Surveillance and Prevention of Occupational Injuries in Alaska:

A Decade of Progress, 1990-1999

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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Foreword

The public health approach of conducting injury surveillance, epidemiologic analysis, planned interventions and evaluation has served as a blueprint for reducing the occupational injury rate in Alaska. Following this approach, the National Institute for Occupational Safety and Health (NIOSH) worked with numerous partners in the public and private sectors on collaborative efforts to prevent occupational injuries and fatalities in Alaska. These efforts included development of a comprehensive, statewide surveillance system that helped identify new and emerging problems, track hazardous conditions over time, target interventions, evaluate efforts and anticipate future problems. During the 1990s, occupational fatalities in Alaska decreased by nearly 50%. This document describes collaborative efforts that contributed to this decrease.

One primary goal in compiling this document was to create a resource that could be used by anyone interested in workplace safety in Alaska or other high-risk areas facing occupational injury challenges. While significant progress was made in the 1990s to reduce fatalities in Alaska's commercial fishing and helicopter logging industries, challenges remain in reducing the burden of fatal occupational injuries in commercial aviation and nonfatal injuries in construction and commercial fishing.

This document summarizes what is known about occupational injuries and fatalities in Alaska by defining problems, describing recent successes, and recommending approaches for preventing occupational injury events. Our hope is that this document will serve as a catalyst to broaden injury prevention efforts to further reduce occupational injuries and fatalities in Alaska and other regions.

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Public Health Summary

What are the hazards?

During the 1980s, Alaska was identified as the state with the highest traumatic occupational fatality rate in the U.S. While considerable progress has been made in reducing the number of occupational deaths and injuries in Alaska, some workers in the state are still at elevated risk. These workers include commercial fishermen working in Alaska waters, and pilots and passengers on air taxi and commuter flights within the state. Many of the workers in these high-risk occupations work in remote locations and experience exposure to harsh and unpredictable weather. Male workers, who form an overwhelming majority of the workers in the highest risk occupations in Alaska, are also at much higher risk for occupational fatalities—96% of all traumatic occupational deaths during 1990-1999 occurred among men.

How can a worker be exposed or put at risk?

Most Alaskan workers are exposed to many of the same risks as are other workers in the U.S. However, workers in the highest-risk occupations in Alaska also face unique and extreme environmental risk factors due to the size of the state, the remote locations of many work sites, and the lack of nearby rescue teams and/or emergency response systems. For example, commercial fishermen in Alaska work some of the coldest and roughest waters of the U.S., and are often under intense pressure to meet harvest deadlines. Cold weather and cold water contribute to worker fatigue and may exacerbate subsequent injuries. Pilots and work-related passengers on commuter flights and air taxis often encounter rapid weather changes as they travel from one remote site to another; the resulting changes in visibility can often contribute to crashes.

What recommendations has the federal government made to protect workers' safety and health?

During the past decade, successful government/industry collaborations have resulted in multiple recommendations to prevent injuries in high-risk industries in Alaska. NIOSH has worked extensively with worker groups, industry representatives, and other government agencies to quickly and effectively address the high worker fatality rates for helicopter logging pilots and crew members through increased industry oversight and revised safety procedures at logging operations. NIOSH has worked with fishing groups; local, national and international government agencies; and industry representatives to promote on-board safety drills, engineering changes to vessels, and the increased use of personal flotation devices for commercial fishermen working in Alaska waters. NIOSH has also been active in promoting aviation safety campaigns for commercial pilots of air taxi and commuter flights around the state through its partnerships with state and federal agencies, flight operators, pilot associations and researchers.

Where can more information be found?

The references at the end of this document provide a useful inventory of published reports and literature. A number of trade associations and occupational safety education organizations have also developed materials regarding occupational safety. Additional information can be obtained from NIOSH through:

1-800-35-NIOSH
(800-356-4674)
or at
www.cdc.gov/niosh

Executive Summary

During 1980-1989, Alaska experienced 34.8 traumatic deaths for every 100,000 workers employed in the state, a rate that was five times the national rate of 7.0 per 100,000. From 1990 through 1999, 648 Alaskan workers died from job-related injuries: 217 commercial fishermen, 107 civilian pilots, 47 military personnel, and 26 loggers. They died from drowning (219), in aircraft crashes (192), by being crushed (53), from intentional injuries (47), in motor vehicle crashes (29) and from falls (26). Many of these deaths were among young people, resulting in over 17,000 worker years of potential life lost before age 65. Due to the high occupational fatality rate in Alaska, the Centers for Disease Control and Prevention, NIOSH responded by establishing a field station in Anchorage in 1991.

First, NIOSH established data-sharing with jurisdictional agencies and from direct on-site investigation of incidents. Comprehensive occupational injury surveillance was established for Alaska, and interagency working groups (of state and federal agencies and industry groups) were formed and facilitated, to address major factors leading to occupational death and injury in the state.

Since 1990, Alaska has experienced a 49 percent overall decline (from 82 deaths in 1990 to 42 deaths in 1999) in work-related deaths, including a 67 percent decline in commercial fishing deaths, and a very sharp decline in helicopter logging-related deaths. These are two of the occupations on which interagency/industry efforts were most focused. For example, the successes in commercial fishing are due in part to the U.S. Coast Guard implementing new safety requirements in the early 1990s. These safety requirements contributed to 89 percent of the commercial fishermen surviving vessel sinkings/capsizings in 1999, whereas in 1991, only 73 percent survived. Another dangerous area in the fishing industry is the deck of fishing vessels. Surveillance data for non-fatal injuries has led to an ongoing research project on deck safety.

Efforts in helicopter logging have also been successful. Crashes in that emerging industry killed 9 Alaskan workers (pilots, co-pilots, and loggers) and seriously injured 10 others during 1992-1993, but an interagency effort led to improvements in regulatory oversight, helicopter logging safety workshops, and formulating and disseminating safety recommendations. Since the first helicopter logging safety workshop in 1994, an international helicopter logging safety committee has been formed, and Alaska has only experienced one additional helicopter logging-related fatality through 1999. These efforts have led to major national and international government-industry collaborative efforts in improving safety in helicopter lift operations.

Although mortality due to crashes of fixed-wing aircraft showed modest decreases in Alaska in 1997-1999, it persists as the leading cause of death for Alaskan workers and is now a major area of concentration.

Using surveillance data as information for action, collaborative efforts have contributed to reducing Alaska's high occupational fatality rate. Results suggest that extending such a focused approach to other areas, and applying these strategies to the full spectrum of occupational injury hazards, could have a broad impact on reducing occupational injuries in other regions.

Surveillance and Prevention of Occupational Injuries in Alaska:

A Decade of Progress, 1990-1999

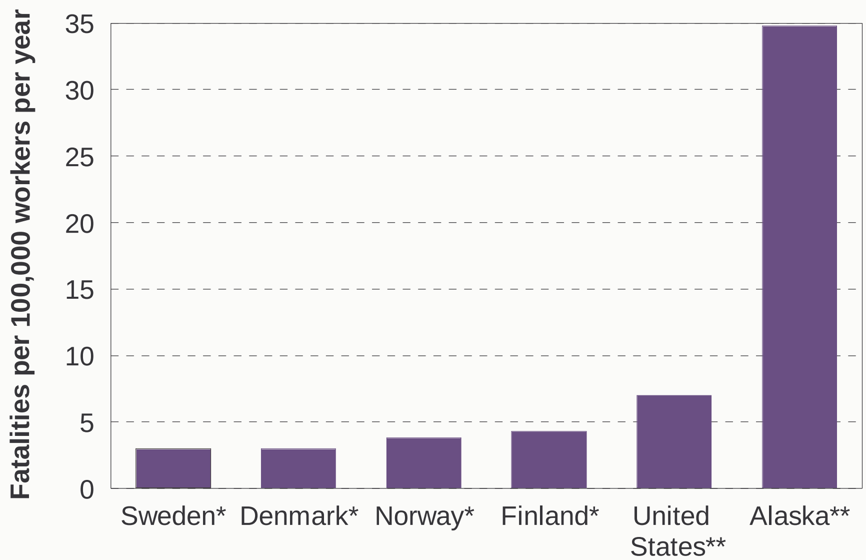
Introduction

During the 1980s, it became apparent that Alaska had the highest occupational fatality rate of any state (34.8/100,000/year, for the 10-year period 1980-1989, 5 times higher than the U.S. average of 7.0/100,000/year).[1] The State of Alaska Department of Labor (AKDOL) estimates that almost 320,000 Alaskans were employed in the workforce by the end of the year 2000. The heightened risk of occupational injuries to these workers, as compared to other U.S. workers, may reflect to some extent the unique physical and demographic features of Alaska. Its northern latitudes, vast mountain ranges, large areas of marshy tundra, and extensive coastline create diverse climatic zones and associated harsh and unpredictable weather. According to the State of Alaska Department of Community and Economic Development, Alaska's economy is "driven by oil, tourism, and fishing. Other important industries include timber, mining, and agriculture. Nearly 85 percent of the state's budget is supplied by oil revenues."[2] The majority of activities in most of these industries take place outdoors, where workers are subject to Alaska's highly variable and often harsh weather.

However, the high mortality rate for Alaskan workers is not necessarily wholly attributable to northern locale, weather conditions, or the prominence of resource harvest industries (fishing, petroleum, logging) and nonroadway transportation. The Nordic Nations share many similar conditions, but have substantially lower occupational injury mortality rates than the U.S. overall,

Photo 1: An aerial view of Alaska's rugged terrain

and Alaska. (See Figure 1.) For example, Norway, which has a similar industrial makeup to Alaska, with commercial fishing, petroleum, tourism, logging, and small-airframe aviation all prominent as industries, experienced an occupational injury mortality rate of 3.8/100,000/year for 1980 through 1989, below that observed for the U.S., and much lower than that for Alaska.[3]



* Source: Arbejdstilsynet, The Danish Working Environment Service, 1980-1989, Copenhagen, 1993.
** Source: Fatal Injuries to Workers in the United States, 1980-1989: A Decade of Surveillance, NIOSH, CDC, 1993.

Figure 1: Occupational Fatality Rate Comparison:
Nordic Nations vs. United States and Alaska, 1980-1989

In response to the high occupational injury rates in Alaska, the National Institute for Occupational Safety and Health (NIOSH) established the Alaska Field Station (AFS) in Anchorage in May 1991. The purpose of the AFS is to address the urgent problem of work-related fatalities by developing surveillance and prevention programs. Program activities are conducted in collaboration with the Alaska Department of Health and Social Services (AKDHSS), Alaska Department of Labor (AKDOL), U.S. Coast Guard (USCG), National Transportation Safety Board (NTSB), Federal Aviation Administration (FAA), Occupational Safety and Health Administration (OSHA), industry, labor organizations, communications media, health-care providers, universities and community colleges, and other individuals and organizations in the public and private sectors that are interested in public health. Since 1992, NIOSH has also funded the Fatality Assessment and Control Evaluation (FACE) program in the AKDHSS Section of Epidemiology.

The NIOSH Alaska Field Station addresses the following research questions:

- How many fatal and severe nonfatal occupational injuries occur in Alaska?
- In which Alaska industries and occupations do they occur?
- What risk factors are identifiable for these events?

- Which of these risk factors can be eliminated or mitigated?
- How can this most effectively be accomplished?

The objectives of the program are

- To characterize and reduce occupational risks in workplaces and industries by using epidemiologic surveillance and analytic methods and engineering hazard and task analysis techniques;
- To establish and refine statewide occupational injury and fatality reporting systems;
- To conduct prevention-oriented research addressing high-risk operations and populations (for example, commercial fishing, air transport, and logging);
- To use the on-site location as a “living laboratory” for conducting state-of-the-art injury surveillance, intervention trials, and demonstration projects; and
- To promote the transfer of worker injury prevention strategies to and from Alaska.

This document describes several programs that were developed toward meeting these objectives and summarizes efforts to prevent occupational injuries in Alaska by many agencies and organizations during the 1990s (with case-based examples for focal efforts). Preliminary evidence of this program’s effectiveness is presented. The information provided is also potentially useful in mounting similar efforts elsewhere.

Methods and Approach to the Problem

To detect and work toward preventing acute traumatic occupational injuries, the NIOSH Alaska Field Station's program development followed a set of principles rooted in the public health model. This model includes

- Describing an accurate picture of the problem by the establishment of effective and timely surveillance systems, obtaining information via data-sharing with jurisdictional agencies and from direct investigation of incidents, tailoring available methodology to local needs, and presenting data in more understandable and/or graphic formats;

- Collaborating with, and constructing working relationships among local, state, regional, and federal government agencies, workers, industry and labor organizations, and nongovernmental organizations (NGOs);

- Using data to drive program priorities via the use of a hierarchical approach for the full spectrum of injury events: those resulting in multiple and single fatalities, severely disabling injury, hospitalized injury, less severe injury (including lost time events), and hazards; and

- Developing prevention strategies and recommendations, with a concentration on the technical, geographical, environmental, political, and cultural features of local and regional injury problems, with programs designed specifically to fit those problems, rather than using a "one-size-fits-all" approach.

The basis of this approach may prove useful elsewhere. Injury surveillance data reflect the status of health in the community. Sharing of occupational injury data often results in increased partnerships with other community agencies, and this technical assistance is provided by NIOSH.

