

**Wildland Firefighter Injuries in
Idaho and Montana – Fire Season 2000**



Matthew Keifer, MD MPH
Principal Investigator

Richard J. Mangan
Co-Investigator

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Dr. Matthew Keifer, MD MPH
Principal Investigator
Depts. Of Medicine & Environmental Health
University of Washington
Seattle, Washington USA

Richard J. Mangan
Co-Investigator
Blackbull Wildfire Services
Missoula, Montana USA

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Executive Summary

Fire season 2000 in Montana and Idaho was one of the most serious in recent memory, with 122,827 fires burning 8,422,237 acres across the U.S. At the peak of the fires in the Western state, on August 29, 2000 more than 28,400 people were involved in suppressing fires.

This study looks at the 2 largest fires that burned in 2000: the Clear Creek fire in Idaho, and the Valley Complex fire in Montana. Our purpose was to review injuries that were documented on these fires, to determine if types of individuals, environmental factors, fatigue and/or fitness levels impacted the numbers and types of injuries.

We found that, while several of our hypotheses were difficult or impossible to validate with the available data, there was an elevated injury frequency rate for the T-1 "Hotshot" crews assigned to the Clear Creek fire. It can be surmised that this higher rate is because, with their high levels of training and experience compared to most T-2 crews, these T-1 crews are assigned to work in the most difficult segments of the fire. Injuries in the fire camp setting were a significant number, and offer opportunities to reduce injuries on future fires.

The study finishes by making recommendations to improve firefighter safety and reduce injuries, both on the fireline and among fire support personnel in the fire camp setting. It also proposes future research needs to better define the types of injuries, the resources affected, and the need to look at fire illnesses as another component of the wildland fire Health and Safety program.

I. Introduction & Purpose

Wildland fires have been, and continue to be, an important natural component of life in North America, and especially in the Pacific Northwest and Northern Rockies. Both lightning-caused and Aboriginal-started fires have shaped the vegetation components of the Region for thousands of years before the arrival of European man. These fires occurred on an annual basis, sometimes burning with low intensity and "cleaning" the understory and accumulated fuels on the ground; other times, the fires were high intensity, destroying much of the existing vegetation and preparing the area for a new cycle of vegetative growth.

Little changed with the arrival of European man in North America: natural and Native American fires continued to burn, and white settlers also joined in the using fire for land clearing and other purposes.

The defining moment for wildfires in the United States came in 1910, when a massive firestorm exploded through northern Idaho and western Montana, scorching millions of acres of forest land, and killing 78 firefighters.

More than ninety (90) years later, wildfires continue to play an important part of life in the area: although there are large cities and towns, with interspersed homes scattered among the recently described "interface", fires throughout the summer and fall continue to ignite and impact the landscape, often times in an unwanted fashion.

While much of society in the 21st Century now functions in a technologically advance state, wildland fire suppression has not significantly advanced since the days of 1910 when the attention of the entire Nation was focused on the fires of Idaho and Montana. It is true that fixed wing aircraft, helicopters, satellites and computers have joined the fight against unwanted fires in recent years. But, the major factor in the control effort remains the men (and women) who battle the fires with hand tools and hoses at the fire's edge.

Wildland firefighting is a dangerous business: between 1910 and 2002, more than eight hundred eighty three (883) fatalities have been recorded on wildfires. In spite of all the improvements made in technology, communications, and protective equipment over the past ninety (90) years, one hundred thirty three (133) individuals died during fire activities between 1990-1998.

While we have reasonably accurate and complete records of the fatalities that have occurred on wildfires, there is a significant gap in the information available about firefighters that have suffered non-fatal injuries battling wildfires. Many of these injuries are well known to those who work in the fire environment: slips/trips/falls; cuts from hand tools and power saws; muscle strains; bruises (and worse) from rolling rocks and falling objects.

Although this knowledge exists in a "general" context, there is a serious lack of specificity regarding the injuries that would allow fire managers and Safety and Health Specialists to develop a meaningful plan to reduce them.

The purpose of this study is review the injuries that occurred on selected large, long-duration wildfires in northern Idaho and western Montana during the 2000 fire season, with special emphasis on: what type of injury occurred; what type of person was injured; and was fitness/fatigue a factor in the injury occurring?

