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Alaska's Model Program for Surveillance and Prevention of Occupational Injury Deaths

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SYNOPSIS

The National Institute for Occupational Safety and Health (NIOSH) established its Alaska Field Station in Anchorage in 1991 after identifying Alaska as the highest-risk state for traumatic worker fatalities. Since then, the Field Station, working in collaboration with other agencies, organizations, and individuals, has established a program for occupational injury surveillance in Alaska and formed interagency working groups to address the risk factors leading to occupational death and injury in the state.

Collaborative efforts have contributed to reducing crash rates and mortality in Alaska's rapidly expanding helicopter logging industry and have played an important supportive role in the substantial progress made in reducing the mortality rate in Alaska's commercial fishing industry (historically Alaska's and America's most dangerous industry). Alaska experienced a 46% overall decline in work-related acute traumatic injury deaths from 1991 to 1998, a 64% decline in commercial fishing deaths, and a very sharp decline in helicopter logging–related deaths. Extending this regional approach to other parts of the country and applying these strategies to the entire spectrum of occupational injury and disease hazards could have a broad effect on reducing occupational injuries.

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In the 1980s, it became apparent to the National Institute for Occupational Safety and Health (NIOSH) that Alaska had the highest rate of acute traumatic occupational injury fatalities of any state in the United States. Alaska's average of 34.8 acute traumatic occupational injury fatalities per 100,000 workers per year for the 10-year period 1980–1989 was almost five times the US average of 7.0 per 100,000 workers per year.[1,2] The high mortality rate for Alaskan workers was not attributable merely to the northern locale and severe weather conditions or the prominence of resource harvest industries (fishing, petroleum, logging) and non-roadway transportation because the Nordic nations share many similar conditions but have lower occupational injury mortality rates than the US overall and much lower than Alaska. For example, Norway—which has a similar industrial makeup to Alaska's, with commercial fishing, petroleum, tourism, logging, and small-aircraft aviation prominent—experienced an acute traumatic occupational injury mortality rate of 3.45 per 100,000 workers per year for 1994–1996.[3]

To address this urgent problem, in 1991—at the invitation of the Alaska Department of Health and Social Services and the Alaska Area Native Health Service of the Indian Health Service—NIOSH's Division of Safety Research established a Field Station in Anchorage to develop effective surveillance and prevention programs for occupational injuries and to coordinate the efforts of a wide variety of agencies.

The goals of the NIOSH Alaska Field Station are: (*a*) to characterize and reduce occupational risks using epidemiologic surveillance and analytic methods and engineering hazard and task analysis techniques; (*b*) to develop statewide occupational injury and fatality reporting systems; (*c*) to conduct prevention-oriented research addressing high-risk operations and populations (for example, commercial fishing, air transport, and logging); (*d*) to use the Field Station as a "living laboratory" for conducting state-of-the-art injury surveillance, intervention trials, and demonstration projects; and (*e*) to promote the transfer to and from Alaska of worker injury prevention technology.

The Field Station's activities are conducted in collaboration with the Alaska Department of Health and Social Services, the Alaska Department of Labor, the US Coast Guard, the National Transportation Safety Board (NTSB), the Federal Aviation Administration (FAA), the Occupational Safety and Health Administration (OSHA), Alaska Area Native Health Services, industry, labor organizations, communications media, health care providers, universities and community colleges, and other private sector individuals and organizations interested in public health.

We have established a comprehensive occupational injury surveillance system for fatal and nonfatal injuries, the Alaska Occupational Injury Surveillance System (AOISS); have formed interagency working groups of state and federal agencies; and have collaborated in other alliances with industry, local governments, and community groups to address the major factors leading to occupational injury and death in the state.

In this article, we describe how a program was implemented to characterize and prevent acute traumatic fatal occupational injuries, using case vignettes to illustrate the application of our approach to two particularly high-risk industries. We present preliminary evidence of the program's effectiveness and provide information potentially useful in mounting similar efforts elsewhere.