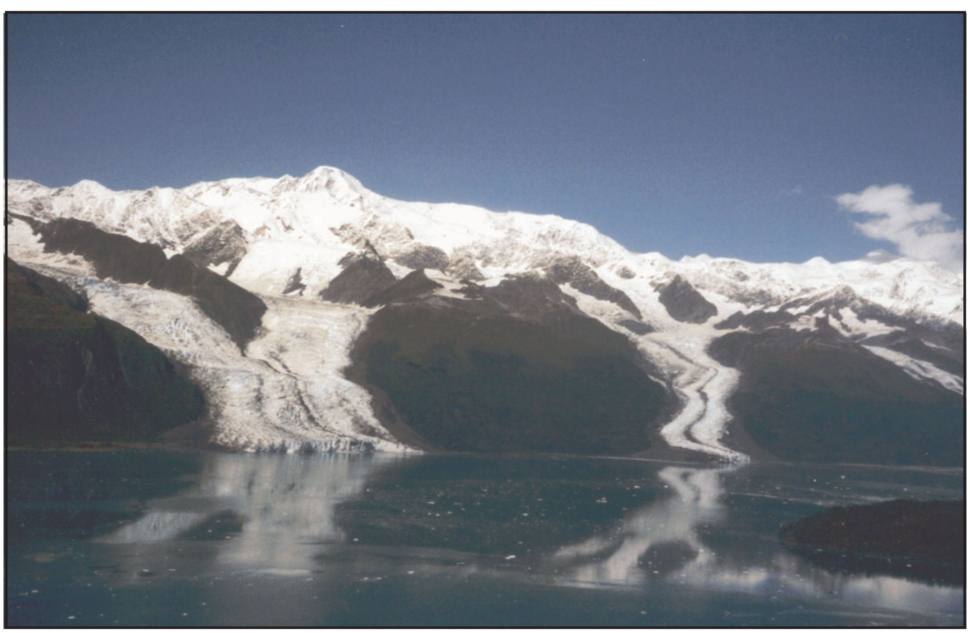


Photo 2: An Alaska mountain range, reflected in the glacial water below

Systematic formation of effective prevention strategies for injuries has been dependent upon a clear understanding of risk factors for these events. Thus, when faced with particularly challenging categories of traumatic fatalities in Alaska's helicopter logging and fishing industries, a refinement of Haddon's Matrix was developed for local use as an analytic and planning tool.[4] (See Table 1.) This type of matrix, first described by Dr. William Haddon of the National Highway Traffic Safety Administration, provides a systematic way to determine the interaction between the host (the injured worker), the agent (the energy that causes the injury, e.g., the mechanical energy of a crushing), and the environment (a highway, for example) when injuries occur. The matrices are often used to classify the risk factors present at the time of injury, as well as pre- and post-events associated with the injury, and thus serve as valuable tools for identifying intervention areas.

Table 1: Haddon Matrix

Phases	**Host/Human**	**Agent/Vehicle**	**Environment**
Pre-event/ Pre-injury			
Event/Injury			
Post-event			

NIOSH employs Haddon's matrices sequentially to help develop and implement worker safety programs. After worker injury cases are investigated, surveillance data is organized into risk factors. Then, a consensus safety recommendation matrix is developed. Working closely with industry, state and federal agencies and nongovernmental organizations, immediate improvements may be made in such areas as worker training, work/rest cycles, and oversight. Surveillance results are then used to evaluate the effectiveness of interventions. Finally, a prevention matrix is developed for further safety refinements in the subject industry. Readers will see examples of these matrices in other sections of this document.

Information on occupational injuries in Alaska has been gathered through an extensive network. NIOSH has designed and implemented a comprehensive surveillance system for occupational injuries, the Alaska Occupational Injury Surveillance System (AOISS). AOISS compiles risk factor information and permits quantitative epidemiologic analyses to be used for sound public health and prevention planning. Press releases from the Alaska State Troopers, reports from electronic or print news media and wire services, or contact from jurisdictional agencies or the Fatality Assessment and Control Evaluation (FACE) program usually alert NIOSH staff to new injuries. The respective jurisdictional agency (e.g., NTSB, USCG, OSHA, AKDOL) is contacted and NIOSH or AKDHSS FACE personnel participate in on-site investigations when possible. The data from other sources which are entered into the AOISS database are obtained (by agreement) from these jurisdictional agency reports and databases. Reports are also requested from the Alaska State Troopers and local police agencies (incident reports), Alaska Bureau of Vital Statistics (death certificates), Alaska Department of Transportation (motor vehicle crash reports) and the State of Alaska Medical Examiner's Office (autopsy reports). Data are shared or reconciled with occupational traumatic injury fatality statistics from the AKDHSS's FACE program and with Alaska's Census of Fatal Occupational Injuries at AKDOL. The system is validated with these two offices and through a follow-up meeting with contacts from all of the jurisdictional agencies. (See Figure 2.)

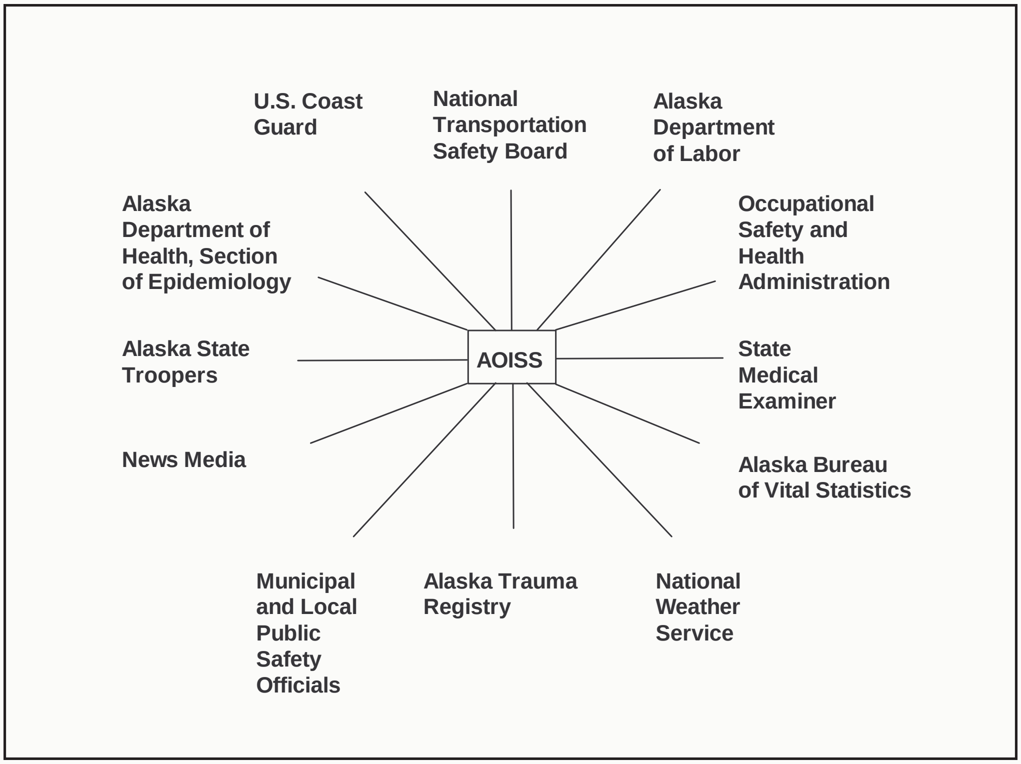


Figure 2: Sources of Data for the Alaska Occupational Injury Surveillance System (AOISS) Database

AOISS also obtains incident and decedent information from the FAA-Alaska Region (Operator Summaries), Federal Department of Transportation (Quarterly Carrier Statistics), Alaska Department of Fish and Game (fishing permit information), and the Alaska Department of Labor (information on workforce population and business licenses). Forensic weather information is obtained from the National Weather Service.

Implementing the ambitious goals of the NIOSH program in Alaska has required collaboration with others. Strong working relationships were established during the early 1990s among the many other federal, state, municipal, and nongovernmental organizations that are engaged in detecting, investigating and/or preventing occupational injuries and fatalities. These relationships, formalized within the Alaska Interagency Working Group for the Prevention of Occupational Injuries, include the Alaska Department of Labor, the Alaska Department of Health and Social Services, the National Transportation Safety Board, the U. S. Coast Guard, the Federal Aviation Administration, the U. S. Forest Service, and the Occupational Safety and Health Administration, and industry organizations, NGOs, and professional associations. This network serves to foster injury surveillance, a broader understanding of occupational injuries in the state, and opportunities to effectively influence the immediate response to emerging occupational injury problems. Included in this group are the jurisdictional agencies overseeing the highest-risk industries in Alaska. The Working Group currently has three committees focusing on preventing deaths and injuries in aviation, commercial fishing (particularly crabbing), and the construction industries.

These collaborations in Alaska emphasize rapid, nonregulatory, collaborative responses in intervention strategies. Industry and workers are invited to be full partners in planning and executing interventions and providing ongoing surveillance data to track successes and/or failures. The Working Groups have also explored other ways to motivate the implementation of prevention efforts by discussing possible voluntary work standards with insurers and assisting in discussions of possible insurance rate discounts for companies subscribing to more rigorous voluntary standards.

Photo 3: A long line commercial fishing vessel

Overview of Alaska's Work-related Fatalities

The demographics of Alaska's workforce in the 1990s often reflected national trends. Fifty-five per cent of Alaska's workers were male, compared to 54 per cent of workers nationally. [5,6] In Alaska, about 96% of worker deaths were among males, compared to 94% nationally. (See Figure 3.)

This disparity is partially explained by the most hazardous Alaska occupations employing primarily males: there were 217 commercial fishermen, 107 civilian commercial pilots and 6 military pilots, 41 other military personnel, and 26 loggers killed on the job during this 10-year period. In all, during 1990-1999, there were 648 acute traumatic occupational injury fatalities in Alaska.

Many of these occupational fatalities were to young workers, resulting in 17,493 Years of Potential Life Lost (YPLL<65). The dollar cost to society in lost future productivity due to these premature work related deaths is estimated to be at least $602,000,000 using the "cost of injury method." [7] "Willingness to pay" methods would result in much higher estimates.

The major circumstances of death for all workers during this 10-year period were drowning (219), aircraft crash (192), being crushed (53), homicide/suicide (47), motor vehicle crash (29), and fall (26). (See Figure 4.)

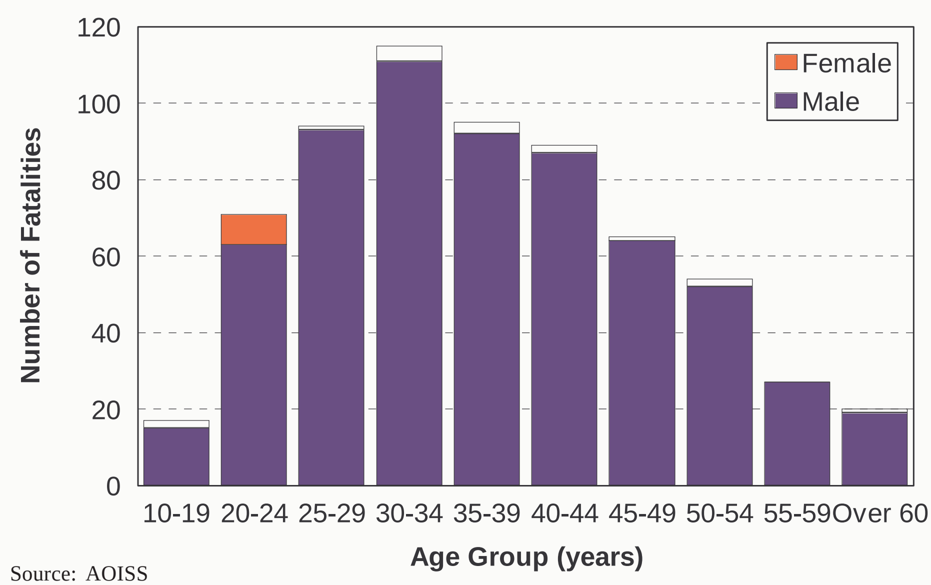
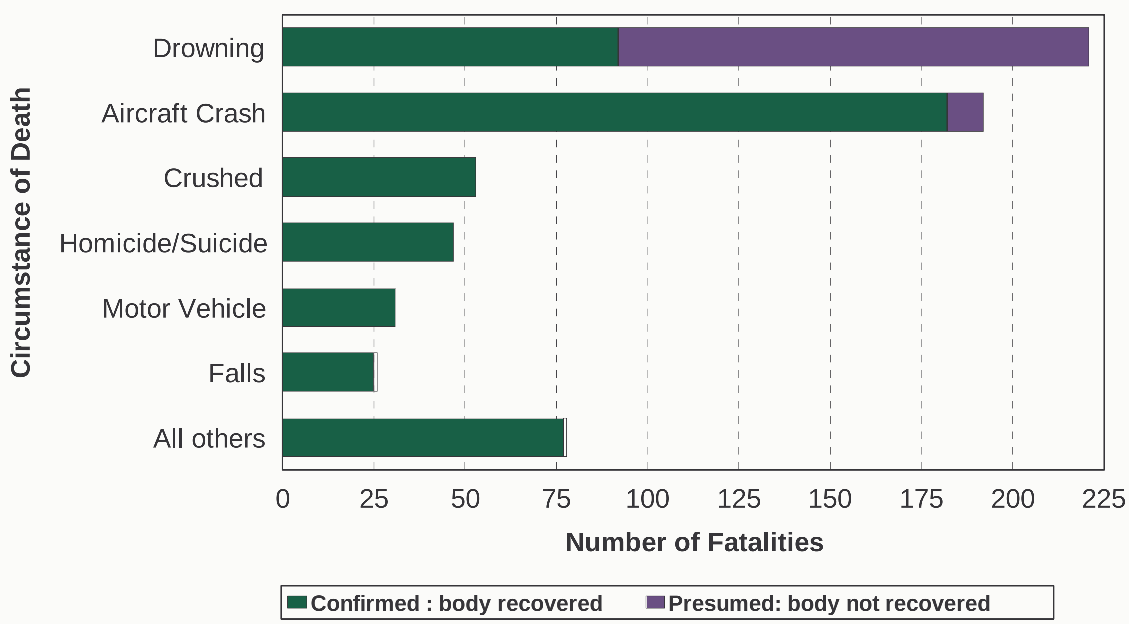


Figure 3: Occupational Fatalities by Age Group and Gender, Alaska, 1990-1999, n= 648