II. Fire Season 2000

Fire season occurs every year across the United States, beginning in the Southeast during January and February, and ending during November and December in Southern California. Over the period of those twelve months, nearly all geographic regions of the US experience wildfires: the numbers and severity of those fires is determined by a number of factors such as winter rainfall/snow pack; fuel conditions; human and natural caused ignitions; and significant weather events such as the Santa Ana winds that affect Southern California.

By any measure, the year 2000 fire season was one for the record books: from the first fire that burned less than an acre in Florida on January 1st, until the end of the calendar year 366 days later, smoke was in the air and firefighters were on the line taking suppression action. The size of early season fires in the Southwest required a large commitment of firefighting resources, and may have resulted in fatigue becoming a factor in firefighter safety over the duration of the fire season. Two 40,000 acre-plus fires burned in New Mexico before the end of February; twelve (12) States experienced large fires before Spring was over; and in New Mexico, the National Park Service had a prescribed fire that escaped, burning 47,650 acres and destroying 235 residences. A firefighting force of more than 2000 battled this fire for several weeks in early May 2000.

A series of lightning storms started numerous fires in Northern Idaho and Western Montana during July and August: while initial attack efforts were often successful, a few fires escaped those efforts and became massive. In Idaho the Clear Creek fire began on July 16, burned 71 days, and eventually burned 216,961 acres. More than 86,000 firefighter-days were expended in the suppression effort. Montana's Bitterroot Valley, July 31st saw 78 new lightning caused fires. They eventually burned 356,000 acres of Public and private lands, destroying 70 homes, 170 other buildings and 94 vehicles.

The large number of fires across the Western States, with the most complex and highest priorities in Idaho and Montana, drained the entire firefighter pool in the US: fighters were imported from Canada, Australia,

New Zealand and Mexico, and six (6) battalions of US Marines were pressed into firefighting service.

On the peak day of August 29, 2000, the firefighting workforce consisted of:

- 28,462 people
- 667 20-person crews
- 1249 engines
- 226 helicopters
- 42 air tankers

At the close of the 2000 fire season in the US, the final total was 122,827 fires burning 8,422,237 acres; the Federal agencies alone spent \$1,362,367,000 in suppression costs.

The 2 fires being reviewed in this study (Clear Creek and Valley Complex) were rated as the #1 and #2 sized fires for the entire year in the US.



III. Hypotheses

While many experienced wildland firefighters have a good "gut-feeling" about what causes injuries on wildfires, there has been a serious gap in the database of information that actually documents the injuries that occur, let alone to do any type of analysis.

For the purposes of analyzing the data developed by this study, the following hypotheses were established:

Hypothesis #1: Injuries to wildland firefighters are associated with:

- A. Type of Crew/Individual
- B. Number of days on the fire
- C. Number of hours on shift

Hypothesis #2: the frequency of injuries is positively correlated with environmental factors (steep slopes, lose footing, tripping on ground fuels, etc).

Hypothesis #3: There is an inverse relationship between the risk of injury and the differing levels of firefighter fitness.

IV. Methodology

Because no previous study has analyzed injuries to wildland firefighters on specific multi-day large fires, the methodology selected was developed to maximize the use of information from the incidents (fires) being studied.

Data Sources

The data used for analysis in this study was derived from material contained in the "Final Fire Package", a compilation of all records that are generated on every large fire managed under the Incident Command System (ICS) in the US by all Federal agencies and many of the State fire agencies.

The Incident Command System (ICS) is a standardized on-scene emergency management concept specifically designed to allow its users to adopt an integrated organizational structure equal to the complexity and demands of a single or multiple incidents, without being hindered by jurisdictional boundaries. Several key components of this concept include standardization of position terminology, equipment typing, and forms.

In extracting data for this study from the Final Fire Packages, the following ICS forms were referenced:

- **ICS-209 "Incident Status Summary"** which is prepared daily on each fire incident, showing the type of resources assigned, by Agency of assignment;
- **ICS-211 "Check-in List"** which documents when each specific resource (crews, individual overhead personnel, engine crews) arrive at the fire incident;
- **ICS-214 "Unit Log"** which the Medical Unit Leader fills out daily documenting events that occur, such as injuries, during their operational period on shift.

