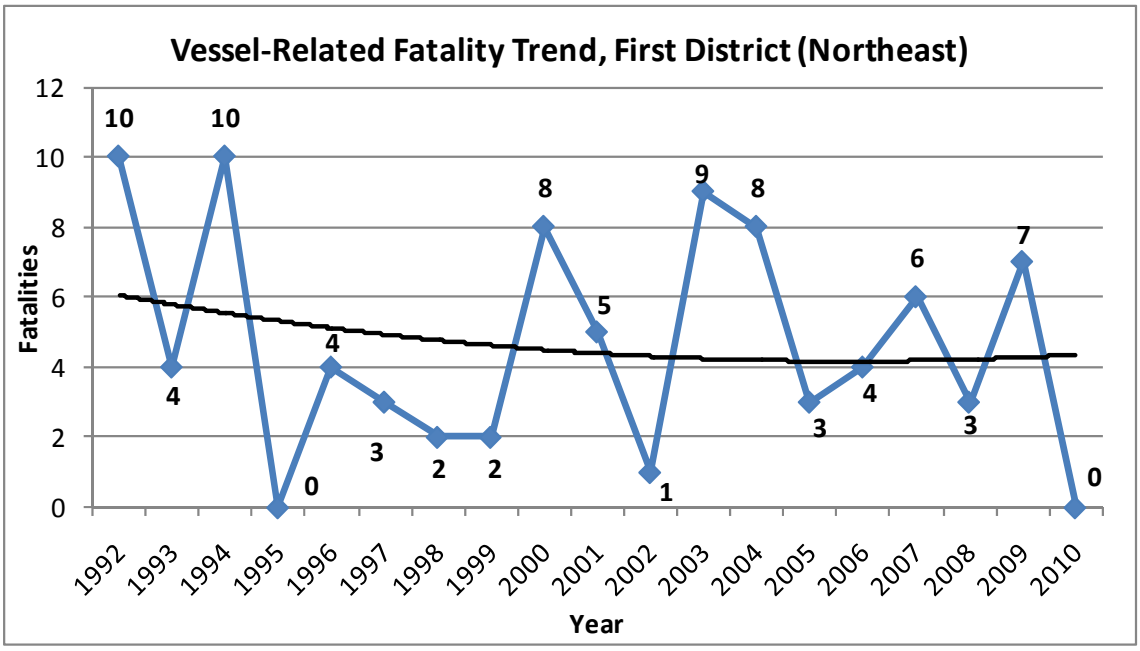
Source: Wheeler, Donald J., Understanding Variation: The Key to Managing Chaos, SPC Press, Inc., Knoxville, TN, 1993.