Source: AOISS

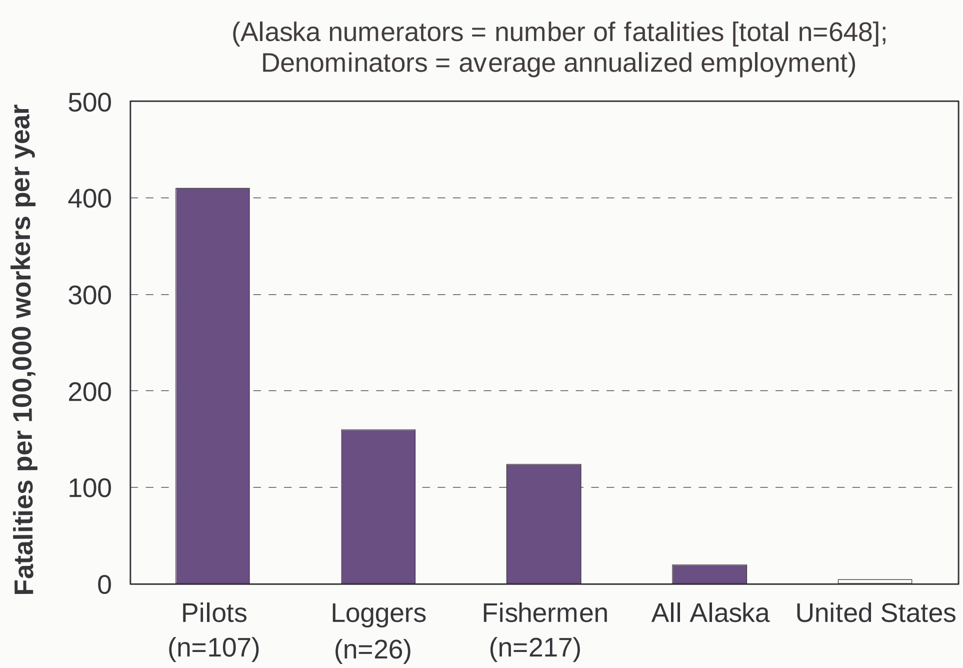
Figure 4: Occupational Fatalities by Circumstance of Death, Alaska, 1990-1999, n= 648

Photo 4: Start of a fishing season in Alaska

Using available workforce denominator data, occupation-specific mortality rates were calculated for Alaska pilots (410/100,000/yr. average for period 1990-1999),[8] loggers (150/100,000/yr. average for period 1990-1999),[9] and fishermen (124/100,000/yr. average for period 1990-1999),[10] compared to an all Alaska rate for 1990-1999 of 22/100,000/workers/year,[11] and an all U.S. rate for 1991-1995 of 4.4/100,000/workers/year.[5] (See Figure 5.)

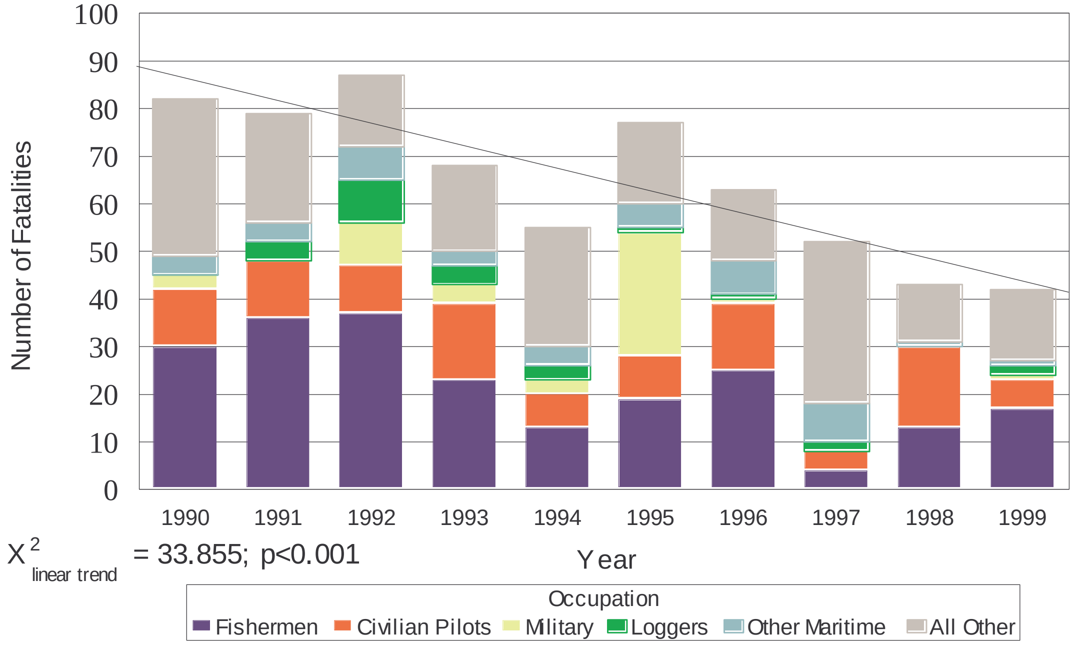
Overall, occupational injury fatalities decreased significantly ($p<0.001$) during the 1990s (from 82 in 1990 to 42 in 1999, a decrease of 49 percent), with the bulk of improvement occurring among fishermen and loggers. Fishermen, Pilots, Loggers, and Other Maritime workers comprised the majority of work-related deaths in Alaska during the 1990s. However, a significant number of workers identified as working in "other" categories were also killed (n = 207 for 1990-1999). These workers in "other" occupations included Construction Laborers (12 killed during 1990-1999), Truck Drivers (11 deaths), Mining Machine Operators (9 deaths), Laborers in Non-construction Industries (8 deaths), Taxi Drivers/Chauffeurs (7 deaths), and Biological/Life Scientists (7 deaths). (See Figure 6.) In all, 98 different occupations are listed in the "other" category.

However, no significant decrease has been noted among pilots, who now account for an increased proportion of occupational mortality in the state. While drowning was the most common cause of death during 1990-1994, major progress was made in reducing the frequency of drowning deaths during the 1990s, so that by 1995-1999, aircraft crashes had become the most common cause of death for Alaskan workers. (See Figure 7.) As causes of occupational death have shifted in the past decade, NIOSH has shifted the focus of its prevention efforts.



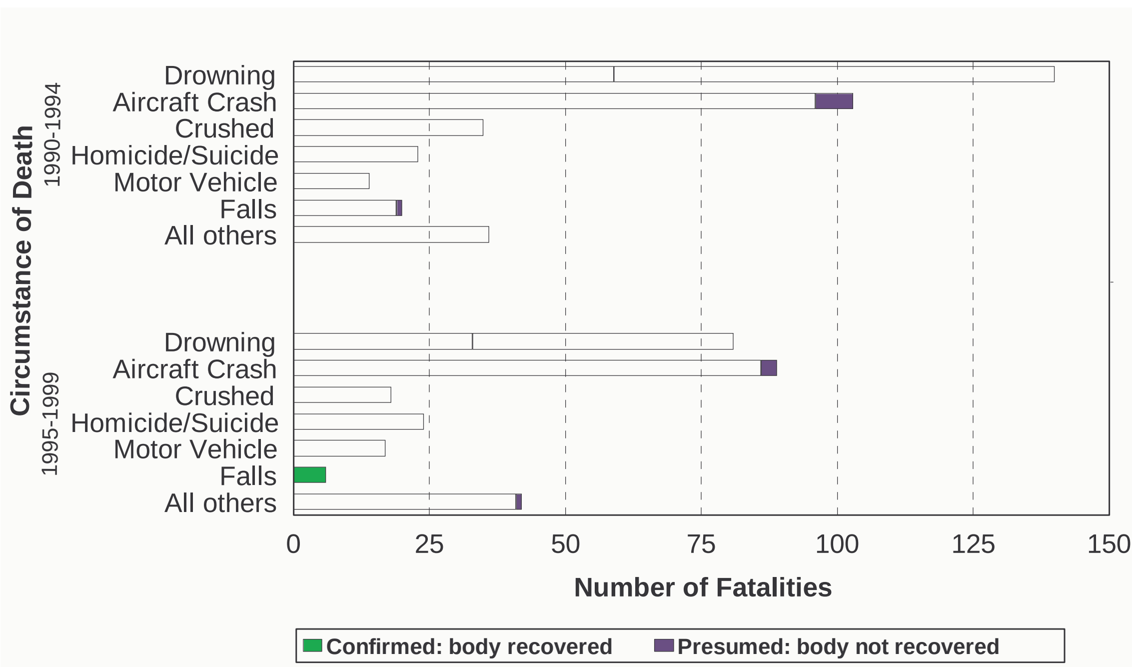
Pilots (Civilian only): FAA Alaska Flight Standards Division, 1998 (n=2600)
Loggers: Alaska Department of Labor, 1998 (n=1631)
Fishermen: NIOSH Alaska Field Station, 2001 (n=17500)
All Alaska: Bureau of Economic Analysis, 2000 (n=366705)
US: 1991-95 Worker Health Chartbook DHHS (NIOSH) Publication number 2000-127, p.30

Figure 5: Fatality Rates by Occupation, Alaska, 1990-1999



Source: AOISS

Figure 6: Occupational Fatalities, Alaska, 1990-1999, n=648



Source: AOISS

Figure 7: Occupational Fatalities by Circumstance of Death, Alaska, 1990-1994, n=371; and 1995-1999, n=277

Helicopter Logging

This section will describe a successful partnership, developed in the early to mid1990s, that resulted in increased safety for a high-risk occupation. The first major focused prevention effort of NIOSH came during the establishment of the Alaska Occupational Injury Surveillance System (AOISS) in 1992. Because of increasing and changing environmental restrictions on road building in Alaska's national forests in the late 1980s, helicopters emerged as a major transportation mode for moving cut logs by the early 1990s. Amid the rapid growth of this new industry in Alaska, between January 1, 1992, and June 30, 1993, there were 6 helicopter crashes (see Table 2), with 9 fatal injuries (including 4 pilots) and 10 severe nonfatal injuries, out of only 25 helicopters flying in logging operations. These events led to an extraordinarily high annual crash rate of 16 percent and a catastrophic pilot fatality rate of 5,000/100,000/year.[12] Investigation revealed that all crashes involved improper operation and/or maintenance practices.

Table 2: Alaska Helicopter Logging Incidents, 1/1/92-6/30/93

Date	Number Killed	Number Injured	Type of Helicopter	Logging Company
2/23/1992	6 (Co-pilot and 5 loggers)	5 (Pilot and 4 loggers)	Manufacturer A Type A Single engine	Company A
3/6/1992	0	2 (Pilot and Co-Pilot)	Manufacturer A Type A Single engine	Company A
11/10/1992	0	0	Manufacturer A Type B Single engine	Company A
2/19/1993	2 (Pilot and Co-Pilot)	0	Manufacturer A Type A Single engine	Company B
5/2/1993	1 (Solo Pilot)	1 (Ground Crew Logger)	Manufacturer A Type C Single engine	Company B
5/8/1993	0	2 (Pilot and Co-Pilot)	Manufacturer A Type A Single engine	Company B

After the occurrence of two serious helicopter logging crashes during one week in May 1993, NIOSH began a series of urgent consultations, culminating in convening an emergency session of the Alaska Interagency Working Group for the Prevention of Occupational Injuries in early July 1993. Prior to this meeting, the first helicopter logging matrix was developed to identify risk factors contributing to these events. (See Table 3.) Based on the collaborative efforts of the Working Group, there were tangible outcomes:

1. All parties had rough agreement on what had happened in these events;

2. The US Forest Service knew the timber sale locations, AKDOL knew the ramp (maintenance) and hangar locations, and both agencies were willing to share this information with the FAA and to collaborate and share costs in making site visits to each in the ensuing weeks. [Due to a peculiarity of CFR Part 133, the regulation for aerial lift-load operations, the FAA only had the chief pilot/headquarter location for each operation, and all of these were out of state.]

3. The Working Group arrived at preliminary consensus recommendations.

Table 3: Potential Risk Factors of Alaska Helicopter Logging Events

	Host/Human	**Agent/Vehicle**	**Environment**
Pre-event/ Pre-injury	Pilot Training Experience Fatigue Stress Alcohol Ground crew Training Experience	Helicopter design Lift & durability Maintenance & repairs Engines & controls Ergonomics Unstable work platform Surplus/improvised equipment	Terrain Weather Landing zones Oversight FAA (CFR pt 133) Industry
Event/Injury	Pilot Reaction to emergency situation (i.e.,autorotation) Task overload Ground Crew Reacting & avoiding	Helicopter Autorotation performance Deformation on impact Fires & explosions	Terrain Weather
Post-event	Types of injury Severity		Little assistance available EMS not available

Photo 5: A helicopter crash at Dora Bay, Alaska

The prevention-matrix approach resulted in recommendations including more vigorous oversight; development of rigorous voluntary industry standards for equipment, maintenance, and training; exclusive use of multi-engine rotorcraft; and more stringent controls on alcohol and drug use in this industry. (See Table 4.)

Table 4: Alaska Helicopter Logging Injury Recommended Countermeasures (From Alaska Interagency Working Group for the Prevention of Occupational Injuries, July 1993)

	Host/Human	**Agent/Vehicle**	**Environment**
Pre-event/ Pre-injury	Increased training for pilots and ground crew Improved work/ rest cycles	Maintenance per manufacturer's recommendations Impact (g)- resistant seats NTSB - to prohibit surplus equipment	Improved interagency communication Increased FAA oversight
Event/Injury	Practical training in autorotation		Emergency (backup) landing zones
Post-event			

By late July 1993, all helicopter logging sites and ramps in the state had been visited by the jurisdictional agencies, with a number of these operations being curtailed or entirely shut down for irregularities. Since that intervention and the implementation of the Working Group's recommendations during July 1993, there were no additional helicopter logging crashes or fatalities in Alaska until July 1996, when a single crash occured, with one fatality. (See Figure 8.) There have been no more since (through December 2001), despite continuation of large-scale helicopter logging in Alaska.