APPROACH TO THE PROBLEM

To detect and work toward preventing acute traumatic occupational injuries, we have followed a set of principles, rooted in the public health surveillance cycle,[4] which we now refer to as the Alaska model for occupational injury surveillance and prevention. This model includes: (*a*) painting an accurate picture of the problem by establishing effective and timely surveillance systems, obtaining information through data-sharing with jurisdictional agencies and from direct investigation of incidents, and tailoring available methodology to local needs; (*b*) building working relationships between local NIOSH personnel and other government agencies, workers, industries, and non-governmental organizations; (*c*) prioritizing prevention efforts by constructing a hierarchy of the full spectrum of injury events: multiple and single fatalities, severely disabling injury, injury resulting in hospitalization, less severe injury including those resulting in lost work time, and hazards; and (*d*) planning prevention efforts with a focus on the technical, geographic, environmental, political, and cultural features of local and regional injury problems, with programs designed specifically to fit those problems instead of using a "one-size fits all" approach.

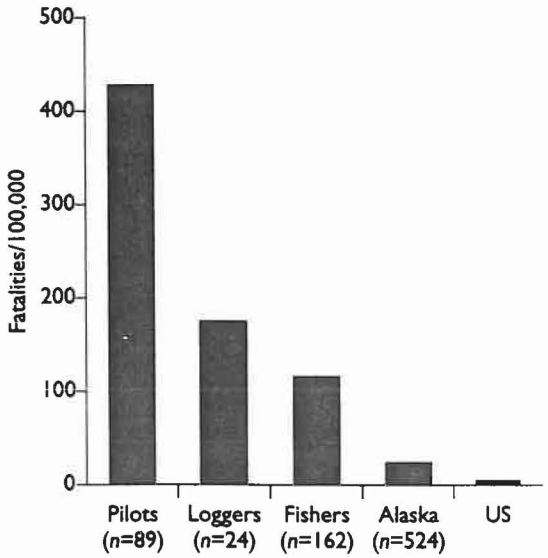
Surveillance. AOISS is a comprehensive surveillance system for fatal and nonfatal occupational injuries. Usually press releases from the Alaska State Troopers, reports from wire services, the Internet, TV, radio, or print news media, or telephone calls and/or faxes from jurisdictional agencies alert us to new cases. The respective jurisdictional agency (for example, NTSB, the US Coast Guard, OSHA, or the Alaska Department of Labor) is contacted and staff members from the Field Station accompany the investigator for

an on-site investigation when possible. Data from other agency sources are entered into the AOISS database, including reports from the Alaska State Troopers (full incident reports), Alaska Bureau of Vital Statistics (death certificates), and the Medical Examiner Office (autopsy reports). We share data and reconcile occupational traumatic injury fatality tabulations with the Alaska Fatality Assessment and Control Evaluation Program (operated by the Alaska Department of Health and Social Services, with NIOSH funding) and with the project officer at the Alaska Department of Labor for Alaska's Census of Fatal Occupational Injuries (a US Department of Labor program).

Inter-agency collaboration. Implementing the ambitious goals of a program to reduce occupational fatalities with very limited personnel and resources was quite challenging. Because the Field Station is primarily a research and public health practice organization, many of our local colleagues in jurisdictional agencies did not initially see our role as intrinsically valuable to their work. However, it is often the case that jurisdictional agencies gather large quantities of data but do not have the in-house capacity to analyze or interpret them. We offer assistance in organizing, analyzing, and interpreting data. By providing technical and analytic assistance to jurisdictional agencies, offering to share data we obtained from other sources, and building personal relationships parallel to more formal agreements, over time we established strong working relationships with many other federal, state, municipal, and non-governmental agencies and organizations that are engaged in detecting, investigating, and preventing occupational injuries and fatalities. These relationships, formalized in the Alaska Interagency Working Group for the Prevention of Occupational Injuries, have since served to foster a broader understanding of occupational injuries in the state and provided opportunities to influence the response to emerging occupational injury problems.

Mindful of an atmosphere in which government's oversight roles are being re-evaluated and in light of recent federal reinvention efforts, we locally emphasize non-regulatory, collaborative responses in our intervention strategies. We ask industry and workers to be full partners in planning and executing interventions and in providing ongoing surveillance data to track success or failure. Recommendations for new rulemaking are only used as a last resort. We have also worked with other ways to motivate corporate management, for example, by discussing possible voluntary work standards with insurers and assisting with negotiations on insurance rate discounts for industry consortia subscribing to more rigorous voluntary standards.