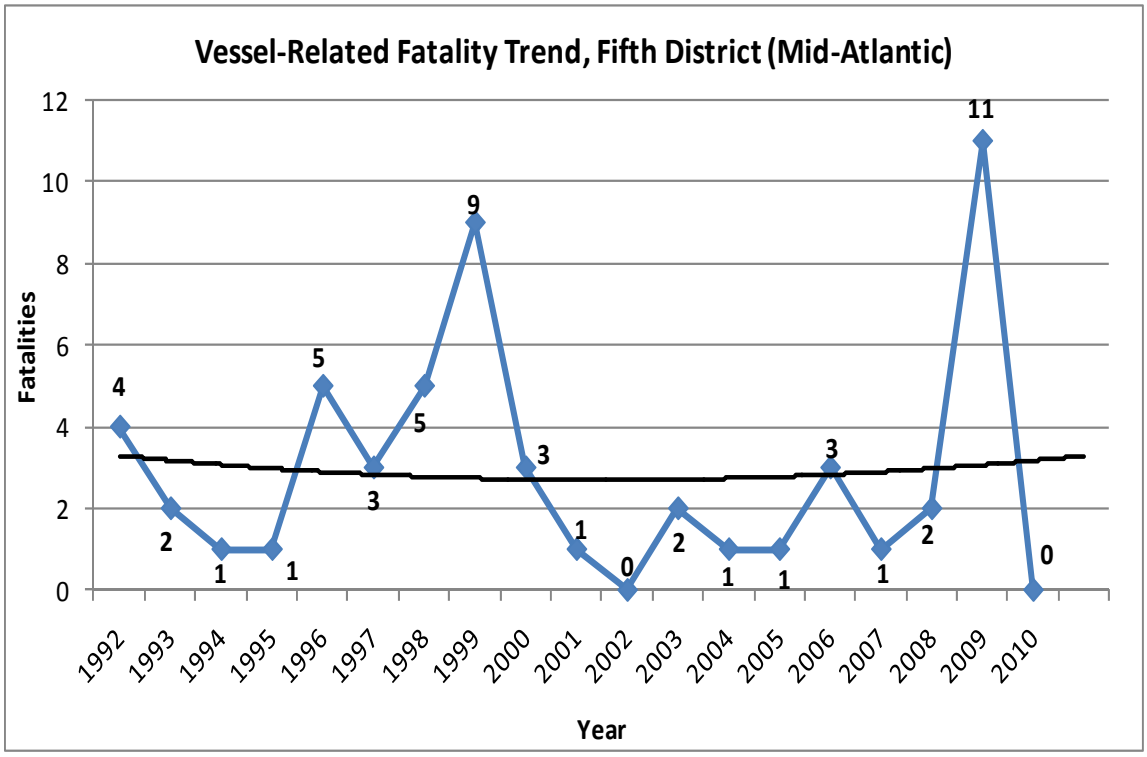
APPENDIX D: HISTORIC CASUALTY COUNTS

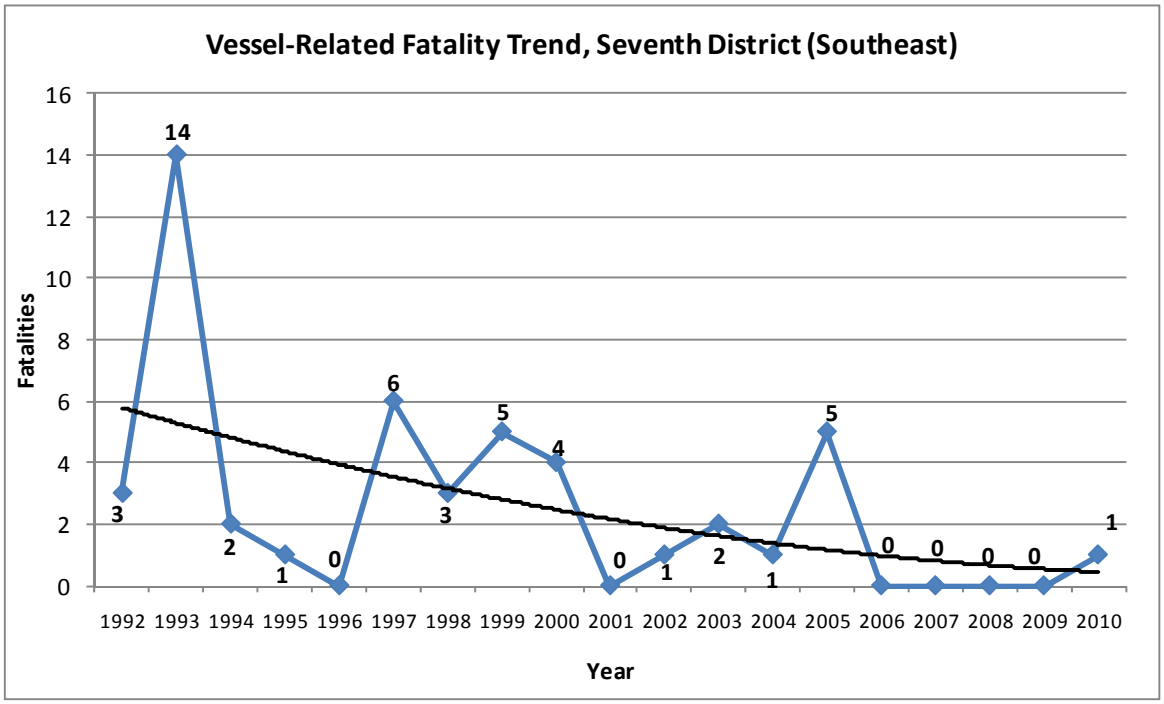
Shown below are counts of lost fishing vessels and fatalities from a previous study, an older data source, known as CASMAIN, and the more modern information systems that were used in this report. The CASMAIN database contains summary data only, but none of the additional details used in this study.