Photo 6: A long line load of logs being lifted by a multi-engine, heavy-lift helicopter

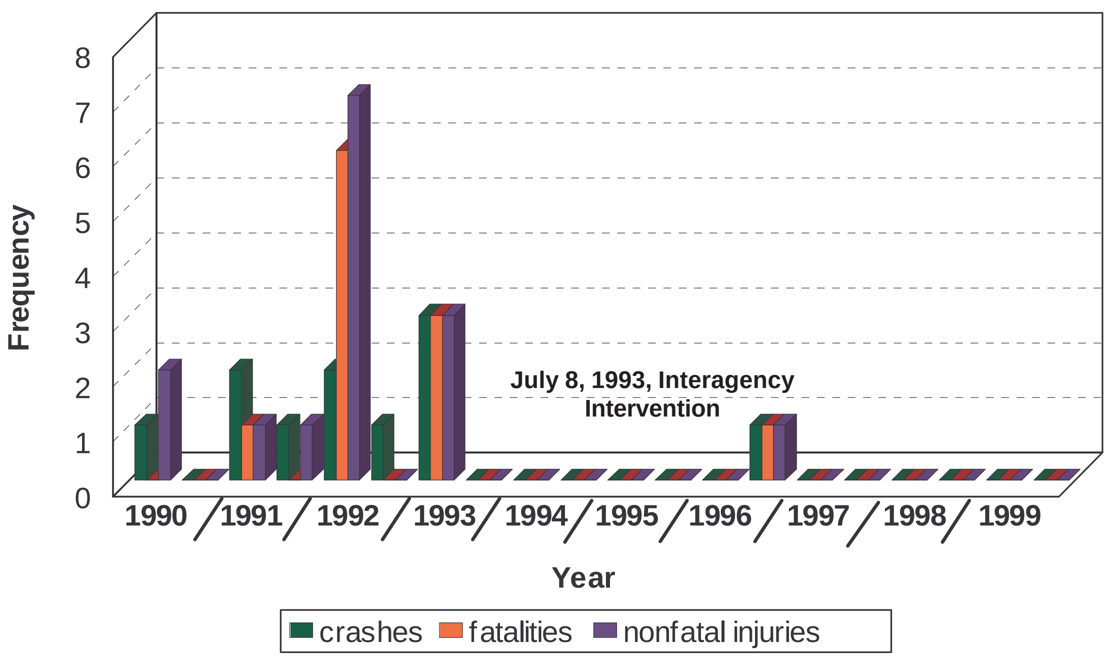


Figure 8: Crashes, Fatalities, and Nonfatal Injuries in Alaska Helicopter Logging Operations, 1990-1999 (By 6-Month Intervals)

This effective application of surveillance data in an interagency intervention for helicopter logging-related crashes has continued. In March 1995, the Alaska Interagency Working Group for the Prevention of Occupational Injuries and NIOSH cosponsored a Helicopter Logging Safety Workshop. An additional prevention matrix was developed to further refine safety countermeasures in the industry. (See Table 5.)

Table 5: Alaska Helicopter Logging Injury Countermeasures

	Host/Human	**Agent/Vehicle**	**Environment**
Pre-event/ Pre-injury	Qualified second pilot Flight/duty time limits Drug/alcohol/ testing Availability of alchol/drug rehabilitation	Multi-engine only Dual drive train Improved controls Improved crash worthiness Limit to certified parts with valid FAA history	Industry SOPs for maintenance safety culture & management Education by helicopter logging association Improve communications among management & crews
Event/Injury	Qualified second pilot	Crash-resistant fuel tanks Controlled deformation	
Post-event		EPIRBs (emergency position indicating radio beacons)	Improve EMS availability CPR/first aid training for crews

Additional workshops were held in 1996 and 1997. (The proceedings of these workshops have been combined and published in one volume.)[13] Building on Alaska's leadership in this area, a Helicopter Logging Safety Committee was formed under the auspices of the Helicopter Association International (HAI), "...to help promote the safe use of helicopters in all aspects of the helicopter logging industry." The committee has established its own "Helicopter Logging Guidelines," which address four issues: (1) general helicopter safety for forestry operations; (2) integration of ground and flight activities; (3) helicopter specific planning; and (4) a pre-accident plan (HAI, 1997).[14] More detailed accounts of these data, events, and interventions have been published elsewhere.[13,15,16]The insurance industry has also played a major role in progress made in helicopter logging by substantially discounting helicopter insurance costs for operators adhering to standards developed by the Helicopter Logging Safety Committee.

The partnership developed among government agencies, HAI, and insurance underwriters has demonstrated the value of joint efforts to address specific occupational safety problems to workers in Alaska.

Commercial Fishing

Working conditions in the commercial fishing industry are very hazardous, compounded in Alaska by isolated fishing grounds, seasonal darkness, cold waters, high winds, icing, and brief fishing seasons. Alaska's commercial fishermen had a high occupational fatality rate of 200/100,000/year for the two-year period 1991-1992.[17] Over 90% of these deaths were from drowning, presumed drowning, or drowning plus hypothermia, in association with vessels capsizing or sinking, or with falls overboard.

Photo 7: Commercial fishermen working in Alaska waters are often exposed to harsh conditions.

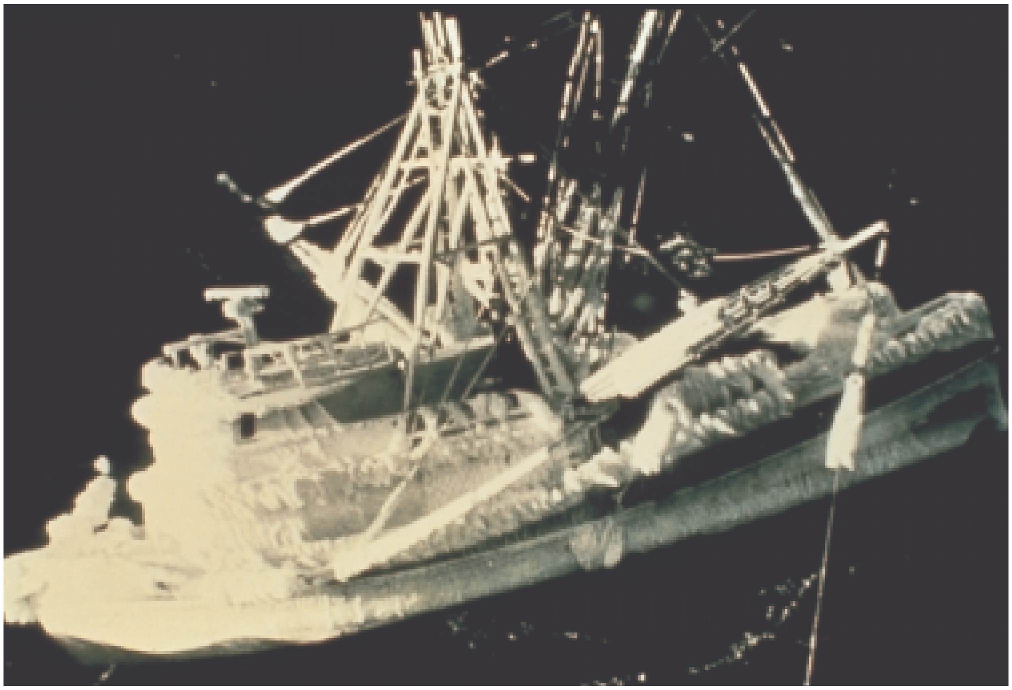


Photo 8: An iced-over fishing vessel, Alaska

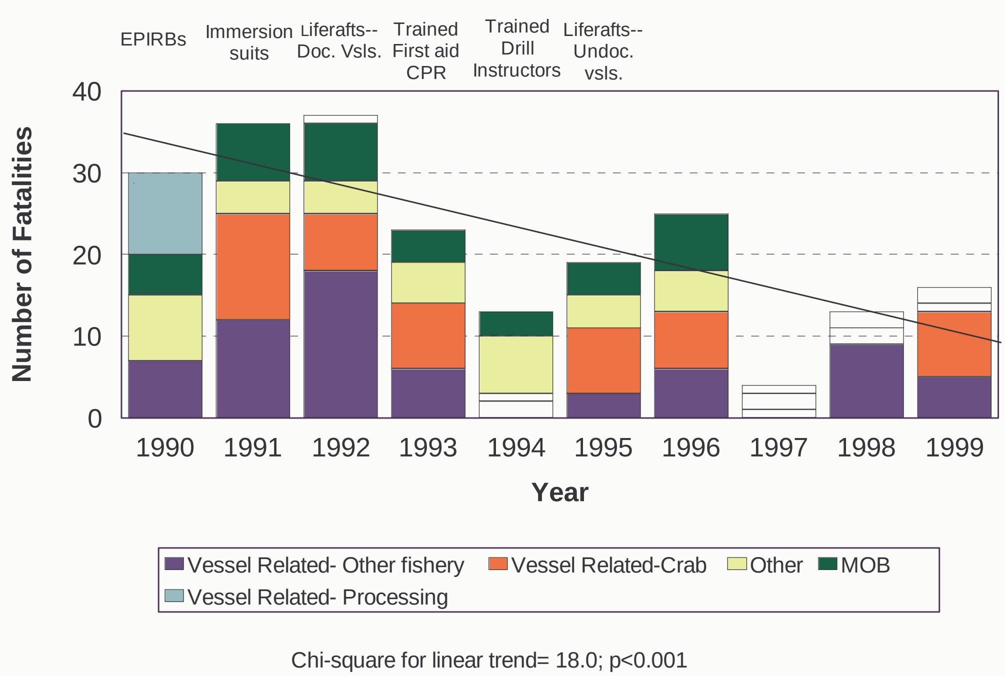
Throughout the 1970s and 1980s, Alaska experienced a boom in its commercial fishing industry. By the mid-1980s, it had become clear that commercial fishing-related deaths were the principal contributor to Alaska's very high occupational fatality rate.[18] In a study published in 1993, researchers found that there were an average of 31 Alaska fisherman deaths per year during 1980-1988.[19]

Photo 9: A partial view of the Port of Kodiak, Alaska

The hazards of commercial fishing captured the attention of the U.S. Congress and led to the enactment of the Commercial Fishing Industry Vessel Safety Act (CFIVSA) of 1988. During 1990-1995, the CFIVSA was implemented incrementally, requiring fishing vessels to begin carrying specific safety, survival, and fire-fighting equipment, and required crew members to obtain first-aid and emergency-drill training. Figure 9 shows the various requirements of the Act, by the individual years of implementation, and demonstrates a concomitant reduction of commercial fishing fatalities with this implementation.

In previous publications, NIOSH had not included floating fish processors in the overall risk factor analysis for commercial fishing. However, to provide a clearer picture of the entire industry, floating fish processor-related fatalities are included in the analysis presented here.

From 1990-1999, Alaska experienced a 49% decline in work-related deaths including a 67% decline in commercial fishing deaths (1990-1992 average compared to 1997-1999 average). By 1999, there had been a significant ($p<0.001$) decrease in the number of deaths in the Alaska commercial fishing industry. (See Figure 9.) While man-overboard drownings and vessel-related events in crabbing (often conducted far offshore and in winter) have continued to occur, and still require urgent attention, marked progress (with a significant downward trend, $p < .001$), has been made in saving lives of those involved in vessel-related events.



Source: AOISS

Figure 9: Implementation of the Commercial Fishing Industry Vessel Safety Act of 1988 and Commercial Fishing Fatalities by Year, Alaska, 1990-1999, n=217

Commercial fishermen represented 217 (33%) of the 648 occupational fatalities that occurred in Alaska during 1990-1999. Given the mean full-time equivalent Alaska commercial fishing workforce of 17,500, this is equivalent to a fatality rate of 124/100,000 workers/year. This rate has decreased from the rate reported in 1991 through 1992 (200/100,000/year); however, it is still 28 times the overall U.S. occupational fatality rate of 4.4/100,000/year. [5]

The commercial fishing workforce's mean full time equivalent (FTE) does not adequately measure the amount of time an individual fisherman or fish processor spends on the water, and that worker's commensurate risk exposure for drowning. NIOSH's work in determining FTEs included consideration of comparability to commercial fishing FTE rates with other countries and industries. The rates assume that workers are on duty 24 hours a day during the opening of fishing seasons lasting less than 15 days. The rates also credit fishermen with 16-hour work days for seasons that last up to 50 days. However, if a person worked on a vessel for more than 50 days continuously, (i.e., they resided on the vessel), they were only counted as working 8 hours per day. It is important to note that the FTE calculations may not reflect the actual amount of time fishermen spent on the water.

Photo 10: Brailing crab at processing plant.

The fatality rate among fishermen varied considerably by type of fishery: shellfish (primarily crab) had the highest rate (407/100,000/year), followed by herring (204/100,000/year), and halibut (119/100,000/year). (See Figure 10.) Fisheries differ in geographic location of fishing grounds, type of harvesting equipment and techniques, time of year, and duration of seasons. Crabbing, a shellfish fishery, is particularly hazardous because harvesting of crab species in Alaska generally takes place during the winter, which is often characterized by rough weather.

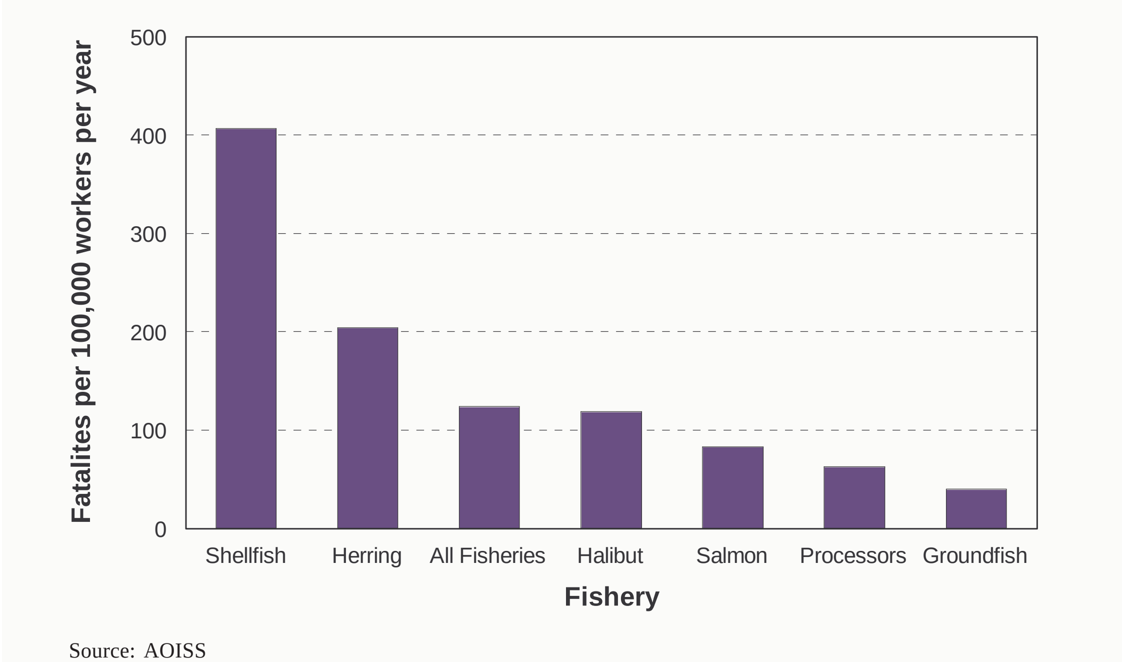


Figure 10: Commercial Fishing Fatality Rates by Fishery, Alaska, 1991-1999

Photo 11: Empty crab pots can weigh up to 800 pounds.