Figure 1. Rates of acute traumatic occupational injury fatalities for selected occupations, Alaska and US, 1991–1998



NOTE: Rates calculated as the number of fatalities divided by the average annualized number of workers employed in the industry: 1717 loggers,[31] 2600 pilots,[30] and 17,400 fishers.[6,26]

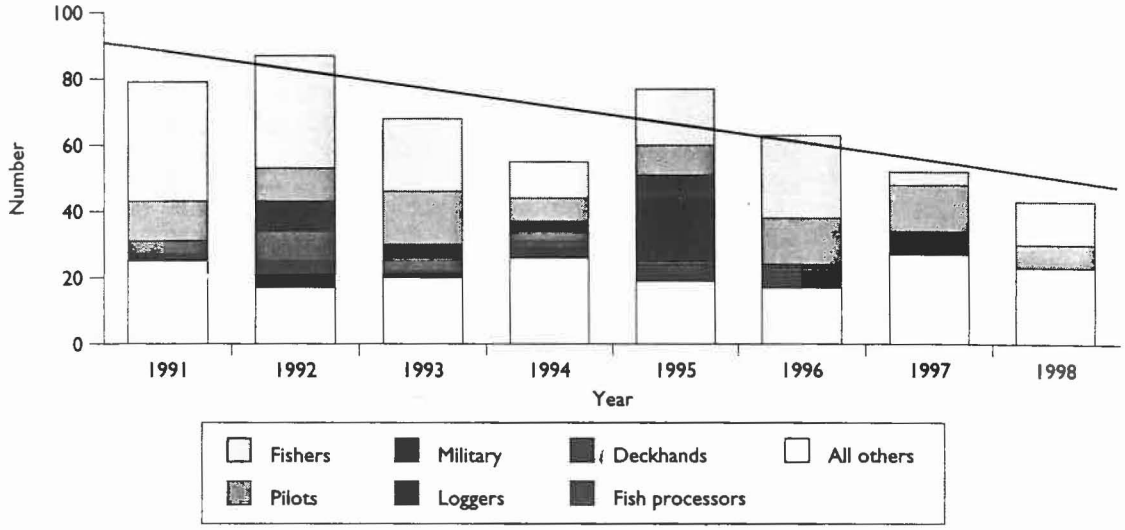
The style of our approach and the imagery we use may prove useful elsewhere. We often use a mirror metaphor to show how surveillance data reflect the status of health in the community. The strategic tools we used in our working group meetings range from relatively dry presentations of statistical and geographic data to rather heated discussions in which we exhort collaborators to make changes quickly to "shamefully" hazardous working conditions. We have carefully titrated our expressions of urgency to the agencies' or industries' enthusiasm for the technical assistance that we provide.

1991–1998 SURVEILLANCE DATA

While we have previously published papers on many aspects of injuries to Alaskan workers,[5–18] this manuscript is the first published overview of our program and the first to contain comprehensive data through 1998.

In Alaska in 1991–1998, 524 acute traumatic occupational injury fatalities were detected by active surveillance. While the age distribution of the workers who died from acute traumatic occupational injuries closely mirrored that of Alaska's workforce,[19] the overwhelming majority (97%) were male. The gender disparity is partially explained by

Figure 2. Number of acute traumatic occupational injury fatalities by occupation and year, Alaska, 1991–1998, (*N* = 524)



NOTE: The line represents the declining trend for total fatalities during this time period ($X^2_{\text{linear trend}} = 16.027$; $P < 0.00006$).

the male dominance of the workforce in the most hazardous Alaskan occupations; 162 commercial fishers, 89 commercial pilots, 24 loggers, and 11 fish processors were killed on the job during this eight-year period.

Using available workforce denominator data, we calculated occupation-specific acute traumatic injury mortality rates for 1991–1998 for Alaskan pilots (430 per 100,000 workers per year), loggers (175 per 100,000 workers per year), and fishers (120 per 100,000 workers per year)[5,6] (Figure 1).

