



Supplemental Figure S1 Map of Alaska showing locations of the southeast and Gulf Coast economic regions and associated municipalities, cities, boroughs, and census areas. Jurisdictions in which >7 fatal logging injuries occurred during 1991–2014 (N = 42 total fatalities) are highlighted in red.

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Supplemental Figure S2 Annual amount of timber harvested (millions of board feet cut) in national forests in Alaska, 1909–2015, with inset showing years 1991–2014 (data downloaded from http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd511209.xlsx on August 1, 2017).

SUPPLEMENTAL MATERIAL

Appendix 1 - Logging-support Injuries

Results

We identified a total of 66 logging-support injuries during 1991–2014; of these, 53 (80%) were nonfatal and 13 (20%) were fatal. All but two logging-support injuries involved male workers (Supplemental Table S3). The median ages of workers sustaining nonfatal and fatal logging-support injuries were 43.0 years (range = 20–73 years) and 43.5 years (range = 30–60 years, age missing for one fatal injury), respectively. The average annual number of logging-support injuries during 1991–2014 was 2.8 (range = 0–7 injuries/year). Injuries occurred most frequently during the months of October (15%) and November (21%) and were reported almost exclusively from the southeast (75%) and Gulf Coast (20%) regions of Alaska (Supplemental Figure 1). Forty eight percent of injured workers were classified as having a water transport-related occupation and 39% had a road transport-related occupation. Forty-seven percent and 30% of logging-support injuries occurred at water and road transport-related sites, respectively. Of the 46 nonfatal logging-support injuries for which an injury severity score was specified, the median score was 4.0 (range = 1–34). Trucks or trailers (40% of nonfatal logging-support injuries) and trees or logs (30%) were the leading sources of nonfatal logging-support injuries; for fatal logging-support injuries these were second to water, which was the leading injury source (42% of fatal injuries). The most common nonfatal logging-support injury events were motor vehicle-related and falls (32% and 30% of nonfatal injuries, respectively). Among fatal injuries, water transport-related events were most frequent (46% of fatal injuries), followed by motor vehicle-related events (23%). Regarding nature of injury, 47% of nonfatal logging-support injuries were fractures, and 40% of fatal logging-support injuries involved submersion or suffocation (i.e., drowning). Nonfatal injuries primarily affected the injured person's trunk (43% of nonfatal injuries) or lower extremities (excluding feet or ankles, 21%); fatal injuries most often affected multiple body systems (40% of fatal injuries) or the injured worker's head (30%).

Discussion

Logging-support injuries were primarily associated with the transportation of felled logs by road or water. They were almost twice as deadly as logging injuries based on the proportion that were

fatal (on average, one in five). In contrast to logging injuries, which disproportionately occurred at logging field sites, logging-support injuries were primarily associated with roads and waterways. In these settings, hazards associated with driving or working around trucks and trailers, and with working on or near water in which logs are being floated, appear to be most significant. High crash and fatality rates have been previously reported for logging truck operation;^{1,2} these crashes are of particular concern because they periodically occur on paved roads where other motorists and pedestrians might be at risk. Use of personal flotation devices (PFDs) can reduce the risk of drowning among water transportation workers, and research on PFD use in at-sea industries has shown that modern purpose-built PFDs can overcome workers' concerns about wearing PFDs.³

References

1. Myers JR, Fosbroke DE. Logging fatalities in the United States by region, cause of death, and other factors — 1980 through 1988. *J Safety Res.* 1994;25:97–105.
2. Sygnatur EF. Logging is perilous work. *Comp Working Cond.* 1998;3:3–9.
3. Lucas D, Lincoln J, Somervell P, Teske T. Worker satisfaction with personal flotation devices (PFDs) in the fishing industry: evaluations in actual use. *Appl Ergon.* 2012;43:747–752.

Supplemental Table S1. Counts of nonfatal and fatal logging injuries among workers in the Alaska logging industry during 1991–2014, by demographic, geographic and occupational characteristics.