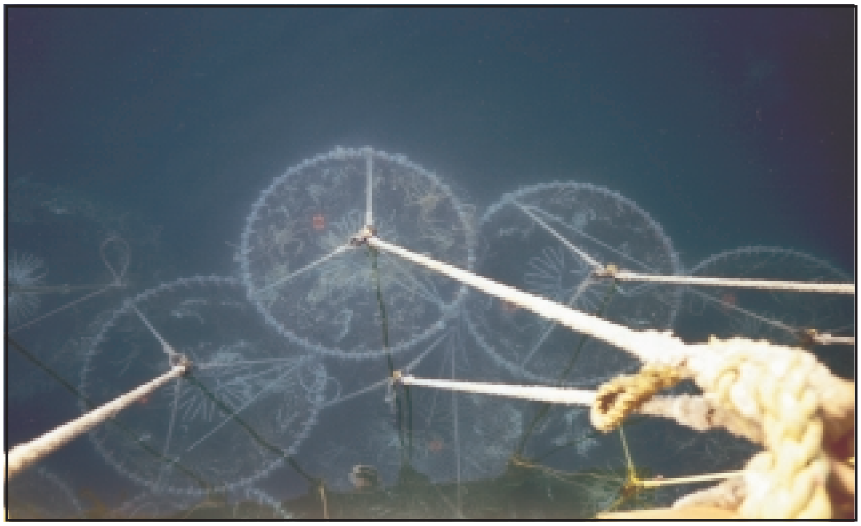


Photo 12: Suspended crab catch.

Most (186, 86%) of the deceased fishermen drowned or died from hypothermia as the result of vessel-related events (133, 72%), falls overboard (43, 23%), diving incidents (5, 3%), or other drowning events (3%). Other fatalities were due to deck injuries (16, 7%), or some other event (15, 7%). Of 133 fatalities in vessel-related events, the largest number (61, 46%) of fishermen were participating in the shellfish fishery. Of those falling overboard and drowning, 22 (51%) were also participating in the shellfish fishery. Fatalities from falling overboard were categorized by cause of immersion: entanglement in net or line (12, 27%), observed fall (12, 27%), unobserved fall (victim missing from vessel) (10, 23%), or being washed or blown into the water (10, 23%). None of the 44 workers who died from falling overboard and drowning were wearing personal flotation devices (PFDs).

Photo 13: A fishing vessel that works in Alaska waters

Of the 133 fishermen who drowned in vessel-related events, information on PFD usage was available for 71—54 (76 %) were not wearing any type of PFD, whereas 17 (24 %) were wearing such devices. (For 62 fishermen in vessel-related events, it is unknown whether they were wearing any type of PFD.) On the other hand, among survivors of such casualties, 34 of 47 were wearing PFDs. Thus, odds ratio calculation shows that survivors of these vessel-related events in which at least one person drowned were 8.3 times (95% CI=3.59-19.24) more likely to have been wearing a PFD than were decedents. (See Table 6.) (For this analysis, immersion suits are included as PFDs.)

Table 6: Personal Flotation Device (PFD) Usage Among Vessel-related Victims and Survivors, Alaska 1990-1999, n=118

	Victims	Survivors	Total
Wearing PFD	17	34	51
Not Wearing PFD	54	13	67
Total	71	47	118

Odds Ratio=8.3 (95% CL=3.6-19.24)

Photo 14: EPIRB, flares and immersion suits on board a commercial fishing vessel.

NIOSH analysis of USCG vessel casualty statistics for 1991 through 1999 revealed that the number of vessels lost per year has remained relatively constant (mean 34, median 36), as did number of workers on board (mean and median 106), whereas remarkable progress has been made in the case-survivor rate (number survivors ÷ number on board) in this type of incident. The case-survivor rate has increased from an average of 78% in 1991-1993, to 92% in 1994-1996, and then to an average of 94% from 1997-1999. (See Table 7.) (This information is not available for 1990). These data only represent fatalities due to the loss of a vessel. Therefore, man-overboard (MOB) events, crushings, and fires are not represented.

While mortality in commercial fishing has indeed been reduced, the continuing pattern of losing 25 to 45 vessels every year and approximately 100 persons who must be rescued each year from cold Alaska waters remains problematic. Successful rescue is still dependent on the expertly trained personnel of the USCG Search and Rescue (SAR) operations, and such efforts can be hindered by distance and the harshness of seas and the weather. Furthermore, the workers involved in USCG SAR operations are themselves at considerable risk for injury or death during these rescue attempts.

Table 7: Recent Decrease in Case Fatality Rate, Alaska Commercial Fishing Industry, 1991-1999

Year	Number of Vessels Lost	Workers on Board*	Worker Fatalities**	Case Fatality Rate***	Case Survivor Rate
1991	39	93	25	27%	73%
1992	44	113	26	23%	77%
1993	24	83	14	17%	83%
1994	36	131	4	3%	97%
1995	26	106	11	10%	90%
1996	39	114	13	11%	89%
1997	31	84	1	1%	99%
1998	37	124	9	7%	93%
1999	28	104	11	11%	89%

*Source: US Coast Guard, 17th District, Fishing Vessel Safety Coordinator
**Fatalities from capsized or lost commercial fishing vessels only
***Case Fatality Rate=(number killed/number at risk) x 100 percent

Surveillance findings for causes of fishing-related fatalities for the Alaska commercial fishing industry parallel those reported in previous surveillance data, incident investigations, and survey information collected for 1980-1992 by NIOSH,[18,19] USCG,[20]NRC,[21]NTSB,[22]and the University of Alaska.[23] Workers at greatest risk for fishing-related fatal injuries are those who fish for crab aboard unstable vessels. However, our more recent findings reveal consistent reduction of fatalities linked to vessel-related emergencies.[24,25]

The causative factors for Alaska commercial fishing-associated fatal and nonfatal injuries are complex. Gear type, fatigue, and environmental conditions also contribute to the severity, if not the frequency, of occupational incidents. (See Table 8.)

Table 8: Features of Commercial Fishing Injury Events in Alaska

	Host/Human	**Agent/Vehicle**	**Environment**
Pre-Event/ Pre-Injury	Captain & crew Fatigue Stress Inadequate training/ exposure	Unstable vessel Unstable work platform Complex machinery and operations	High winds Large waves, icing Short daylight Limited fishing seasons Vessels far apart
Event/Injury	Captain & crew Reaction to emergency PFD not available/ not working	Leaning or capsized vessel Delayed abandonment Emergency circumstance not understood Man overboard (MOB)	High winds Large waves Darkness Poor radio communications Cold water
Post-Event	Poor use of available emergency equipment Hypothermia Drowning Lost at sea	Vessel sinking, Poor crew response to MOB	High winds Large waves Cold water

The impressive progress made during the 1990s in reducing mortality in fishing-related incidents in Alaska has occurred largely post-event, primarily by keeping fishermen who have evacuated capsized or sinking vessels afloat and warm (using immersion suits and life rafts), and by being able to locate them readily, via electronic position indicating radio beacons (EPIRBs). All of these regulations required by the CFIVSA were implemented during 1990 through 1995. (See Table 9.)

Table 9: Alaska Commercial Fishing Injury Countermeasures - Commercial Fishing Industry Vessel Safety Act of 1988 (implemented 1990-1995)

	Host/Human	**Agent/Vehicle**	**Environment**
Pre-event/ Pre-injury	Drills		Navigation publications Compasses Anchors
Event/Injury	Immersion suits PFDs	Fire extinguishers/ systems Firemen's outfits/ SCBAs High water alarms Bilge pumps/alarms	
Post-event	Immersion suits PFDs	Distress signals Life rafts EPIRBs	First-aid kits CPR & first aid

Photo 15: Fishing in Southeast Alaska

The CFIVSA emphasized the use and availability of safety equipment during and after emergencies at sea. The findings presented here show considerable reductions in fatalities in some sectors of this industry, but show persistent problems in other areas and no change in the most severe nonfatal injuries. NIOSH has recommended augmenting the current standard approach to minimizing the deaths associated with commercial fishing by attempting to prevent such emergency incidents in the first place, as well as preparing workers in advance on how to react to emergencies if they should occur.[24,25] One of Alaska's innovative marine safety training programs, conducted by the Alaska Marine Safety Education Association (AMSEA), has effectively prevented fishing-related deaths.[26]

The critical etiologic factors that must be addressed for definitive, primary prevention efforts in this industry are vessel stability and hull integrity to keep vessels afloat, licensing and training of operators and crew to ensure a minimum level of competency, coordination of management regimes and safety considerations, avoidance of the harshest sea and weather conditions, and avoidance of falls overboard. Special attention should also be given to worker safety around deck machinery, an area that has not been addressed with current regulations. Efforts are underway to concentrate on the relationship between the vessel, fishing equipment and the worker. (See Table 10.)

Table 10: Alaska Commercial Fishing Injury Countermeasures - Proposed by CDC/NIOSH Alaska Field Station

	Host/Human	**Agent/Vehicle**	**Environment**
Pre-event/ Pre-injury	Licensing of skipper Increased training on vessel stability Increased drills	Reassessment of stability after refitting Retrofitting of sponsons Separating lines from workers	Evaluate impact of management regimes for fisheries No-sail guidelines due to weather Development/refinement of icing nomograms
Event/Injury	Wearing personal flotation devices (PFDs) Man overboard (MOB) alarms Personal emergency position indicating radio beacons (EPIRBs)		
Post-event			

Alaska efforts have started to benefit fishermen in other parts of the U.S.: in 1999, the USCG established a "Fishing Vessel Casualty Task Force" to perform a fast track examination of commercial fishing industry operational and safety issues that may have contributed to a recent increase in marine casualties on the east coast of the U.S. A report of their findings was published in April 1999 and included a list of recommendations for the fishing fleet.[27] The task force relied heavily on three earlier government studies including a 1987 report from the NTSB,[22] a 1991 NRC proposal for a national fishing safety program,[21] and a 1997 NIOSH study [24] of Alaska fishing-related deaths.

Several countries have reported similar safety problems with their commercial fishing fleets. Iceland experienced a commercial fishing fatality rate of 89.4/100,000/year from 1966 through 1986.[28] Safety programs implemented by different countries vary, focusing on vessel quality, operator licensure, crew standards, and safety training.[21] In the United Kingdom, comprehensive regulations implemented in 1975 include inspections of fishing vessels, personnel training, staffing and watch-keeping requirements.[21,29] However, more recent research from the United Kingdom shows that vessel casualties are still a major problem. Fatigue is a common theme in UK commercial fishing incidents, so another recommendation calls for a reduction in the numbers of hours worked by the crew.[30]

The Canadian commercial fishing industry operates in cold waters and has fisheries similar to the northern U.S. fishing industry. Canada experienced high mortality rates, 46/100,000/year for the period 1975 through 1983.[31] In the mid-1980s, Canada examined the fatalities in their fishing industry and developed many safety standards that have been implemented, including (a) requiring safety training to obtain a commercial fishing license, (b) increasing public awareness programs targeting high-risk fisheries, (c) inspecting fishing vessels under 15 gross tons, and (d) requiring the annual submission of self-inspection checklists as a prerequisite for vessel fishing licensure. Although rates of nonfatal injuries associated with vessel emergencies and workplace hazards continue to occur at about the same rate as previously occurred, fatalities have generally been reduced.[21]

The USCG has also recently developed a number of innovative programs, including damage control training, vessel risk indexing, and safety checks prior to historically high-risk fishery season openings. Effective surveillance and interventions for commercial fishing-related mortality in Alaska, historically the worst-case setting in the United States, should provide a useful paradigm and productive venue for prevention of similar deaths throughout the world. Using surveillance data as the basis for action, collaborative efforts have been used to continue the progress made in reducing the fatality rate in Alaska's commercial fishing industry since the implementation of the CFIVSA. Although other factors, such as changing fisheries management and climate change, may have contributed to these successes, the strong temporal association between the implementation of the regulations and the fatalities in Alaska's commercial fishing industry are evidence of the effectiveness of a collaborative approach.

The substantial progress made to date in Alaska's most hazardous industry, through the application of the public health prevention model, as well as the incorporation of new technologies and comprehensive training, should encourage others to try similar approaches elsewhere, and in response to other problems. Building further on the progress already made in preventing deaths in the historically dangerous occupation of fishing could lead to much safer working conditions for commercial fishermen.