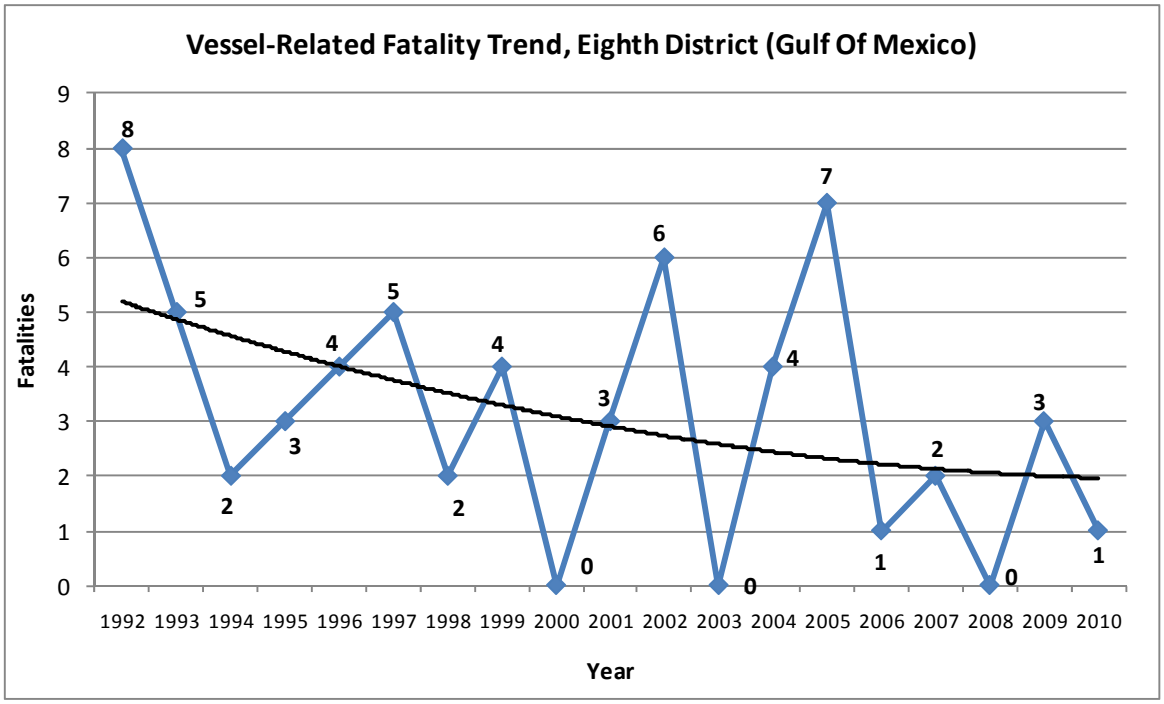
Historic F/V Casualty Figures			
Year	Vessels Lost	Fatalities	Data Source
1970	215		Study: *U.S. Commercial Fishing Vessel Losses*. Marine Safety Evaluation Branch, Office of Merchant Marine Safety, U.S. Coast Guard Headquarters, October 1983
1971	181		
1972	146		
1973	171		
1974	188		
1975	169		
1976	178		
1977	151		
1978	89		
1979	209		
1980	197		
1981	250		
1982	270	87	*CASMAIN database, (VCAS table)*
1983	293	149	
1984	280	91	
1985	279	109	
1986	187	98	
1987	207	112	
1988	224	106	
1989	255	120	
1990	192	84	
1991	217	89	
1992	139	85	*Marine Safety Information System (MSIS)*
1993	148	92	
1994	153	75	
1995	117	62	
1996	166	82	
1997	138	61	
1998	125	71	
1999	123	77	
2000	85	37	
2001	133	58	
2002	122	37	*Marine Information for Safety & Law Enforcement (MISLE)*
2003	107	43	
2004	112	37	
2005	99	42	
2006	75	42	
2007	61	33	
2008	55	43	
2009	57	46	
2010	57	32	