The major circumstances of death for workers during this eight-year period were drownings (169), aircraft crashes (162), being crushed (46), homicides (31), motor vehicle crashes (24), and falls (17). We followed standards developed by NIOSH and the National Center for Health Statistics in including homicides and suicides when they occur at work.[1]

Many of the 524 fatalities were among young workers (44.3% among workers younger than age 35). The negative impact on society of occupational fatalities occurring early in life can be quantified in terms of years of potential life lost before age 65 (YPLL<65). We calculated YPLL<65 by subtracting each worker's age at death from 65 for all 1991–1998 Alaskan occupational fatalities, resulting in 13,886 YPLL<65.[10]

We estimated the dollar cost to society in lost future productivity due to the 524 premature, work-related deaths to be $519 million by multiplying YPLL<65 times the mean annual income for all Alaskan workers ($37,450), obtained from the Alaska Department of Labor.

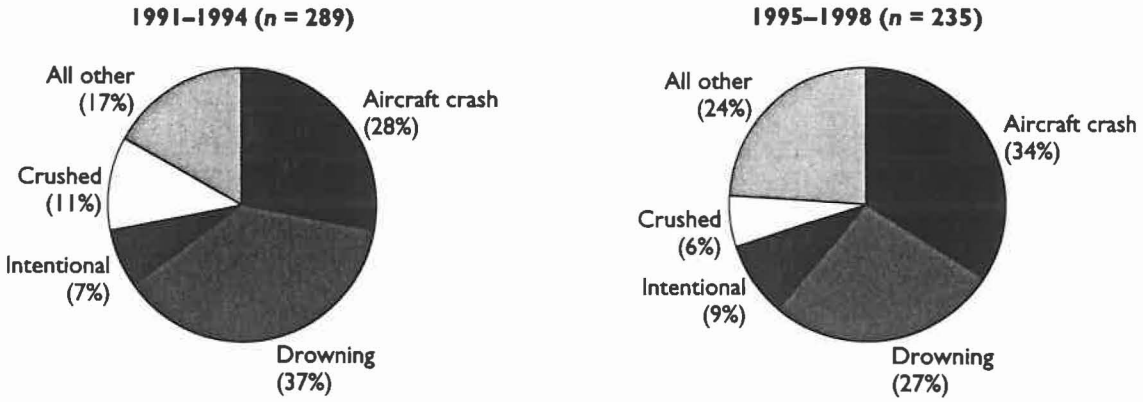
1991–1998 Trends

Overall, acute traumatic occupational injury fatalities decreased significantly from 79 in 1991 to 43 in 1998 ($P < 0.0006$), a 46% decrease, with the bulk of improvement occurring among fishers and loggers (Figure 2). However, no significant decrease was noted among pilots, who now account for a higher proportion of mortality than any other occupation. While drownings among commercial fishers was the most common cause of acute traumatic occupational injury death for Alaskan workers during 1991–1994, aircraft crashes had become the most common cause by 1995–1998 (Figure 3).

Applying Surveillance Data: Using Time-Phase Matrices

Formulating effective prevention strategies for injuries is dependent on having a clear understanding of risk factors for these events. Faced with high rates of traumatic fatalities in two Alaskan industries—helicopter logging and fishing—we developed a refinement of Haddon's time-phase matrices[20] for use as an analytic and planning tool. Using surveillance data, we generate a time-phase matrix for risk factors identified during investigations of fatal events, then

Figure 3. Acute traumatic occupational injury fatalities by type, Alaska, 1991–1998



NOTE: Intentional includes homicides and suicides that meet the National Institute for Occupational Safety and Health/National Center for Health Statistics criteria for injury at work.[1]

develop a consensus safety recommendation matrix using each cell in the original time-phase matrix. By working closely with industry, immediate improvements may be made—for example, in worker training, work/rest cycles, and oversight. Surveillance results are then used to evaluate the effectiveness of interventions. Finally, a prevention matrix is developed that includes recommendations for further safety refinements in the subject industry.

We initially took this approach for helicopter logging crashes, and have since taken a similar approach toward commercial fishing–related deaths. We first constructed a hazard matrix (Figure 4), then a matrix for the interventions required by the US Commercial Fishing Industry Vessel Safety Act of 1988 and a prevention matrix for use in planning further interventions for each time-phase cell, with an emphasis on pre-event (primary prevention) efforts. (In Figure 5, these are combined for the sake of brevity.)