Commercial Aviation

A disproportionate number of all U.S. aircraft crashes occur in Alaska. Between 1990-1999 there were 915 commuter and air taxi crashes in the U.S. (includes only the 50 states and District of Columbia) of which 234 (26%) were fatal, resulting in 708 deaths. Alaska accounted for 357 (39%) of the total U.S. crashes, 55 of which were fatal (24% of the U.S. fatal crashes), resulting in 149 deaths (21% of all U.S. deaths).[32] Alaska's aircraft crash rate (crashes per 100,000 flight hours) for air taxi and general aviation during 1992-1994 was 2.5 times higher than the U.S. average.[33]

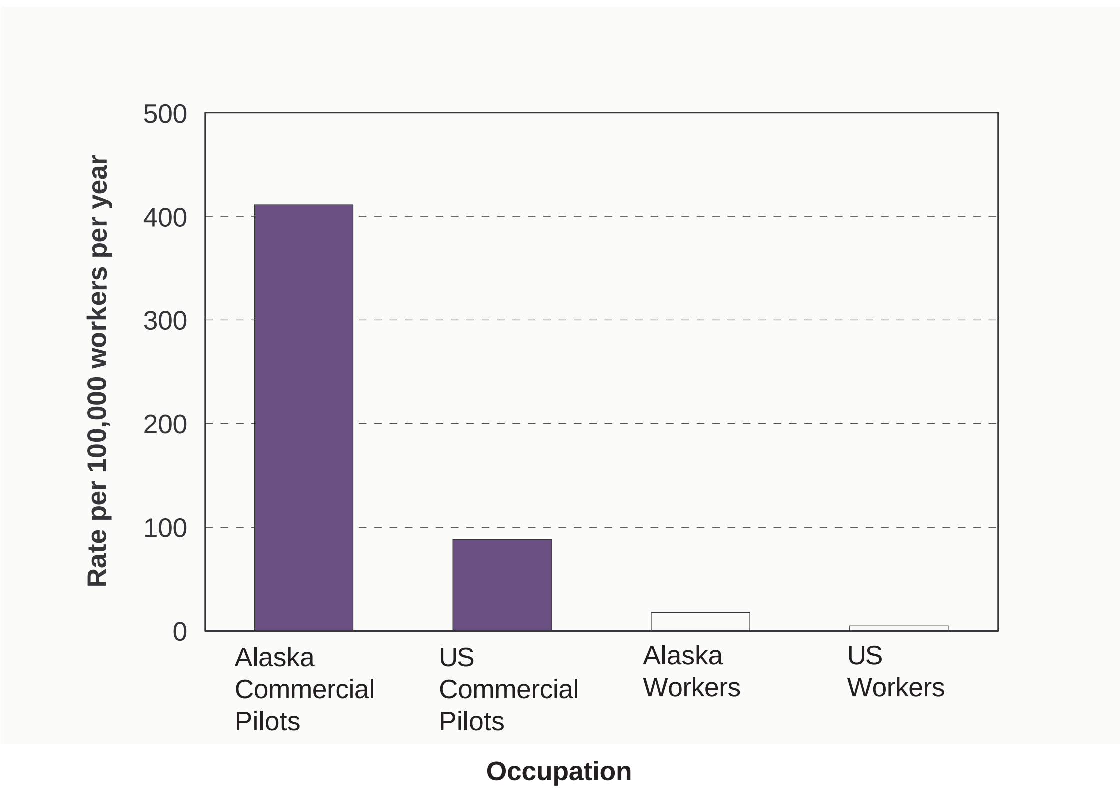
To understand the importance of air transportation in Alaska, some background information on the Alaska environment is needed. With over 586,000 square miles, Alaska has more than twice the land area of Texas and with over 47,000 miles of shoreline, more shoreline than the remaining 49 states combined.[34] It also has 17 of the 20 highest peaks in the U.S., including the highest peak in North America, Mt. McKinley; unfortunately, only 60% of Alaska has radar coverage above 10,000 feet mean sea level.[35] Radar coverage allows aircraft to be seen and followed on a radar screen by air traffic control, and allows for flight in low-visibility conditions.

Even though Alaska is very large, it has only 12,200 miles of public roads, approximately the same mileage as Vermont, a state with less than 2% of the land area of Alaska. Furthermore, 90% of Alaska's communities are not connected to a highway system.[36] That is, even if a road is in place, it may not go any farther than the edge of town or may be an ice road (frozen river or stream) that is only usable during winter. Because of this, commuter and air taxi flights must often serve in lieu of a traditional road system. This makes aircraft essential for personal and commercial transportation of passengers, cargo, and mail to outlying communities.

Photo 16: Aerial view of Alaska

Between 1990-1999, aviation crashes in Alaska caused 106 civilian occupational pilot deaths. (One pilot was killed in an occupational homicide and was not included in this crash analysis.) This is equivalent to 410/100,000 pilots/year, approximately 100 times the mortality rate for all U.S. workers. This rate is higher than for any other occupation in Alaska; the next two highest occupational fatality rates are logging (150/100,000/year) and commercial fishing (124/100,000/year). (See Figure 5 on page 10.) During the 1990s there were a total of 1,684 general and commercial aircraft crashes in Alaska, equivalent to a crash every 2 days. Of these crashes, 188 were fatal and resulted in 402 deaths. On average there were 19 fatal crashes per year with 2 fatalities per crash and 40 fatalities per year, equivalent to a fatality every 9 days.[32]

The pilot fatality rate of 410/100,000/year is nearly five times the rate for all U.S. pilots (80/100,000/year).[37](See Figure 11.) This equates to a 12% cumulative risk for a commercial pilot in Alaska being killed in an aircraft crash over a 30-year career.



AK Pilots (Civilian only): FAA Alaska Flight Standards Division, 1998 (n=2600)
US Commercial Pilots: Bureau of Labor Statistics, 2000
All Alaska: Bureau of Economic Analysis, 2000 (n=366705)
US: 1991-1995 Worker Health Chartbook DHHS (NIOSH) Publication number 2000-127, p.30

Figure 11: Occupational Fatality Rates for Alaska and US Pilots and Workers, 1990-1999

Although Alaska has experienced an overall downward trend in occupational fatalities since 1990 (from 82 fatalities in 1990 to 42 fatalities in 1999, a decrease of 49%), occupational aviation fatalities continue to be a major problem. The work-related deaths resulting from aircraft crashes include pilots and copilots, as well as passengers who fly in order to do their jobs, including biologists, health-care workers, and government employees. During the 1990s, there was a proportional change in occupational fatalities with aircraft crash now the leading cause of death to Alaska's workers. (See Figure 12.)

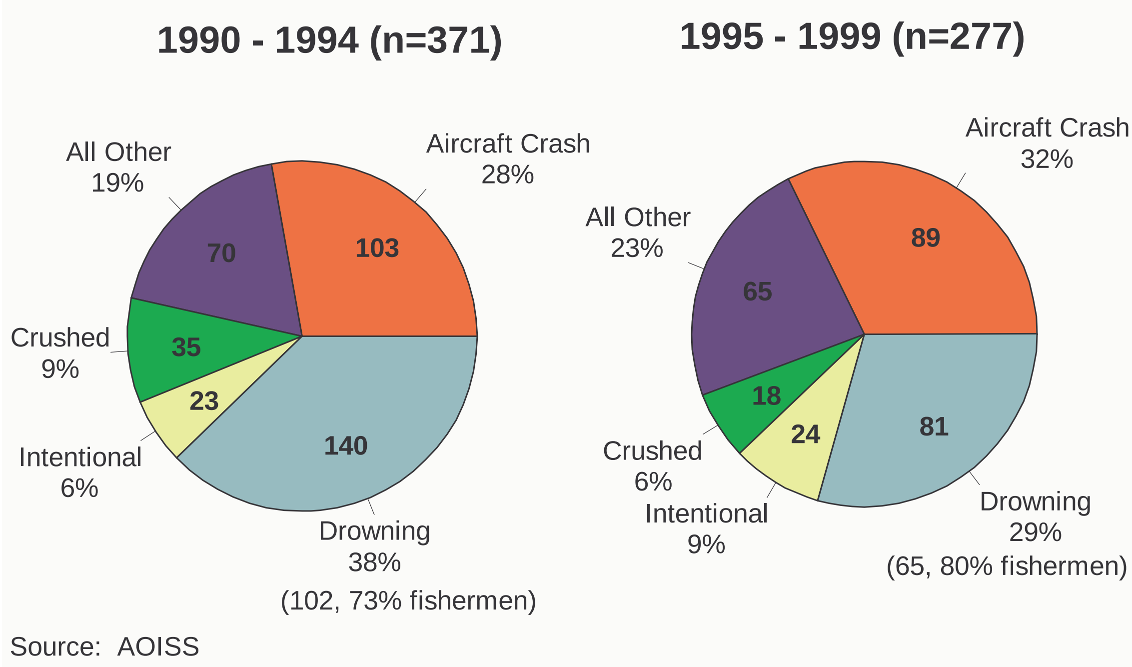


Figure 12: Proportion of Occupational Fatalities in Alaska, 1990-1999

A total of 114 work-related crashes occurred in Alaska from 1990-1999, resulting in 192 fatalities. In this period, 106 civilian pilots and 6 military pilots died in aircraft crashes. Workers from other occupations, who were flying in the course of their work duties, accounted for an additional 80 occupational deaths due to these crashes. Of those, 31 deaths were to military nonpilots and 49 to civilian nonpilots. Twenty-four of the military deaths resulted from one catastrophic crash in 1995. (See Figures 13 and 14.)

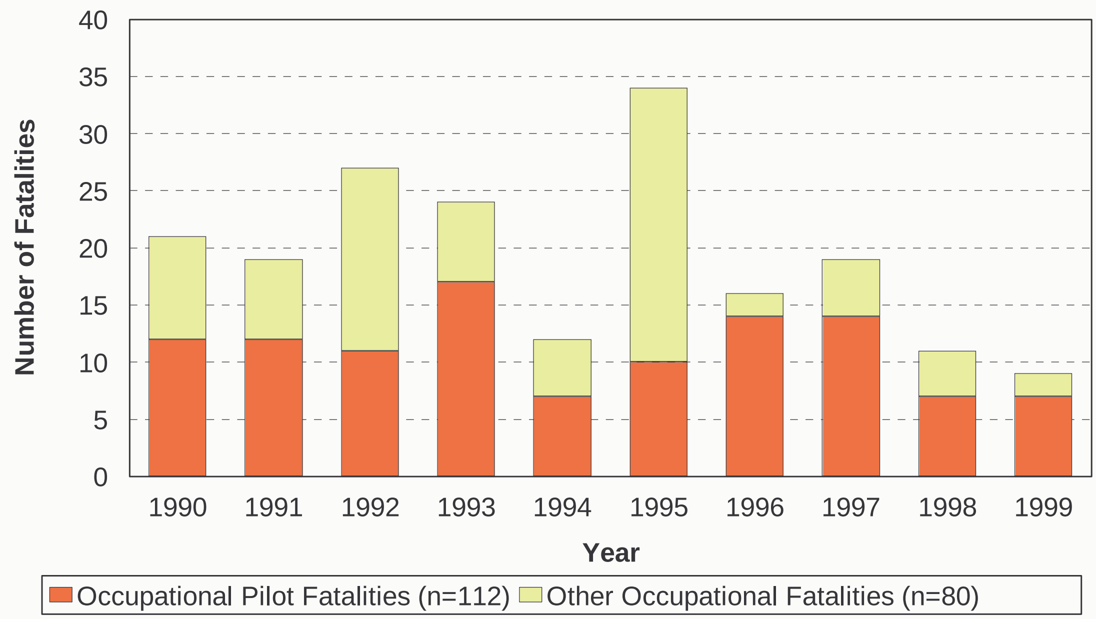


Figure 13: Work-Related Aircraft Crash Fatalities, Alaska 1990-1999 (n=192)

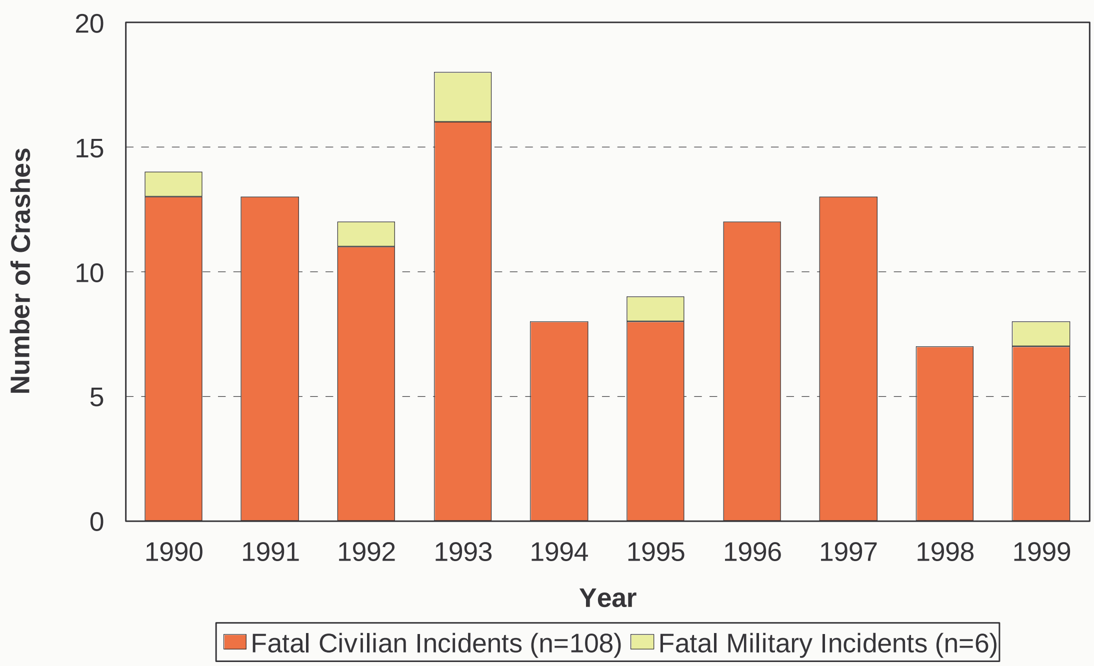


Figure 14: Civilian and Military Work-Related Fatal Aircraft Crashes, Alaska 1990-1999 (n=114)

In addition to the human tragedy which any fatal crash entails, the financial cost to society from these work-related deaths is substantial. For example, with an average of 11 occupational pilot deaths per year in Alaska, the total cost to society is estimated at more than $18 million per year. (Using the cost of injury method includes lost future wages, direct and indirect costs, etc. The total would be much higher if calculated by the more commonly used “willingness to pay” method.)[7]Reducing pilot deaths would also indirectly forestall the costs and increased hazards resulting from the continual loss of experienced and trained pilots in Alaska.