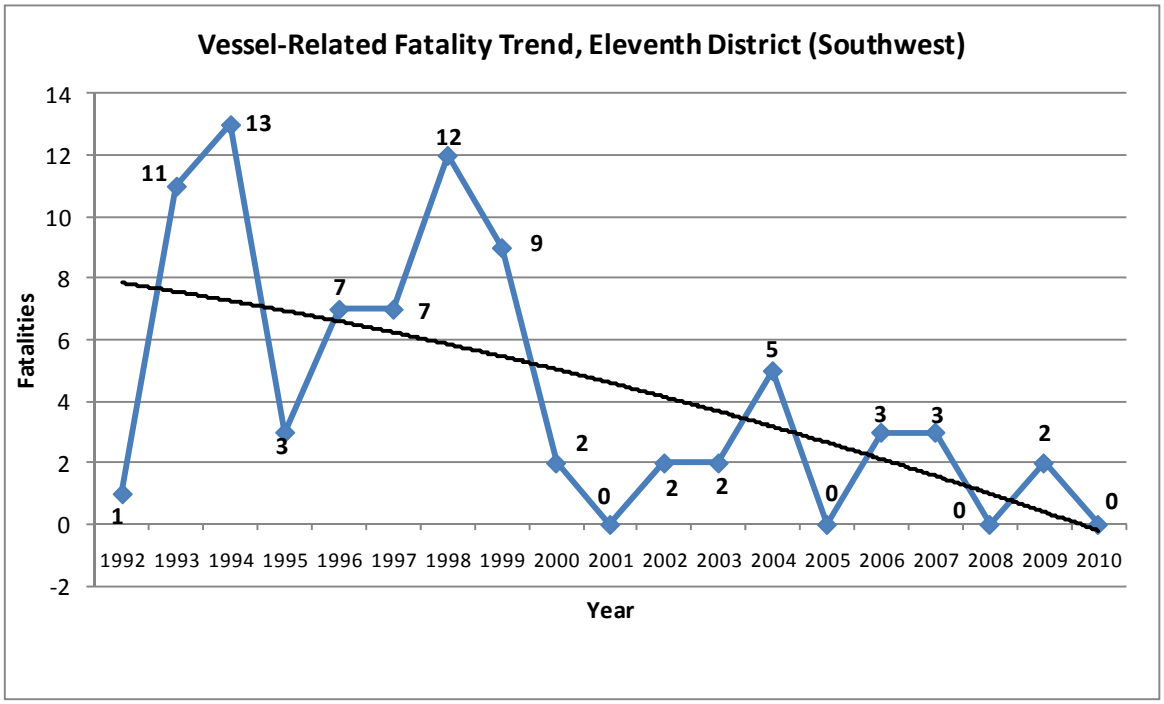
APPENDIX E: VESSEL-RELATED FATALITIES, BY DISTRICT

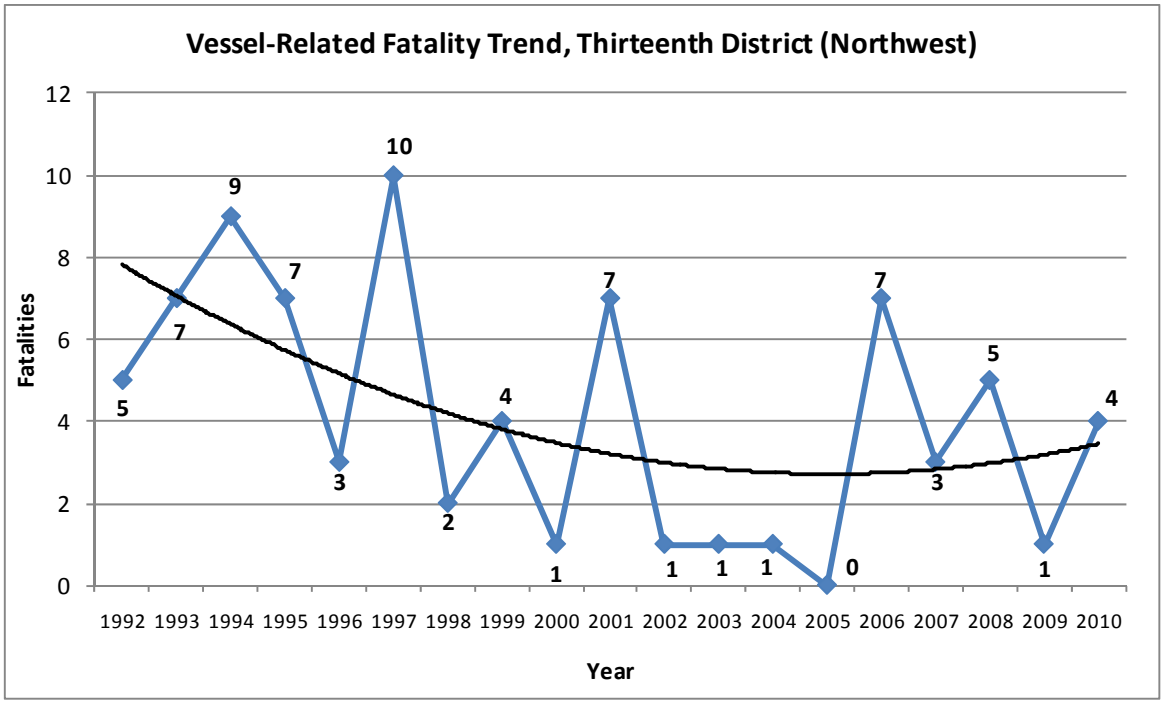


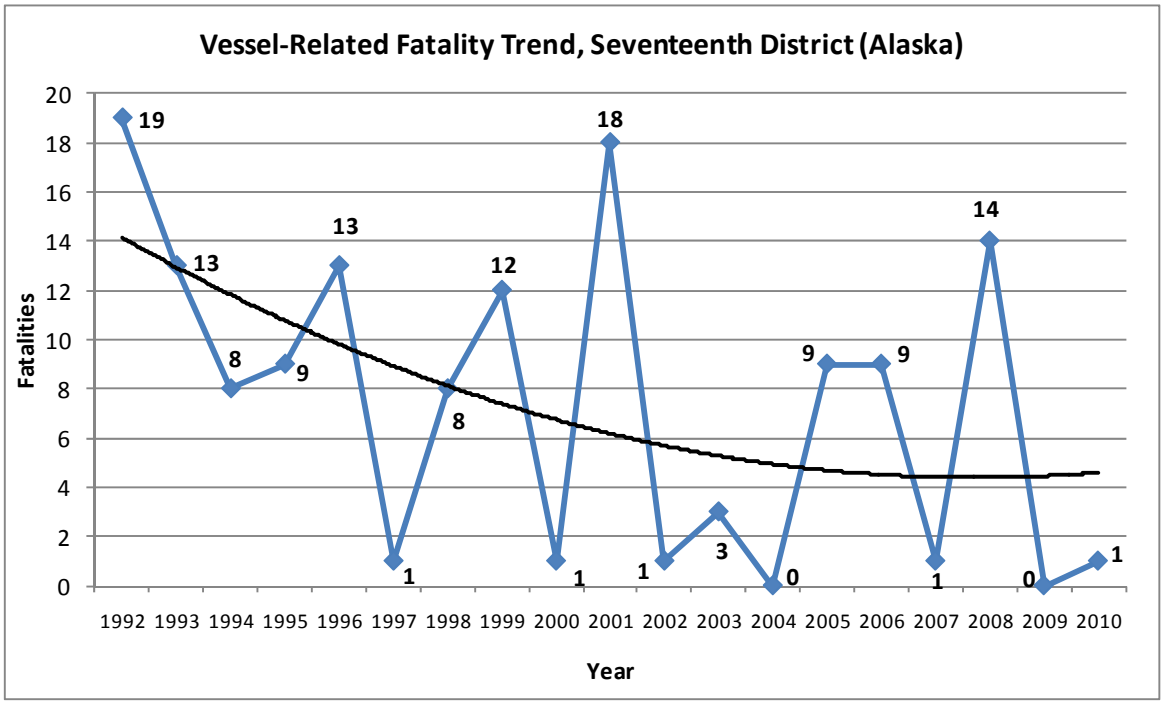



Vessel-Related Fatality Trend, Seventh District (Southeast)
Fatalities
Year
0
2
4
6
8
10
12
14
16
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
3 14 2 1 0 6 3 5 4 0 1 2 1 5 0 0 0 0 1