CASE STUDY IN APPLYING SURVEILLANCE DATA: HELICOPTER LOGGING

The first major test of our approach came just as we were establishing our surveillance system in early 1992. Because of changes in environmental restrictions on roadbuilding in Alaska's national forests in the late 1980s, using heli-

Figure 4. Time-phase hazard matrix for fatal injury events, commercial fishing industry

	Host/human	*Agent/vehicle*	*Environment*
Pre-event/pre-injury	Captain and crew fatigue, stress; prescription and/or illegal drugs/alcohol; inadequate training; exposure to elements	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 and crew reaction to emergency; personal flotation device not available/not working	Leaning or capsized vessel; delayed abandonment; emergency circumstance not understood; "man-overboard"	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 "man-overboard"	High winds; large waves; cold water

Figure 5. Time-phase matrix of countermeasures to reduce the number of fatal injury events, commercial fishing industry

	Host/human	*Agent/vehicle*	*Environment*
Pre-event/pre-injury	Licensing of skipper; increased training on vessel stability; increased drills; **drills**	Reassessment of stability after refitting; retrofitting of sponsors	Evaluate impact of management regimes for fisheries; no-sail weather guidelines; development/refinement of icing nomograms; **navigation publications; compass**
Event/injury	Wearing personal flotation devices (**PFDs**); "man-overboard" alarms; personal emergency position indicating radio beacons (EPIRBs); **immersion suits**	**Fire extinguishers/ systems; firefighters' outfits; self-contained breathing apparatus; high water alarms; bilge pumps**	
Post-event	**Immersion suits; PFDs**	**Distress signals; life rafts; EPIRBs**	**First aid kits; CPR and first aid training**

NOTE: Items in bold type are required by the Commercial Fishing Industry Vessel Safety Act of 1988, implemented 1991–1998.

copters to move the cut logs emerged as a major means of logging in Alaska in the early 1990s. From January 1, 1992, through June 30, 1993, there were six helicopter crashes, with nine people killed (four pilots) and 10 others severely injured, out of only 25 helicopters and 50 pilots flying in helicopter logging operations, for an extraordinarily high annual crash rate of 16% and a catastrophic pilot fatality rate of 5000 per 100,000 working pilots per year.[13,21] Investigations revealed that all crashes involved improper operational and/or maintenance practices.[14]

After two serious helicopter logging crashes (the fifth and sixth since the beginning of 1992) occurred during one week in May 1993, we began a series of urgent consultations, culminating in an emergency session of the Alaska Interagency Working Group for the Prevention of Occupational Injuries in early July 1993. Although the Working Group had originally been envisioned as a relatively formal setting for periodic sharing of activities, we found that it could also serve as an effective vehicle for rapid action. Sequestered for eight hours in a conference room in Anchorage's federal building for a marathon meeting, participants arrived at a plan of action and a set of preliminary safety recommendations for the helicopter logging industry. All participants had rough agreement on what had happened in the fatal events. The US Forest Service knew the timber sale locations, the Alaska Department of Labor knew the maintenance ramp and hangar locations, and both agencies were willing to share this information with the FAA (which due to a feature of the pertinent federal code, CFR 14, Part 133, had only the out-of-state chief pilot or headquarters location for each operation) and to collaborate and share costs in making oversight and safety inspection site visits to each in the next two weeks. Using the prevention-matrix approach, the Working Group agreed on a set of recommendations including more vigorous oversight of helicopter logging operations; development of rigorous voluntary industry standards for equipment, maintenance, and training; exclusive use of multi-engine rotorcraft; and more vigorous controls on alcohol and drug use in this industry.[14,22]

By late July 1993, all helicopter logging sites and maintenance ramps in the state had been visited by the jurisdictional agencies (FAA and the Alaska Department of Labor) which resulted in a number having their operations limited or shut down for irregularities. There were no additional helicopter logging crashes or fatalities in Alaska through July 1996, when a single crash did occur, with one fatality (Figure 6), and as of September 1999 there have been no more, despite continued growth of helicopter logging in Alaska.