The costs and impacts of these events are not limited to pilots. There are currently an average of 10 nonpilot occupational aircraft crash deaths per year in Alaska, which result in a yearly cost of more than $10 million. There is also an average of 20 nonoccupational aircraft crash deaths per year in Alaska, for a cost of more than $25 million per year. The costs of pilot fatalities, nonpilot occupational fatalities, and nonoccupational fatalities from aviation crashes result in a total yearly cost in Alaska of over $53 million, or over $1.3 million per fatality (using the cost of injury method).

Photo 17: Small aircraft crash site in Alaska

One of the most lethal types of aviation crash is Controlled Flight Into Terrain (CFIT).[38] CFIT is a leading cause of commuter and air taxi aircraft fatalities in Alaska. CFIT crashes are aircraft collisions with land or water in which the pilot was in control of the aircraft (i.e., no detectable mechanical failure or emergency), but had lost situational awareness (i.e., unaware of altitude, terrain elevation, and/or latitude and longitude). Although CFIT represented only 17% of all crashes for 1991-1998 in Alaska, it was responsible for 59% of all commuter and air taxi fatalities. Neither the annual number of commuter and air taxi crashes nor the annual number of CFITs has improved significantly over the past decade.[38] (See Figure 15.)

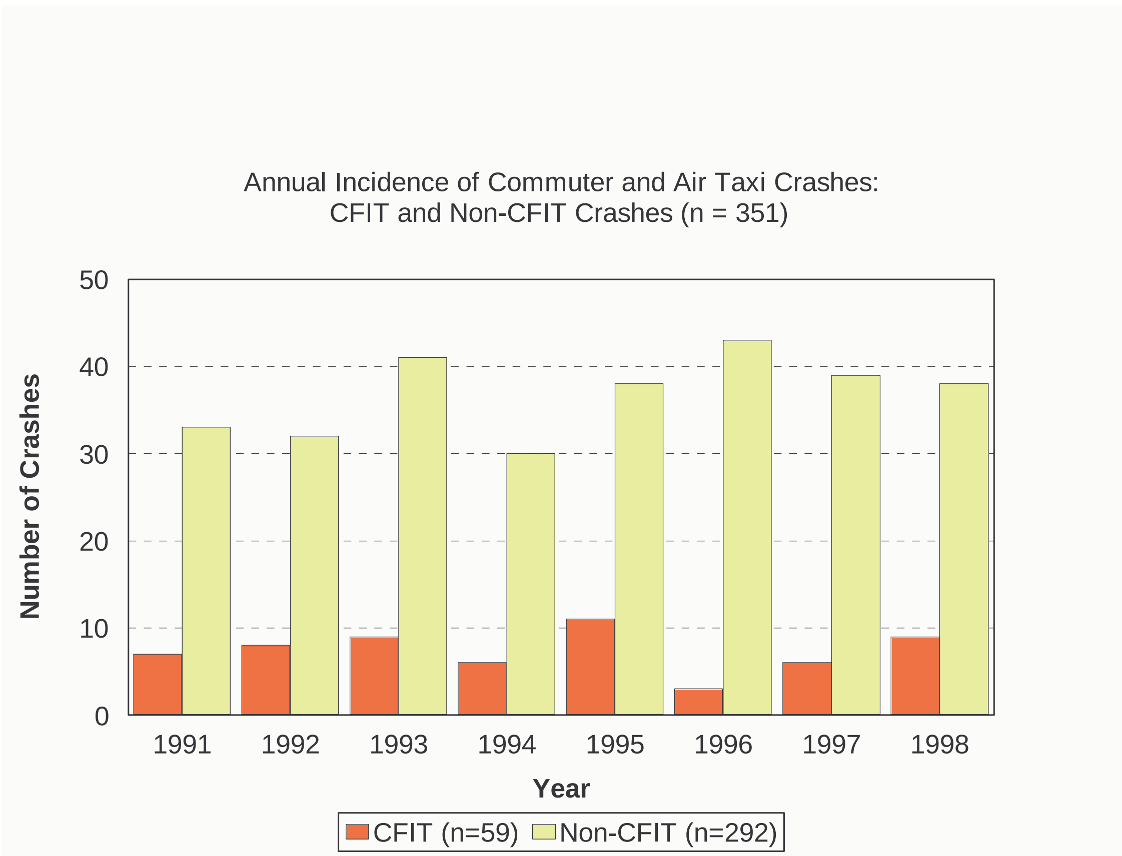


Figure 15: Fixed-Wing, Commuter and Air Taxi Crashes, Alaska 1991-1998

Recent evaluation by NIOSH of work-related crashes occurring in Alaska from 1990-1999 found that 108 nonmilitary work-related crashes resulted in 155 work-related deaths; 106 of these deaths were nonmilitary pilots; 47 (44%) of these pilot deaths were attributed to CFIT.

One contributing factor to CFIT crashes in Alaska is that pilots continue flying itineraries under visual flight rules (VFR) despite poor visibility weather conditions that call for instrument navigation. Visual flight rules pertain when weather conditions allow for a pilot to navigate without instrumentation. The majority of flights in Alaska take place under these conditions. However, operating under instrument flight rules (IFR) may be needed if a pilot flies into reduced visibility weather in instrument meteorological conditions (IMC). Legal instrument flying requires advanced training, an instrument rating, and sophisticated avionic equipment. It further requires that a pilot file a flight plan, and that while in transit, he or she stay in communication with air traffic control. Of the 49 fatal CFIT crashes that occurred from 1990-1999, 29 (59%) were attributed to pilots on VFR-only flights entering instrument meteorological conditions. These 29 crashes resulted in 47 (63%) of the work-related deaths.

The high occupational pilot fatality rate in Alaska and the high fatality rate associated with CFIT crashes reinforce the importance of addressing this type of crash and examining the associated risk factors. Understanding the factors that result in a pilot flying a well-functioning aircraft into the ground due to inappropriate or poor decision making and/or inadequate situational information could help in the design of appropriate training programs and other interventions. This could ultimately result in a major reduction of commercial aviation fatalities.

Other possible interventions for human factors that could help reduce the number of occupational aviation fatalities in Alaska include expanded decision-making training for pilots; strengthened company operational procedures, including management involvement in go/no-go decision making; improved methodology to assess personal and operational pressures to proceed in poor flight conditions; Alaska-specific training for pilots new to the area; and flight schedules that allow for adequate rest for all flight staff.

Technological improvements that could result in fewer aviation deaths for Alaska workers include expansion of navigational aids and weather reporting systems to reduce the likelihood of encountering unexpected weather. Improvements can also be made in the area of aviation technology to aid navigation in reduced visibility weather, through global positioning systems, ground proximity warning systems, and ground collision avoidance systems.

Unfortunately, although mortality due to crashes of fixed-wing aircraft showed modest decreases for Alaska workers in 1997-1999, it persists as the leading cause of death for Alaska workers and is now a major area of concentration. Investigative and interagency efforts among the Federal Aviation Administration, National Transportation Safety Board, and NIOSH have clarified some of the major risk factors for these events: while a single catastrophic crash of a United States Air Force E3 Airborne Warning and Control Systems (AWACS) aircraft at Elmendorf Air Force Base in September 1995 cost 24 lives, the great majority of aviation-related occupational mortality occurs in small, fixed-wing single-engine aircraft flying unscheduled (air taxi, CFR Part 135) itineraries. The Alaska Interagency Working Group for the Prevention of Occupational Injuries Aviation Committee is currently working on collaborative studies of crashes of single-engine, fixed-wing aircraft, and is mounting a major initiative in this area. The FAA also implemented the Capstone Program in Southwestern Alaska to determine if the application of global positioning system technologies can be effective in preventing some of these incidents. To help confront the issues associated with aviation in Alaska and to establish interventions, detailed analyses of crash data, collaborations with aircraft operators, and evaluation of new technologies are currently underway.

Photo 18: Aerial view over Alaska illustrating VFR conditions at lower altitudes, IMC above

Nonfatal Injuries to Alaska Workers

Surveillance of nonfatal, work-related injuries can come from various data sources. Originally designed for internal quality control of patient care for hospital and state trauma systems, trauma registries contain many fields of information that are useful for injury surveillance. Trauma registries are unique sources of injury data: demographics, geographic information, disability, medical cost, payment source, cause of injury, discharge diagnosis, and severity scoring are only a few of the examples of data that are collected. NIOSH has developed a strong partnership with the State of Alaska Department of Health and Social Services (AKDHSS), Section of Community Health and Emergency Medical Services, Alaska Trauma Registry (ATR). This partnership includes federal program support and funding for the ATR. This section describes how the ATR is being used for nonfatal work-related injury surveillance in Alaska.

The ATR has proven to be a useful information source in monitoring nonfatal work-related injuries in Alaska and can serve as a model for other trauma registries nationwide.[39] The ATR is a population-based data system, gathering information on traumatic injury hospitalizations from all of Alaska's 24 acute-care hospitals. (See Figure 16.) In 1988 a pilot project began in seven Alaska hospitals for development of a trauma registry to assess quality of patient care in the local trauma systems. Success as a quality assurance tool led to the implementation of a statewide trauma registry (in all 24 hospitals in Alaska) in January 1991.[40] At that time local injury prevention organizations recognized that the ATR contained sufficient information to be used as an injury surveillance data source. Since 1991 the ATR has been used extensively as a quality assurance and injury prevention data source. NIOSH has collaborated with the development and implementation of work-related injury information collection in the ATR. Information on work-related injuries, including industry and occupation, is currently being used for injury surveillance in this area. To be included in the ATR, patients must have suffered a traumatic injury or poisoning, defined by an ICD-9-CM "N" code (discharge diagnosis) ranging from 800.00 to 995.89. Patients either have to be admitted to a hospital in Alaska, transferred to another acute care facility for a higher level of care, or declared dead in the Emergency Department. Up to 158 data elements are abstracted from medical record charts. The information is sent to AKDHSS to be compiled into the ATR database. A data subset is then created for occupational injury prevention research. The injury surveillance data for work-

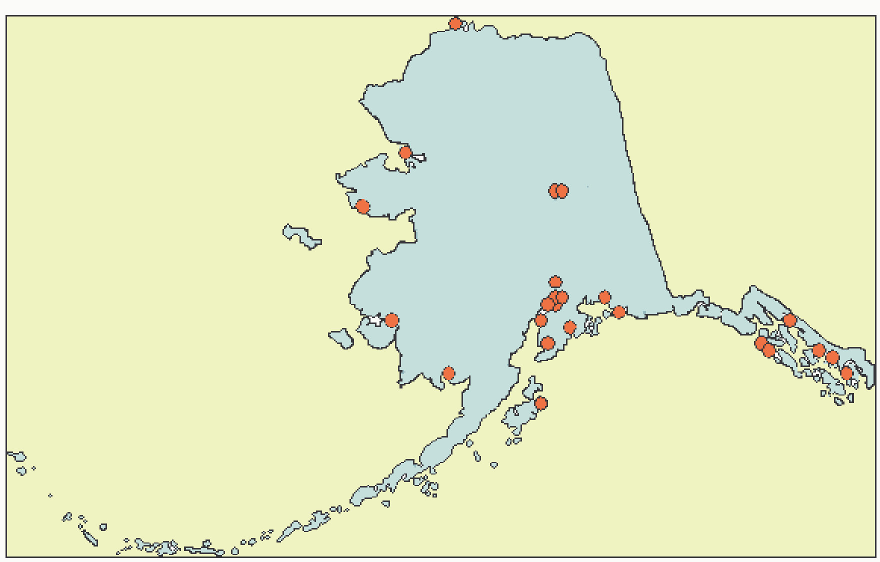
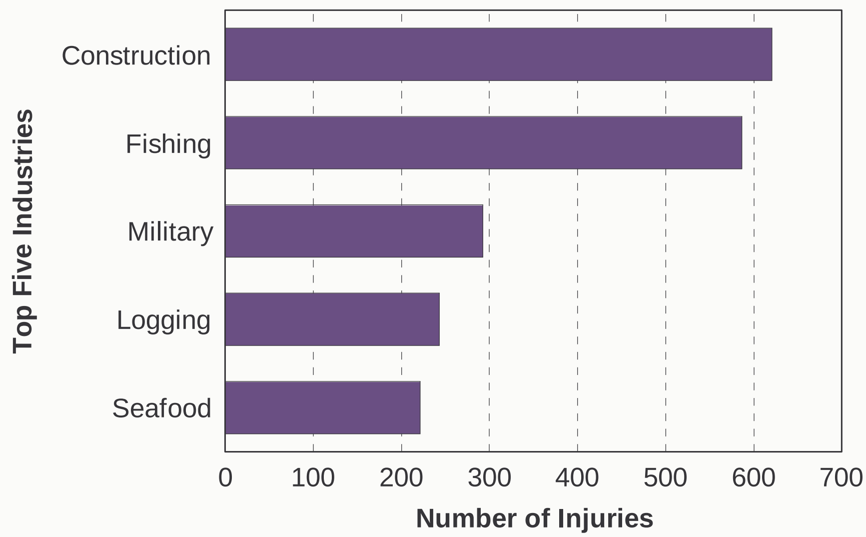


Figure 16: Acute care hospitals in Alaska

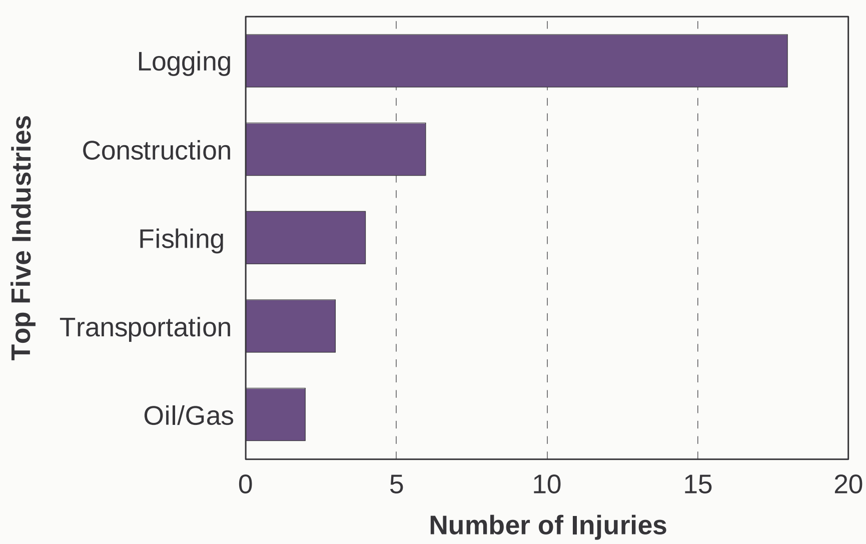
related injuries are then transferred to NIOSH and undergo further coding and analysis. Analysis of trend data and identification of hazardous processes are used in developing injury prevention strategies specifically targeted to high-risk industries and work environments.