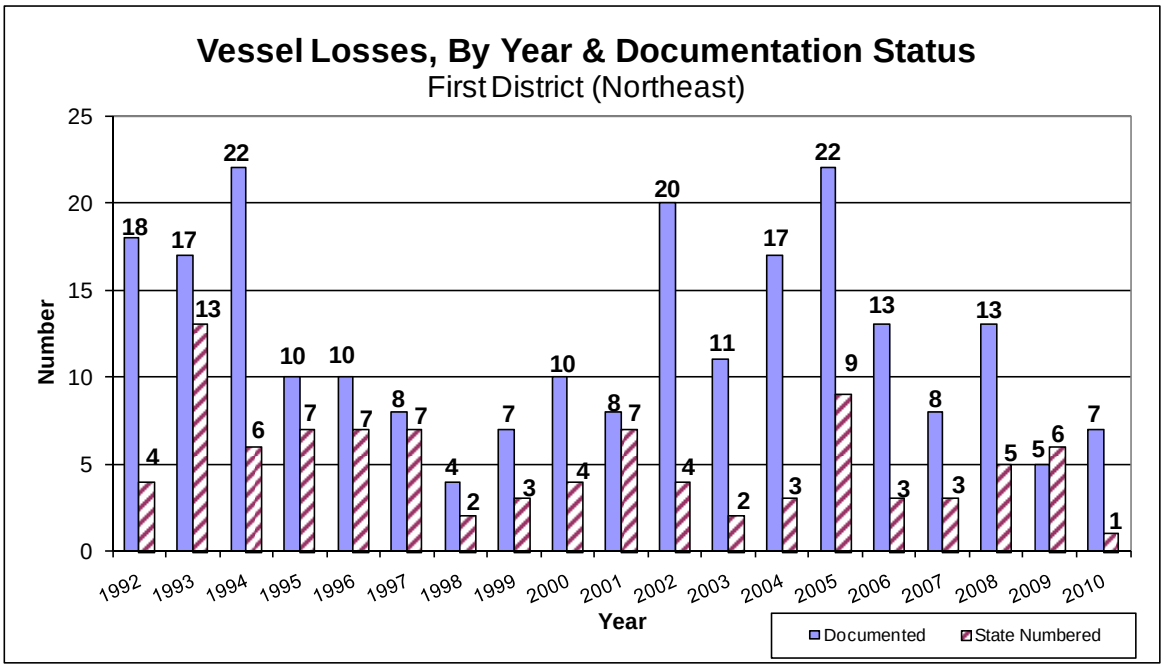

Vessel-Related Fatality Trend, Eighth District (Gulf Of Mexico)
Fatalities
Year
0
1
2
3
4
5
6
7
8
9
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
8 5 2 3 4 5 2 4 0 3 6 0 4 7 1 2 0 3 1