In addition to the ICS forms reviewed, nationally accepted fire documentation was reviewed, including:

- **NFES Form #1672** "Field First Aid Station Log Patient Evaluation" which gives information on the more "serious" injuries that are treated;
- **CA-1** "Report of Traumatic Injury and Claim for Compensation", a Department of Labor form used by Federal employees to document on-the-job injuries;
- **CA-16** "Request for Examination and Treatment", another Department of Labor form required when federal employees are sent to physicians and/or medical facilities (outside of the fire base camp).

Data Analysis

The data contained on these Fire forms extracted and placed in an MS Excel database for analysis. Resources were separated by Agency of Employment, and Type of resource (crew, engine, overhead, etc) using standard Incident Command System (ICS) typing.

Data for the medical Unit logs and associated injury report forms were reviewed, and stratified by type of person injured, type of injury suffered, and location where the injury occurred (fireline versus incident base camp). Whenever the data was available, the age and gender of the injured individual was also noted, although this information was not always available because of federal "Privacy Act" issues.

The data included from these reports was:

- Fire (Incident) Name;
- Case #;
- Date of Injury;
- Type of Resource (person) injured);
- Geographic Area of Origin;
- Gender;
- Age;
- Type of Injury (see Appendix X);
- Location of Injury (see appendix X);
- Fireline/Camp.

One of the original intents of the study was to determine if there was a correlation between days on the fire (incident) and the injury event. It was not possible to obtain this information because Privacy Act concerns mandated that the injured individual's unit of assignment was often "redacted" and prevented us from identifying the date of arrival at the fire.

An important aspect of this study was a comparative analysis of accident frequency rates by type of resource, based upon number of person days worked. Resources were typed by activity (hand crew, engine crew, camp crew, overhead, etc), as well as Agency affiliation and geographic area of origin (US Forest Service from the Southern US versus State personnel from California, etc). The geographic Areas identified by the National Wildfire Coordinating Group (NWCG) were used for this delineation, and included:

- 1 = Northern Rockies;
- 2 = Rocky Mountains;
- 3 = Southwest US (Arizona & New Mexico);
- 4 = Great Basin;
- 5 = California;
- 6 = Pacific Northwest (Oregon & Washington);
- 8 = Southeast (20 Southern States from Virginia to Texas);
- 9 = Eastern (Eastern US States from Maine to West Virginia, and the mid-West States);
- 10 = Alaska;
- 11 = Canada;
- 20 = Australia/New Zealand.

Although standardization is a key component of the Incident Command System, some variances occurred in the reporting processes used on the daily ICS-209 form. For example, some Incident Management Teams reported the numbers of crews assigned to their Fire/Incident, while others not only identified the number of crews, but also the total number of crew members assigned. When discrepancies appeared in the numbers reported compared with the ICS "standard" (a "crew" is defined as 16-20 persons), adjustments were made to achieve consistency with total numbers reported. Variance in these numbers is estimated at +/- 1% when the totals for the entire fire/incident are considered.



V. Barriers

Because a study of this nature has never been undertaken before (looking at wildland firefighter injuries from recorded fire records on various fire incidents), there were barriers that arose throughout the study that impacted its timeliness and ability to analyze all the desired aspects of firefighter injuries.

1. Although there was strong support among the wildland fire community for this study when it was initially proposed, obtaining the records proved difficult once the study had been approved. The administrative managers in the U.S. Forest Service responsible for the records determined that a "Freedom of Information" request had to be initiated to both the Regional Offices in Ogden, Utah and Missoula, Montana to receive these records. While the desired records were eventually received, there was a considerable time lag involved.
2. The same administrative managers determined that, since the Medical Unit records and injury reports contained information about specific individuals, then any information that would compromise their anonymity had to be "redacted", or blacked out. In many of the records received, the redactions removed references to employing agency, resource type (hand crew, engine crew, overhead, camp crew), as well as information identifying the age and/or gender of the injured individual. This not only restricted the level of analysis possible, but also prevented any in-depth follow-up with specific individuals that might have provided additional information about their injury, and their previous work history in the hours, days, weeks and even months prior to the injury occurrence.
3. The completeness and quality of the medical unit records were highly variable, ranging from "excellent" to "poor". While some medical personnel were thorough and complete in documenting the injury and the individuals involved, other records gave only cursory information that made further analysis difficult at best.
4. The ICS-209, which is completed daily on all large fires, show the numbers and types of resources assigned to a specific incident, and was our basis for comparing the total numbers of resource types on an incident versus the injury occurrence rates. There were numerous days

when it was difficult to accurately account for the total personnel shown versus the individual resources broken out by agency and resource type.