	Nonfatal logging injuries (N = 416)	Fatal logging injuries (N = 51)	All injuries combined (N = 467)
Sex			
Male	411	51	462
Female	4	0	4
Unspecified	1	0	1
Year			
1991	36	5	41
1992	35	12 [†]	47
1993	39	7 [‡]	46
1994	40	5	45
1995	33	0	33
1996	23	4	27
1997	25	2	27
1998	15	0	15
1999	27	4	31
2000	23	4	27
2001	21	0	21
2002	9	1	10
2003	16	0	16
2004	3	0	3
2005	8	0	8
2006	7	0	7
2007	8	0	8
2008	9	1	10
2009	8	1	9
2010	5	0	5
2011	10	1	11
2012	6	2	8
2013	5	0	5
2014	5	2	7
Month			
January	10	1	11
February	20	9	29
March	29	1	30
April	43	0	43
May	48	7	55
June	58	3	61
July	44	6	50
August	55	7	62
September	47	3	50
October	34	7	41
November	20	7	27
December	8	0	8

	Nonfatal logging injuries (N = 416)	Fatal logging injuries (N = 51)	All injuries combined (N = 467)
Region			
Southeast	285	48	333
Gulf Coast	96	3	99
Matanuska-Susitna	6	0	6
Interior	5	0	5
Anchorage	2	0	2
Southwest	2	0	2
Unspecified	20	0	20
Borough or census area			
Prince of Wales-Hyder Census Area	159	20	179
Ketchikan Gateway Borough	45	8	53
Kodiak Island Borough	40	1	41
Hoonah-Angoon Census Area	32	7	39
Valdez-Cordova Census Area	33	1	34
Kenai Peninsula Borough	23	1	24
Petersburg Borough	12	7	19
City and Borough of Wrangell	14	3	17
City and Borough of Juneau	8	0	8
City and Borough of Yakutat	8	0	8
City and Borough of Sitka	5	2	7
Matanuska-Susitna Borough	6	0	6
Fairbanks North Star Borough	3	0	3
Haines Borough	1	1	2
Municipality of Anchorage	2	0	2
Aleutians West Census Area	1	0	1
Kusilvak Census Area	1	0	1
Southeast Fairbanks Census Area	1	0	1
Yakutat City and Borough	1	0	1
Yukon-Koyukuk Census Area	1	0	1
Unspecified	20	0	20
Site			
Logging field site or camp	369	49	418
Water transport-related site	6	0	6
Road transport-related site	4	1	5
Air transport-related site	3	1	4
Other specified	2	0	2
Unspecified	32	0	32
Occupation			
Logger	368	45	413
Mechanic	9	0	9
Pilot or copilot	2	6	8
Other specified	7	0	7
Unspecified	30	0	30

† 6 of 12 (50%) with helicopter as their source

‡ 2 of 7 (29%) with helicopter as their source

Supplemental Table S2. Counts of nonfatal and fatal logging injuries among workers in the Alaska logging industry, 1991–2014, and separately across periods 1991–2004 and 2005–2014, by injury source, injury event, injury nature, and primarily affected body part. Counts associated with characteristic categories collapsed into “Other specified” in Table 2 of main text are provided in this table.

Source	1991–2014			1991–2004			2005–2014		
	Nonfatal logging injuries (N = 416)	Fatal logging injuries (N = 51)	All injuries combined (N = 467)	Nonfatal logging injuries (N = 345)	Fatal logging injuries (N = 44)	All injuries combined (N = 389)	Nonfatal logging injuries (N = 71)	Fatal logging injuries (N = 7)	All injuries combined (N = 78)
Trees or logs	205	23	228	168	20	188	37	3	40
Heavy machinery or equipment	66	6	72	55	4	59	11	2	13
Chainsaw	49	0	49	40	0	40	9	0	9
Helicopter	4	12	16	4	12	16	0	0	0
Truck or trailer	12	1	13	11	1	12	1	0	1
Metal object, small (fragment, wire, rod)	9	0	9	9	0	9	0	0	0
Other cutting implement	7	0	7	5	0	5	2	0	2
Cliff or embankment	5	0	5	5	0	5	0	0	0
Rock	5	0	5	5	0	5	0	0	0
Airplane	3	1	4	3	1	4	0	0	0
Avalanche or landslide	1	3	4	1	3	4	0	0	0
Ladder	4	0	4	1	0	1	3	0	3
Tire	4	0	4	3	0	3	1	0	1
Firearm	2	1	3	1	1	2	1	0	1
Incinerator	3	0	3	2	0	2	1	0	1
Other	2	0	2	2	0	2	0	0	0
Water	0	2	2	0	2	2	0	0	0
Wildlife	1	1	2	1	0	1	0	1	1