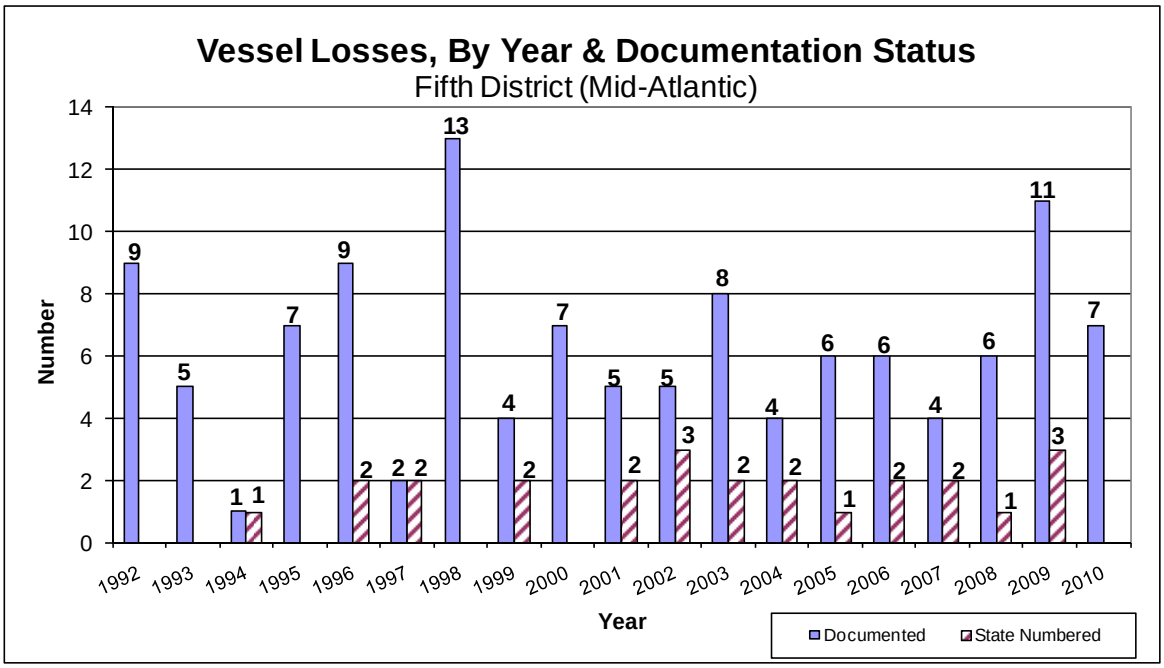

Vessel-Related Fatality Trend, Eleventh District (Southwest)
Fatalities
Year
14
12
10
8
6
4
2
0
-2
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
1 11 13 3 7 7 12 9 2 0 2 2 5 0 3 3 0 2 0

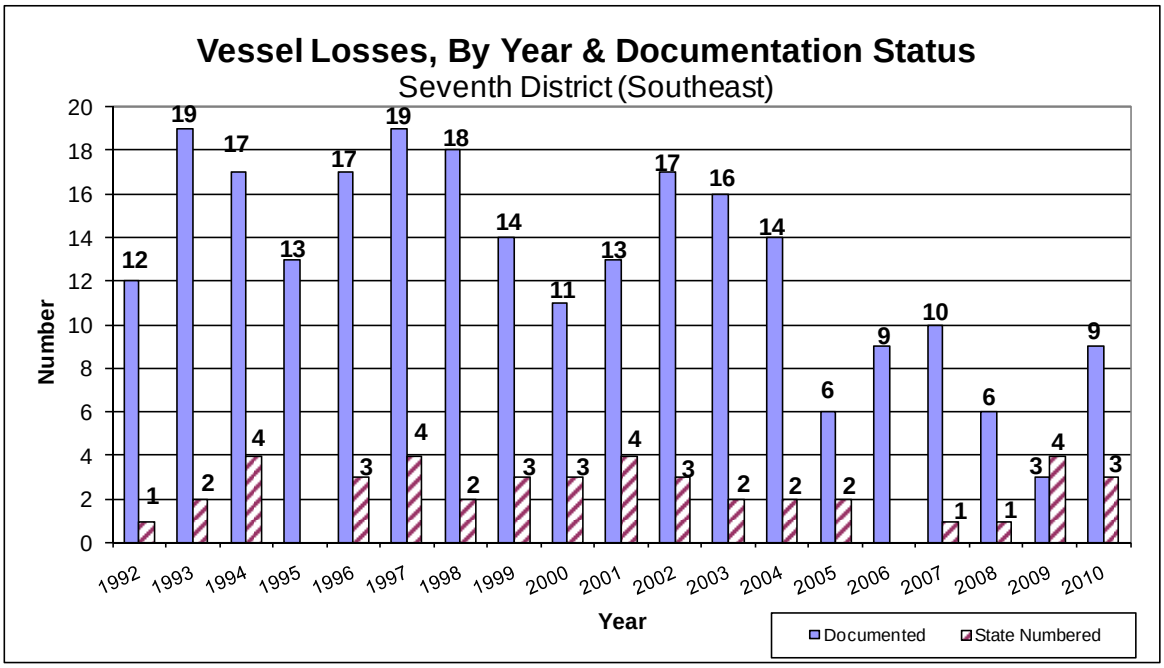

Vessel-Related Fatality Trend, Thirteenth District (Northwest)
Fatalities
Year
12
10
8
6
4
2
0
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
5 7 9 7 3 10 2 4 1 7 1 1 1 0 7 3 5 1 4