In spite of these barriers, the available data still allowed for a meaningful analysis of the firefighter injuries by resource types, and some limited analysis based on both gender and age of the injured firefighters.



VI. Findings

Although the Clear Creek fire in Idaho and the Valley Complex fire in Montana were the 2 largest fires that occurred in the U.S in 2000, they were unique, and very different from one another. Those differences are reflected in the injuries that occurred on each. For that reason, this findings discussion will address each fire and the resultant injuries as separate entities.

Clear Creek Fire Injuries

The Clear Creek fire was a lightning-caused fire that began in mid-July 2000 and burned for 71 days, eventually covering 216,961 acres in an area northwest of Salmon, Idaho. Eighty six thousand, six hundred seventy seven (85,677) person days were expended in the suppression effort. Because much of the burned area was away from main roads and too steep for mechanized equipment, hand crews were an important component of the firefighting workforce on Clear Creek: 10,558 person-days of Type 1 (Hotshot crew) days were used, as was 31,067 person-days of Type 2 hand crews. Because of their expertise and experience levels, Type 1 "Hotshot" crews are frequently used in the most difficult and dangerous parts of the fire; the Clear Creek fire was no exception. Type 2 hand crews, on the other hand, are generally not as experienced as the Type 1 Hotshot crews. They are usually placed in less difficult fireline conditions, but are sometimes used side-by-side with Type 1 crews, or in their place, as fire conditions and crew availability dictates.

The composite mix of resources used for the fire suppression effort on the Clear Creek fire include: T-1 Crews: 10558 person-days (12.3%); T-2 Crews: 31067 person-days (36.2%); Engines: 6447 person-days (7.5%); Helitack/Heli-rapellers: 2161 person-days (2.5%); Overhead: 25862 person-days (30.2%); Heavy Equipment: 4655 person-days (5.4%); and Camp/others: 4927 person-days (5.8%).

While the numbers show T-2 crews and Overhead to be the largest groups assigned, there is a wide range of hazards and risks associated with the resource types represented: T-1 and T-2 crews, as well as most Engines, are directly involved in the suppression effort on the fireline. Some over the

personnel classified as "Overhead" are also involved in leadership positions on the fireline. Many others in "Overhead", as well as the Helitack/heli-rapellers and Camp/others, seldom if ever are on the fireline. Their work environment is the incident Base camp, helibases and helispots, and driving the roads between the incident facilities.

Injury records from the Clear Creek fire showed that a total of seventy eight (78) reportable injuries occurred: 55 on the fireline (70.5%) and 23 in the fire camp (29.5%). On a fire that was fought for 71 days, this averaged 1.1 reportable accidents per day; coincidentally, the overall accident frequency rate for this fire was 1.1/1000 person-days worked.

Falls, both on the fireline and in the incident base camps, were the largest single cause of injuries on the Clear Creek fire; 34.6% of all injuries were caused by falls: 19 on the fireline (34.6%) and 8 in camp (34.8%). Strains were the next most frequently occurring injury (14 injuries, 17.9%), causing injuries both on the fireline (9 injuries, 16.4% of fireline injuries) and in camps 5, 21.7%). The other most significant cause of injuries on Clear Creek was from falling objects, which were 14.1% of all injuries (11 injuries): 7 occurred on the fireline (12.7%), and 4 happened in camp (17.4%).

Other injuries, which accounted for less than 10% of the totals, included being hit by rolling objects such as rocks, 2.6%; burn injuries, both on the fireline and in camp, 6.4%; vehicle accidents, 6.4%; blowing material, 3.8%; and both power tool cuts and puncture wounds at 1.3%. 3 injuries, 3.8%, were classified as "other - undefined".

In all but one case on the Clear Creek fire, it was possible to determine both the gender and age of the injured personnel. Ten (10) females were injured (12.8%), and sixty-eight (68) males (87.1%). The females suffered 3 injuries on the fireline, and 7 injuries in the camp setting. Their ages were 22, and 48-58 years old. The injuries included one (1) cut, one (1) impact from a falling object, and five (5) falls. Three (3) women on the fireline were injured by a rolling object (1), a vehicle accident (1), and an undefined injury (1). Their ages ranged from 20-45 years old. The males had fifty-two injuries on the fireline (76.4%) and 16 injuries in camp (23.6%). The males injured in camp ranged in age from 17-60 years of age, evenly distributed on a decadal basis.