From 1991 through 1997, the construction and commercial fishing industries had the highest number of injuries among ATR work-related cases. In analysis of injury risk by industry, using available denominator data to calculate rates, the logging industry led with the highest injury rate, (18/1,000 workers/year), followed by construction (6/1,000 workers/year). (See Figures 17 and 18.)



Source: ATR

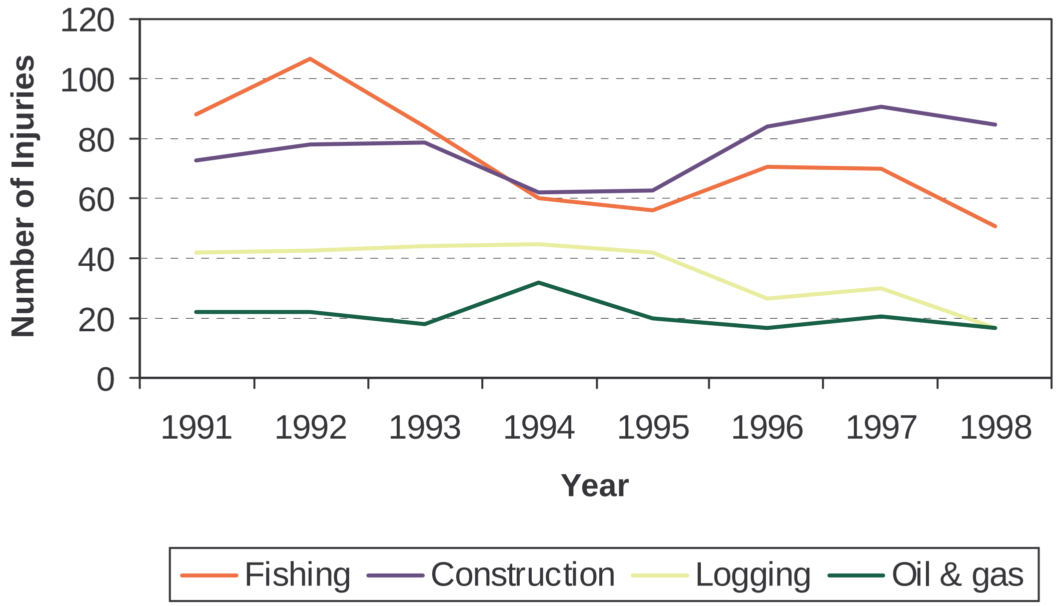
Figure 17: Number of Work-related Injuries by Industry, 1991-1998



Source: ATR

Figure 18: Work-related Injury Rates per 1000 Workers, by Industry 1991-1998

For the time period 1991 through 1993, commercial fishing had the highest number of injuries for all industries in the ATR. Since 1994, the construction industry surpassed commercial fishing as the industry with the highest number of injuries each year, and has led ever since. The annual trend for nonfatal work-related injuries by industry shows an overall decline during the time period analyzed. (See Figure 19.) However, considering the variables that can be involved in deciding if a patient will be admitted to an Alaska hospital, other factors might influence the number of work-related hospitalized cases found in the ATR, e.g., the recent trend of treating more patients with serious injuries on an outpatient basis.



Source: ATR

Figure 19: Numbers of Nonfatal Injuries by Industry and Year

Industry Analysis

Injury prevention efforts are targeted to those industries identified by ATR surveillance as having the highest number of injuries and high injury incidence rates, including construction, logging, and commercial fishing.

An analysis of work-related injury allows research into types of injuries, using the ICD-9-CM "N" codes from the ATR. The Registry includes information on body regions injured, derived from "N" codes. The registry also records ICD-9-CM "E" codes, which describe the cause of injury. NIOSH is focusing its injury prevention efforts on the leading three causes of injury, types of injury, and body regions affected, in each of the priority industries.

Photo 19: Residential construction site in southcentral Alaska

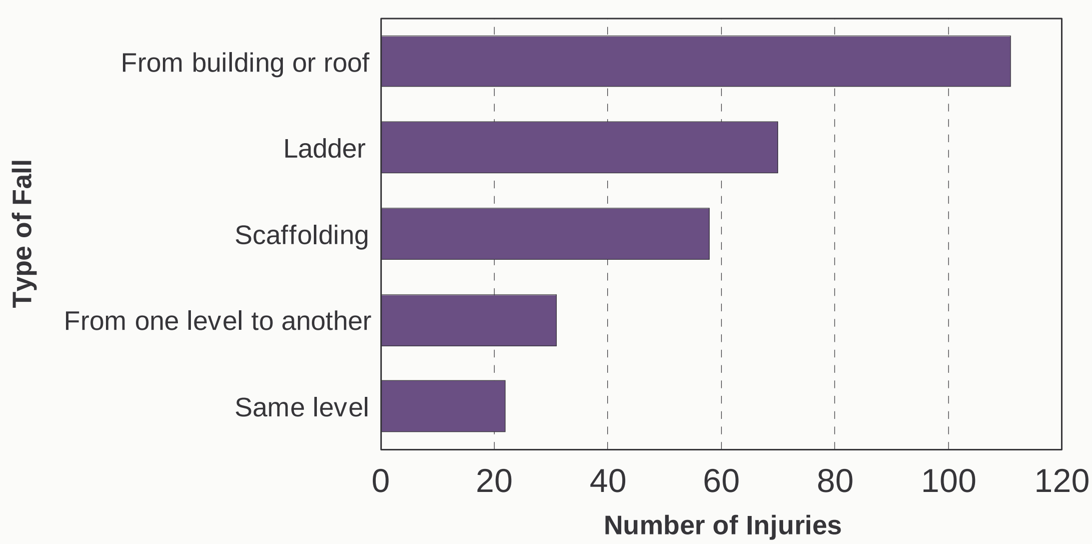
Construction Industry

Leading causes of injuries in the construction industry include falls, machinery, and being struck by an object. (See Table 11.) Falls can be categorized as: falls from buildings or roofs; falls from ladders; falls from scaffolding; falls from one level to another (usually from a distance of 8 feet or less); and falls on the same level, which include slips and trips. Local conditions can aggravate these hazards with ice and snow. (See Photos 19 and 21.) As shown in Figure 20, the majority of the falls in hospitalized construction workers in Alaska were from buildings or roofs. Fractured bones were the leading type of injury to construction workers, followed distantly by open wounds. The majority of injuries to construction workers occurred to their extremities. (See Table 11.)

Table 11: Construction Industry Injury Profile, Alaska 1991-1998, n= 621, Source: ATR

Cause of Injury		Nature of Injury		Body Region Injured	
Fall	315	Fractured bone	355	Lower extremity	194
Machinery	105	Open wound	70	Upper extremity	175
Struck by object	72	Sprain/strain	37	Spine	71
Other	129	Other	159	Other	181

These data have helped to focus worker education programs on preventing injuries in the construction industry. Through the Alaska Injury Prevention Center, a local community safety-oriented nonprofit organization, information has been provided to local contractors to assist in their safety training. ATR data has also been used to emphasize and direct statewide construction safety training at the Alaska Governor's Safety and Health Conference.



Source: ATR

Figure 20: Work-related Fall Injuries in the Construction Industry, 1991-1998

Logging Industry

In the Alaska logging industry, the majority of hospitalized injuries were caused by being struck by an object, followed by cutting or piercing objects, then falls. (See Table 12.) The objects most commonly striking workers were trees, logs, or limbs. The most common type of injury was a fractured bone, and the body region most commonly injured was the lower extremity, which includes workers' legs and feet.

Table 12: Construction Industry Injury Profile, Alaska 1991-1998, n= 244, Source: ATR

Cause of Injury		Nature of Injury		Body Region Injured	
Struck by object	122	Fractured bone	143	Lower extremity	93
Cutting/piercing object	43	Open wound	43	Upper extremity	52
Fall	42	Sprain/strain	21	Head	45
Other	37	Other	37	Other	54

Work is currently being done with the Alaska Department of Labor and AKDHSS to categorize and prevent the high rate of hospitalized injuries in the logging industry. Information on nonfatal injuries has been shared with logging safety personnel at the Occupational Safety and Health Administration Region X Logging Safety Summit.[41] The ATR data has been used by the University of Washington, Pacific Northwest Agricultural Safety and Health Center, in the *Occupational Research Agenda for Northwest Forestlands* [42] to set priorities in health and safety research in the northwest logging industry.

Photo 20: Typical logging camp scene in southeast Alaska

Commercial Fishing

Injuries from machinery were the leading cause of nonfatal injuries in the commercial fishing industry. Falls ranked a close second. These falls most often occurred into holds, through open hatchways, and as a result of slipping on ladders and gangways. Injuries from machinery often involved equipment unique to this industry. “Crab pots” (baited cages weighing up to 800 lbs.) and “crab pot launchers” were listed as factors in a number of injuries. A crab pot launcher is a hydraulic lift which raises and tilts the pot over the top of the gunwale where it slides into the water. Fishing nets, lines, and winches were also repeatedly mentioned in the injury description. Extremities were the body region most often injured. (See Table 13.)

Table 13: Commercial Fishing Industry Injury Profile, Alaska 1991-1998, n= 587, Source: ATR

Cause of Injury		Nature of Injury		Body Region Injured	
Machinery	187	Fractured bone	279	Upper extremity	184
Falls	149	Open wound	73	Lower extremity	171
Struck by object	98	Burn	29	Spine	35
Other	153	Other	206	Other	197

Contributing factors in commercial fishing deaths differ from the factors associated with nonfatal injuries to workers in this industry. Most commercial fishing deaths result from the loss of a vessel or from a fisherman falling overboard. Most nonfatal injuries occur while working on the vessel, either on deck or below, from machinery on deck, falls, and/or being struck by objects. The deck of a fishing boat is an unusually hazardous working environment. Not only are workers exposed to the elements, but the deck affords an unstable work platform, as it is constantly moving and is often congested with machinery. In addition it may be covered with oil, ice, water, and fish slime. In its 1991 study on fishing vessel safety, the National Research Council (NRC) noted: “The apparent high incidence of workplace accidents suggests inadequately designed safety features in machinery, deck layouts, and fishing gear.”[21] Research on the relationships among the vessel, fishing equipment, and workers, and efforts to develop and organize safer on-deck equipment is currently underway by NIOSH.

As previously noted, trauma registries are unique sources of a variety of useful injury data. Researchers are encouraged to explore trauma registries as a data source for work-related injury surveillance and work with health departments or hospitals that collect these data so they can be aware of the utility of trauma registries for occupational injury surveillance.

Conclusions and Future Directions

Using surveillance data as information for action, collaborative efforts in Alaska have been very successful in applying the insights gained from surveillance to the prevention of occupational mortality and serious injury. Specifically, epidemiologic analysis has been effectively applied toward reducing mortality in Alaska's rapidly expanding helicopter logging industry, and has played an important supportive role in tracking the continuing progress made in reducing the mortality rate in Alaska's commercial fishing industry. However, data has also shown that problems persist with prevention of falls overboard in the fishing industry, and other injuries related to the work processes on fishing vessels and fishing vessel stability. Interagency efforts are ongoing to address these factors.

Although mortality due to crashes of fixed-wing aircraft showed modest improvements for Alaska workers in 1997-1999, it persists as the leading cause of death for Alaska workers. To address these concerns, the Alaska Interagency Working Group for the Prevention of Occupational Injuries Aviation Committee is currently working on collaborative studies of crashes of single-engine, fixed-wing aircraft, and is mounting a major initiative in this area.

Results suggest that the extension of the NIOSH approach to occupational injury surveillance and prevention in Alaska to other locales, and application of these strategies to the full spectrum of occupational injury hazards, could have a broad impact on the reduction of occupational injuries. Some of the methodologic refinements presented here may be useful elsewhere: e.g., sequential layering of Haddon matrices provides a useful insight for injury prevention planning. This method should be widely applicable. With the combination of these successful collaborations and future projects, more interventions will be developed to continue to reduce these high numbers of occupational injuries and fatalities for Alaska's workers.

Photo 21: Cold weather construction site in Anchorage, Alaska

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List of Acronyms

AFS	Alaska Field Station
AKDHSS	Alaska Department of Health and Social Services
AKDOL	Alaska Department of Labor
AMSEA	Alaska Marine Safety Education Association
AOISS	Alaska Occupational Injury Surveillance System
ATR	Alaska Trauma Registry
CFIT	Controlled Flight into Terrain
CFIVSA	Commercial Fishing Industry Vessel Safety Act
CFR	Code of Federal Regulations
DHHS	Department of Health and Human Services
EMS	Emergency Medical Services
EPIRBs	Electronic Positioning Indicating Radio Beacons
FAA	Federal Aviation Administration
FACE	Fatality Assessment and Control Evaluation
FTE	Full time equivalent
HAI	Helicopter Association International
ICD	International Classification of Diseases
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
MOB	Man Overboard
NGO	Non-governmental Organization

NIOSH	National Institute for Occupational Safety and Health
NRC	National Research Council
NTOF	National Traumatic Occupational Fatalities
NTSB	National Transportation Safety Board
OSHA	Occupational Safety and Health Administration
PFDs	Personal Flotation Devices
SAR	Search and Rescue
SCBA	Self-contained breathing apparatus
SOP	Standard Operating Procedure
USCG	United States Coast Guard
VFR	Visual Flight Rules
YPLL	Years of Potential Life Lost