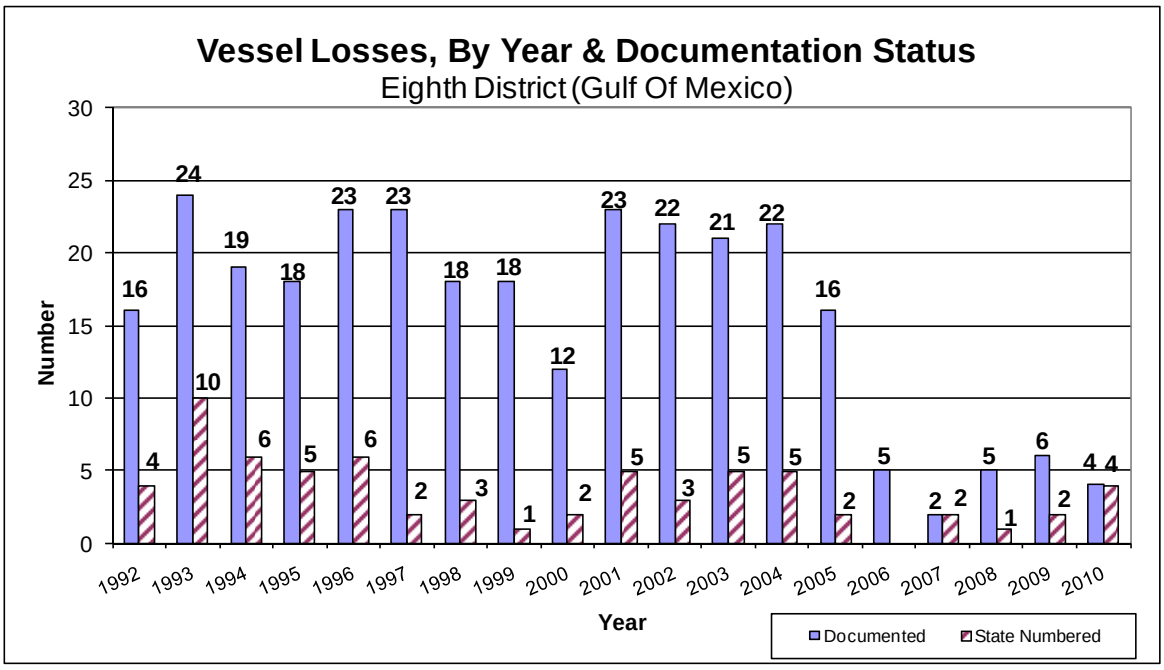

Vessel-Related Fatality Trend, Seventeenth District (Alaska)
Fatalities
Year
0
2
4
6
8
10
12
14
16
18
20
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
19
13
8
9
13
1
8
12
1
18
1
3
0
9
9
1
14
0
1