	1991–2014			1991–2004			2005–2014		
	Nonfatal logging injuries (N = 416)	Fatal logging injuries (N = 51)	All injuries combined (N = 467)	Nonfatal logging injuries (N = 345)	Fatal logging injuries (N = 44)	All injuries combined (N = 389)	Nonfatal logging injuries (N = 71)	Fatal logging injuries (N = 7)	All injuries combined (N = 78)
Gas	1	0	1	1	0	1	0	0	0
Generator	1	0	1	1	0	1	0	0	0
Hydraulic fluid	1	0	1	0	0	0	1	0	1
Metal slag	1	0	1	1	0	1	0	0	0
Pickup truck	1	0	1	1	0	1	0	0	0
Raised walkway	1	0	1	1	0	1	0	0	0
Stairs	1	0	1	1	0	1	0	0	0
Wood smoke	1	0	1	1	0	1	0	0	0
Yard	1	0	1	1	0	1	0	0	0
Unspecified	25	1	26	21	0	21	4	1	5
Event									
Struck by falling object	136	16	152	111	13	124	25	3	28
Injuries caused by cutting/ piercing instruments/ objects	66	0	66	56	0	56	10	0	10
Struck by or against object	52	7	59	40	6	46	12	1	13
Falls	55	0	55	47	0	47	8	0	8
Machinery-related	43	0	43	34	0	34	9	0	9
Aircraft-related	7	14	21	7	14	21	0	0	0
Caught in or between objects	18	3	21	15	2	17	3	1	4
Motor vehicle-related	15	5	20	14	4	18	1	1	2
Fires or explosions	8	0	8	7	0	7	1	0	1
Overexertion and strenuous movements	7	0	7	7	0	7	0	0	0
Avalanche or landslide	1	3	4	1	3	4	0	0	0
Shooting	2	1	3	1	1	2	1	0	1
Electrical exposure	1	1	2	1	1	2	0	0	0

	1991–2014			1991–2004			2005–2014		
	Nonfatal logging injuries (N = 416)	Fatal logging injuries (N = 51)	All injuries combined (N = 467)	Nonfatal logging injuries (N = 345)	Fatal logging injuries (N = 44)	All injuries combined (N = 389)	Nonfatal logging injuries (N = 71)	Fatal logging injuries (N = 7)	All injuries combined (N = 78)
Mauling	1	1	2	1	0	1	0	1	1
Contact with hot object(s)	1	0	1	1	0	1	0	0	0
Poisoning	1	0	1	1	0	1	0	0	0
Water transport-related	1	0	1	1	0	1	0	0	0
Unspecified	1	0	1	0	0	0	1	0	1
Nature									
Fracture	204	0	204	169	0	169	35	0	35
Open wound	78	0	78	66	0	66	12	0	12
Intracranial injury	32	14	46	24	14	38	8	0	8
Multiple traumatic injuries	0	27	27	0	23	23	0	4	4
Strains and sprains	25	0	25	25	0	25	0	0	0
Internal injury	18	0	18	13	0	13	5	0	5
Contusion	17	0	17	16	0	16	1	0	1
Crushing injury	15	1	16	10	0	10	5	1	6
Dislocation	9	0	9	9	0	9	0	0	0
Burns	6	0	6	5	0	5	1	0	1
Fatal and nonfatal submersion or suffocation	0	5	5	0	4	4	0	1	1
Gunshot wound	2	1	3	1	1	2	1	0	1
Electrocution	0	2	2	0	2	2	0	0	0
Poisoning	1	0	1	1	0	1	0	0	0
Unspecified	9	1	10	6	0	6	3	1	4
Primarily affected body part									
Trunk	126	3	129	106	2	108	20	1	21
Lower extremities (excluding foot / ankle)	92	0	92	72	0	72	20	0	20
Head	64	13	77	54	12	66	10	1	11

	1991–2014			1991–2004			2005–2014		
	Nonfatal logging injuries (N = 416)	Fatal logging injuries (N = 51)	All injuries combined (N = 467)	Nonfatal logging injuries (N = 345)	Fatal logging injuries (N = 44)	All injuries combined (N = 389)	Nonfatal logging injuries (N = 71)	Fatal logging injuries (N = 7)	All injuries combined (N = 78)
Foot or ankle	51	0	51	44	0	44	7	0	7
Hand or wrist	38	0	38	32	0	32	6	0	6
Upper extremities (excluding hand / wrist)	38	0	38	34	0	34	4	0	4
Multiple body parts	3	23	26	2	20	22	1	3	4
Body systems	0	7	7	0	6	6	0	1	1
Neck	0	1	1	0	1	1	0	0	0
Unspecified	4	4	8	1	3	4	3	1	4

Supplemental Table S3. Counts of nonfatal and fatal logging-support injuries among workers in the Alaska logging industry during 1991–2014, by demographic, geographic and occupational characteristics.