The effective application of surveillance data in an interagency intervention to reduce helicopter logging–related crashes has continued. The Interagency Working

Group and NIOSH co-sponsored Helicopter Logging Safety Workshops in March 1995, 1996, and 1997.[23] Because of Alaska's leadership in this area, the Helicopter Association International established a Helicopter Logging Safety Committee and has organized an international consortium to improve safety practices in the industry.[14,22,24]

CASE STUDY IN APPLYING SURVEILLANCE DATA: COMMERCIAL FISHING

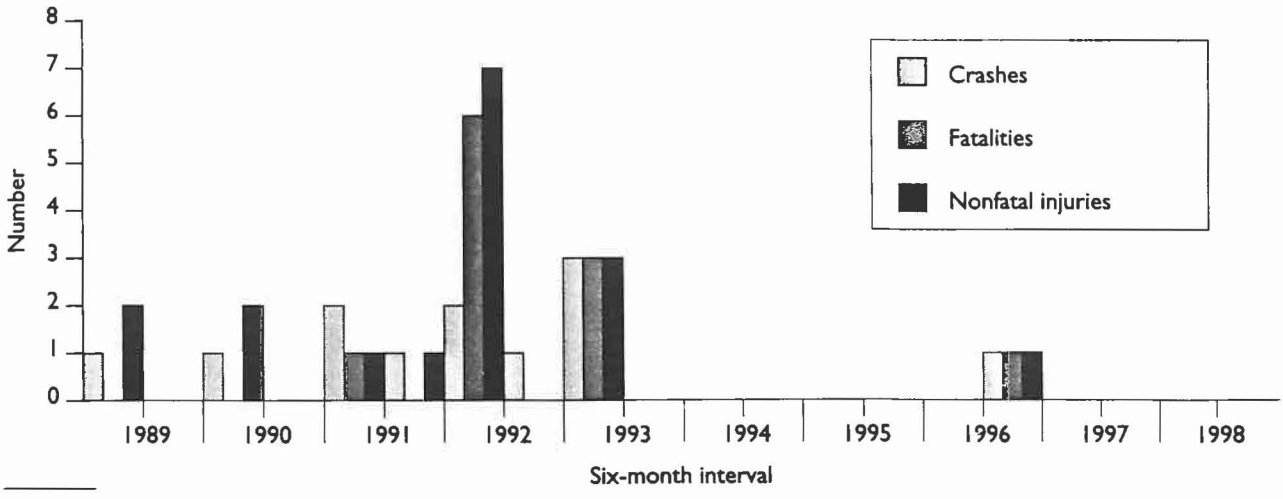
Commercial fishing is historically Alaska's[6] (and the nation's[25]) most dangerous industry. Between 1991 and 1995, the Commercial Fishing Industry Vessel Safety Act of 1988 has been implemented stepwise, requiring new safety equipment on cold-water fishing vessels, including immersion (survival) suits and life rafts. Alaska experienced a significant decline from 1991 to 1998 in mean annual commercial fishing deaths (Figure 7). Figure 7 shows a decreasing trend in acute traumatic commercial fishing fatalities from 1991 to 1998, with an artificially low number in 1994 due to the closing of several crab fisheries that year. While "man-overboard" drownings and vessel-related events in crabbing (often conducted far offshore and in winter) have continued to occur and still urgently require attention, marked progress has been made in saving the lives of those involved in vessel-related events[26] (Table).

We have pushed for, and have published comprehensive recommendations for primary prevention in Alaska's fishing industry,[26] addressing the persistent problems in crabbing and "man-overboard" events, based on the prevention matrices we developed (Figures 4 and 5). The US Coast Guard has recently developed a number of innovative programs in this area, including damage control training and marine vessel risk indexing, which are currently undergoing evaluation.

Our efforts in Alaska have started to benefit fishers in other parts of the US. In 1999, the US Coast Guard established a Fishing Vessel Casualty Task Force to perform a fast track examination of commercial fishing industry operational and safety risks that may have contributed to a recent increase in marine casualties on the east coast of the US. A report of their findings, published in April 1999, was accompanied by 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,[28] a 1991 National Research Council proposal for a national fishing safety program,[29] and our 1997 study of fishing deaths.[26] Eight of the major recommendations for national changes in commercial fishing safety policies came from our 1997 Alaska report.