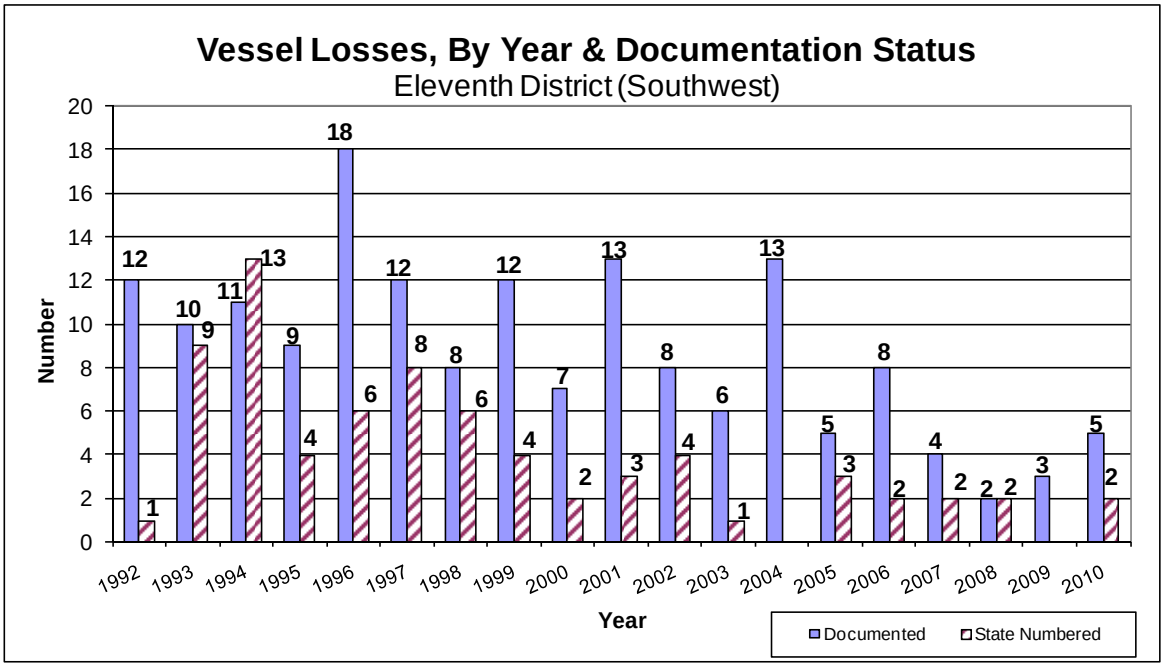
APPENDIX F: VESSEL LOSSES, BY DISTRICT & YEAR

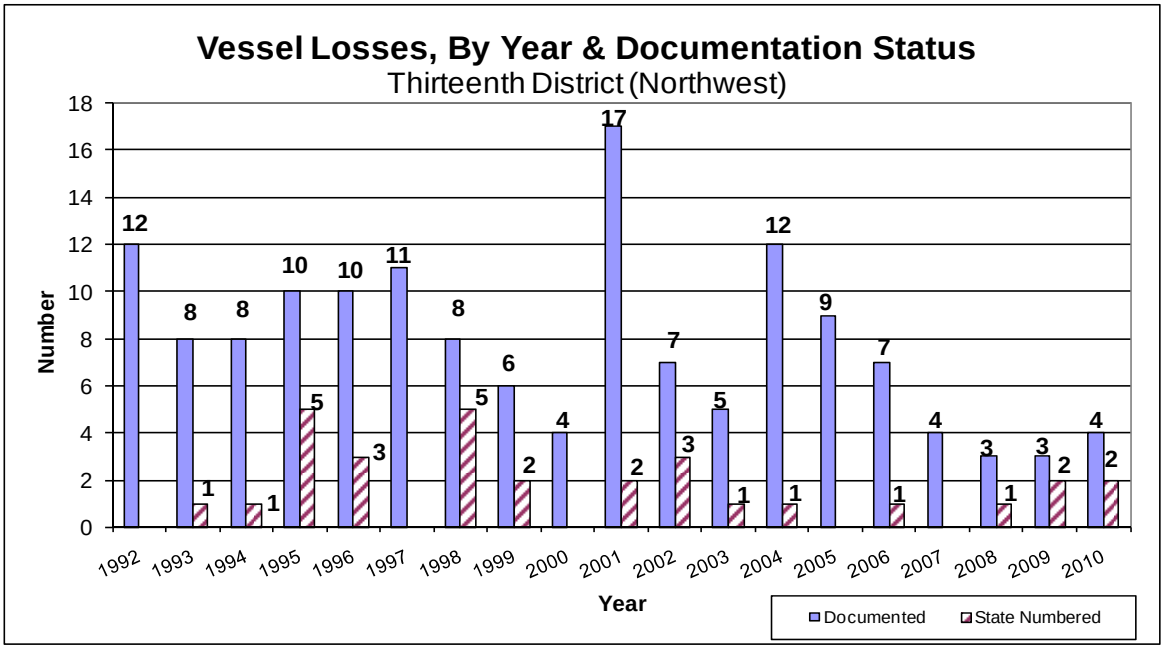


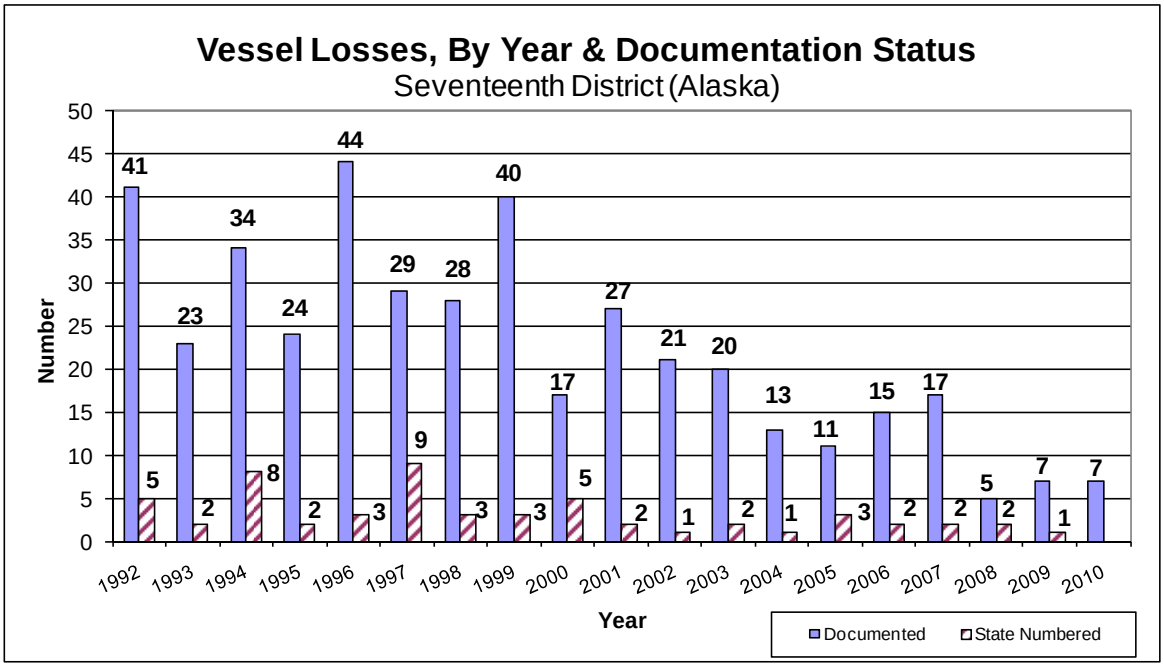



Vessel Losses, By Year & Documentation Status
Seventh District (Southeast)
Number
Year
Documented
State Numbered
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
12 1 19 2 17 4 13 17 3 19 4 18 2 14 3 11 3 13 4 17 3 16 2 14 2 6 2 9 10 1 6 1 3 4 9 3


Vessel Losses, By Year & Documentation Status
Eighth District (Gulf Of Mexico)
Number
Year
Documented
State Numbered
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
16 4 24 10 19 6 18 5 23 6 23 2 18 3 18 1 12 2 23 5 22 3 21 5 22 5 16 2 5 2 2 5 1 6 2 4 4


Vessel Losses, By Year & Documentation Status
Eleventh District (Southwest)
Number
Year
Documented
State Numbered


Vessel Losses, By Year & Documentation Status
Thirteenth District (Northwest)
Number
Year
Documented
State Numbered


Vessel Losses, By Year & Documentation Status
Seventeenth District (Alaska)
Number
Year
Documented
State Numbered
1992 41 5
1993 23 2
1994 34 8
1995 24 2
1996 44 3
1997 29 9
1998 28 3
1999 40 3
2000 17 5
2001 27 2
2002 21 1
2003 20 2
2004 13 1
2005 11 3
2006 15 2
2007 17 2
2008 5 2
2009 7 1
2010 7