	Nonfatal logging-support injuries (N = 53)	Fatal logging-support injuries (N = 13)	All injuries combined (N = 66)
Sex			
Male	51	13	64
Female	2	0	2
Year			
1991	5	1	6
1992	3	4	7
1993	5	2	7
1994	4	0	4
1995	4	2	6
1996	6	0	6
1997	4	1	5
1998	1	0	1
1999	4	0	4
2000	5	0	5
2001	2	1	3
2002	2	1	3
2003	1	0	1
2004	0	0	0
2005	1	0	1
2006	1	0	1
2007	1	0	1
2008	0	0	0
2009	0	0	0
2010	0	0	0
2011	1	0	1
2012	2	0	2
2013	1	1	2
2014	0	0	0
Month			
January	3	0	3
February	2	0	2
March	2	2	4
April	3	0	3
May	6	2	8
June	7	0	7

	Nonfatal logging-support injuries (N = 53)	Fatal logging-support injuries (N = 13)	All injuries combined (N = 66)
July	3	0	3
August	7	1	8
September	3	0	3
October	9	1	10
November	8	6	14
December	0	1	1
Region			
Southeast	40	8	48
Gulf Coast	11	2	13
Southwest	0	2	2
Interior	0	1	1
Unspecified	2	0	2
Borough or census area			
Prince of Wales-Hyder Census Area	24	1	25
Ketchikan Gateway Borough	6	1	7
Valdez-Cordova Census Area	4	1	5
City and Borough of Yakutat	2	2	4
Kenai Peninsula Borough	3	1	4
Kodiak Island Borough	4	0	4
Hoonah-Angoon Census Area	3	0	3
Petersburg Borough	0	3	3
Aleutians West Census Area	0	2	2
City and Borough of Juneau	2	0	2
City and Borough of Sitka	1	0	1
City and borough of Wrangell	0	1	1
Fairbanks North Star Borough	0	1	1
Haines Borough	1	0	1
Yakutat City and Borough	1	0	1
Unspecified	2	0	2
Site			
Water transport-related site	22	8	30
Road transport-related site	16	3	19
Logging field site/camp	12	2	14
Other	1	0	1
Unspecified	2	0	2
Occupation			
Water transport-related occupation	24	8	32
Road transport-related occupation	24	2	26
Forest service	2	2	4
Self employed	3	1	4

	Nonfatal logging-support injuries (N = 53)	Fatal logging- support injuries (N = 13)	All injuries combined (N = 66)
Source			
Truck or trailer	20	2	22
Trees or logs	15	2	17
Water	1	5	6
Heavy machinery or equipment	5	0	5
Deck of boat	4	0	4
Firearm	0	2	2
Logging deck	2	0	2
Boat hatch	1	0	1
Metal object, small (fragment, wire, rod)	1	0	1
Other cutting implement	1	0	1
Train	0	1	1
Unspecified	3	1	4
Event			
Motor vehicle-related	17	3	20
Falls	16	0	16
Water transport-related	3	6	9
Struck by falling object	4	1	5
Caught in or between objects	3	1	4
Machinery-related	4	0	4
Struck by or against object	3	0	3
Injuries caused by cutting/ piercing instruments/ objects	2	0	2
Shooting	0	2	2
Overexertion and strenuous movements	1	0	1
Nature			
Fracture	24	0	24
Strains and sprains	7	0	7
Contusion	6	0	6
Fatal and nonfatal submersion or suffocation	1	4	5
Intracranial injury	4	1	5
Open wound	5	0	5
Crushing injury	1	1	2
Gunshot wound	0	2	2
Internal injury	2	0	2
Multiple traumatic injuries	0	2	2
Dislocation	1	0	1
Unspecified	2	3	5
Primarily affected body part			
Trunk	23	0	23
Lower extremities (excluding foot/ ankle)	11	0	11

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	Nonfatal logging-support injuries (N = 53)	Fatal logging-support injuries (N = 13)	All injuries combined (N = 66)
Head	5	3	8
Upper extremities (excluding hand/ wrist)	7	0	7
Body systems	1	4	5
Multiple body parts	1	2	3
Hand or wrist	3	0	3
Foot or ankle	2	0	2
Neck	0	1	1
Unspecified	0	3	3