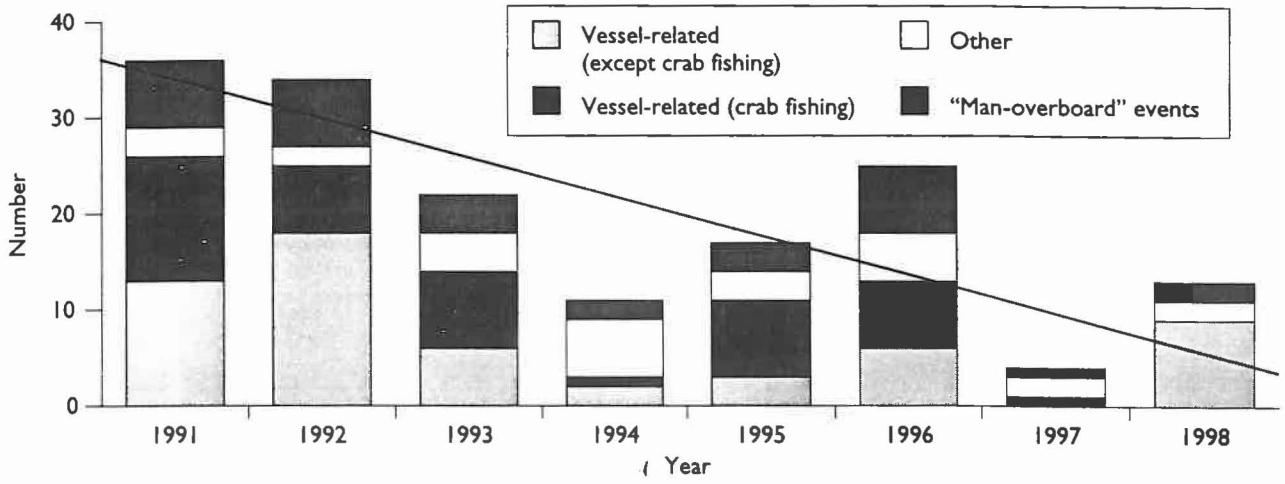
Also, Alaska's innovative marine safety training program, conducted by the Alaska Marine Safety Education Association has been shown to be efficacious in preventing fishing-related deaths, as described in an earlier publication.[29]

Figure 6. Crashes, fatalities, and nonfatal injuries in Alaska helicopter logging operations, six-month intervals, 1989–1998



NOTE: Interagency intervention occurred in July 1993.

Figure 7. Commercial fishing fatalities by year, Alaska, 1991–1998 (*N* = 162)



NOTE: The line represents the declining trend for commercial fishing fatalities during this time period ($X^2_{\text{linear trend}} = 26.852$; $P < 0.001$).

FUTURE DIRECTIONS

Using surveillance data as the basis for action, collaborative efforts have been very successful in reducing crash rates and mortality in Alaska's rapidly expanding helicopter logging industry and have played an important supportive role in the progress made in reducing the mortality rate in Alaska's commercial fishing industry during implementation of the Commercial Fishing Industry Vessel Safety Act of 1988 as well as in numerous local injury prevention efforts. Although other factors, such as changing social organization and climate change, may have contributed to these successes, the strong temporal association between the interventions described above and rapid changes in crash rates and mortality in helicopter logging operations and mortality in Alaska's commercial fishing industry are evidence of the effectiveness of this collaborative approach.

Unfortunately, mortality due to crashes of fixed-wing aircraft has not decreased in Alaskan workers and is now one of our major areas of concentration. The FAA, NTSB, and NIOSH have determined some of the major risk factors for these events. While a single, catastrophic crash of a US Air Force E3 Airborne Warning and Control System 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 itineraries (typically for air taxi services).[13] The most common type of fatal crash involves "controlled flight into terrain" (for example, hitting the earth, mountainsides or canyon sides, or trees), often following an unexpected shift from visual flight conditions (good weather and visibility) to instrument flight conditions (poor visibility, usually attributable to weather).[16] Poor pilot decision-making (for example, pressing on despite information about possible unfavorable conditions exceeding the plane's capabilities) is also often implicated in these events. To address these concerns, the

Table. Case fatality rate, capsized or lost commercial fishing vessels, Alaska commercial fishing industry, 1991–1998

Year	Number of vessels lost*	Number of people on board*	Number of fatalities	Fatality rate (percent)
1991....	39	93	25	27
1992....	44	113	26	23
1993....	24	83	14	17
1994....	36	131	4	3
1995....	26	106	11	10
1996....	39	114	13	11
1997....	31	84	1	1
1998....	37	124	9	7

NOTE: Fatality rate = (number killed/number on board) x 100 percent

*Source of data: Sue Jorgenson, Fishing Vessel Safety Coordinator, US Coast Guard, 17th District, January 1999.

Aviation Committee of the Alaska Interagency Working Group for the Prevention of Occupational Injuries is currently working on collaborative studies of crashes of single-engine, fixed-wing aircraft and is planning a major initiative in this area. The FAA is also currently pilot-testing its Capstone program in Alaska and Hawaii to determine if the application of global positioning system technology and other high-technology navigational aids can be effective in preventing some of these incidents.

Layered Haddon time-phase matrices have proven to be a useful tool in planning for injury prevention. This method should be widely applicable to other industries and other parts of the country. Extending Alaska's approach to occupational injury surveillance and prevention to other parts of the country and applying these strategies to the full spectrum of occupational injury and disease hazards could have a broad impact on the reduction of occupational injuries.

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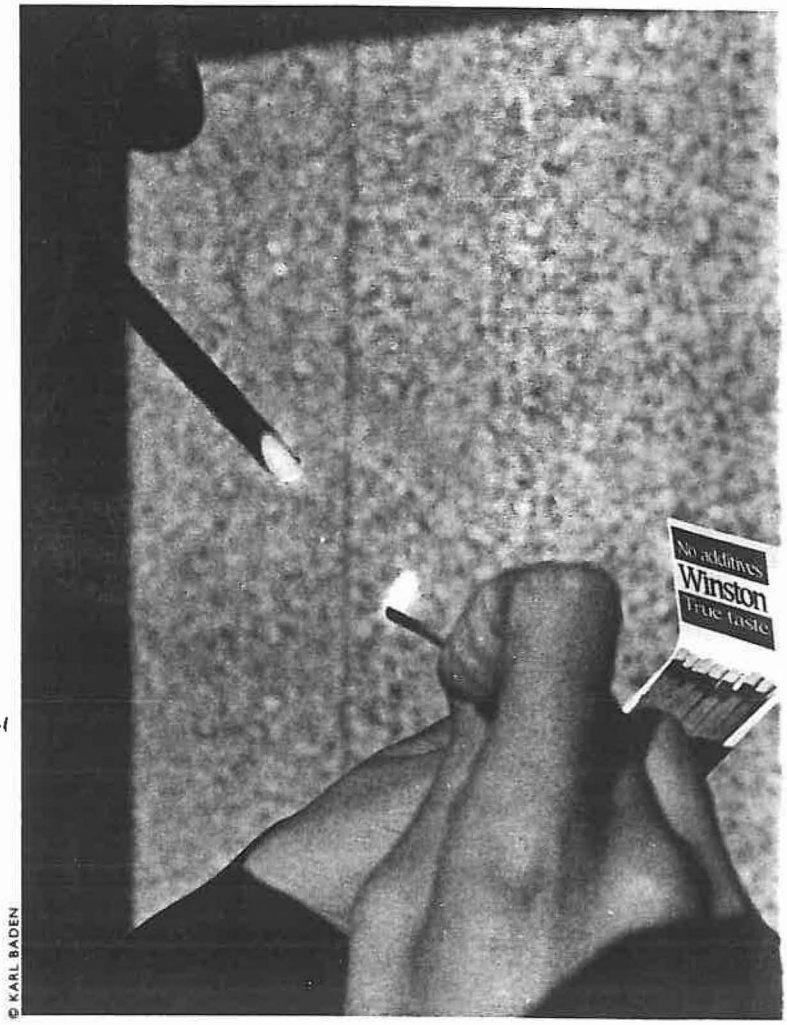

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In India and Nepal, bricks are carried for shipping or storage; each brick weighs between one and two kilograms (2.1–4.4 pounds). A small child may haul more than 1000 bricks on her or his head or back each day. See David Parker's photo essay of children at work around the world, p. 516–21. ■