Looking more closely at the injuries by type of individual injured, we found that while the T-1 "Hotshot" crews only comprised 12.3% of the total workforce, they experienced 23.1% of the injuries overall, and 32.7% of all fireline-related injuries. The US Forest Service "Hotshots", which were 76.5% of the total T-1 crew workforce, had thirteen (13) injuries (16.7% overall, and 23.6% of fireline injuries). Bureau of Land Management "Hotshots" consisted of 6.5% of the T-1 "Hotshot" workforce, and experienced 5 injuries: four (4) were on the fireline (5.1% of the total, and 7.3% of the fireline injuries), and one (1) occurred in Camp. Perhaps of more interest is that the BLM Hotshots, while comprising 6.5% of the T-1 crew workforce, experienced 27.7% of the injuries. Of the other T-1 crews assigned (National Park Service, Bureau of Indian Affairs, and State) which made up 16.9% of the T-1 crews, only the BIA experienced one (1) personal injury on the fireline, and none in camp.

The Type 2 crews assigned to the Clear Creek fire show a decidedly different record of participation and injuries. The State, Private and Federal T-2 crews were assigned to the fire for 10216 person-days (32.0% of T-2 Crew days), while the US Marine Corps and US Army units worked 20854 person-days (68.1%).

The review of the T-2 crew accidents shows a total of thirty (30) accidents: twenty seven (27), or 90%, were charged against the Federal, State and Private crews, while only three (3) accidents (90%) were reported by the Military. Twenty eight (28) of the injuries occurred on the fireline, while two (2) occurred in Fire Camp. Twenty eight (28) of the injured T-2 firefighters were male, and two (2) were female. Ages of the injured ranged from 20-60 years old, with 22 of the 30 falling in the 20-39 age range.

The injury frequency rates among the non-Military units, based on 1000 person-days worked, range from 0.65 for the private contract crews to 2.15 for the State crews and 2.71 for the USFS crews, to a high of 11.86 for BIA crews.

The Military record of three (3) injuries may not reflect all the injuries that occurred to their personnel, since each Military unit that was deployed to the fires came with a fully staffed medical component, including medical doctors and/or physician assistants.

Thirteen (13) of the T-2 crew injuries were from falls (43.3%), while the remainder of the seventeen (17) accidents were well-distributed between impacts from falling objects (4) and rolling objects (3), burns (3), strains (3) cuts from hand tools (1), blowing material in the eyes (1) and "un-defined" (2).

Engine crews, with 6447 person-days on the fire, had only 5 reportable injury accidents, and three (3) of those resulted from a single vehicle accident. The other two injuries, one (1) fall and one (1) injury from a falling object, both occurred on the fireline to males in their early 30's. The injury frequency rate for engine personnel was 0.78/1000 person-days.



Valley Complex Fire Injuries

The Valley Complex started several weeks later than the Clear Creek fire, and was located in an area with greater road access. It also had a large number of homes and other structures "at risk" in Montana's Bitterroot Valley, and there was serious competition among numerous other fires for scarce resources like crews and engines.

There were a total of fifty one thousand, nine hundred and twenty six (51926) person-days reported on the Valley Complex fire. Suppression action occurred from August 2 - September 24. Type 1 "Hotshot" crews spent 1417 person-days (2.7%); Type 2 crews had 18882 person-days (36.4%), which included 12022 person-days from the Military. Engine crew had 7240 person-days (13.9%), helitack/Heli-rapellers spent 1047 person-days (2.0%), Overhead had 16887 Person-days (35.5%), Camp/Others were at 4790 (9.2%), and heavy equipment operators spent 1663 person-days (3.2%).

Forty three (43) injuries occurred on the Valley Complex: twenty nine (29) on the fire line (67.4%), and fourteen (14) occurred in camp (32.6%). Of those injured, thirty five (35) were males, and eight (8) were female. Twenty five (25) males were injured on the fireline, and ten (10) in the camp setting; four (4) females were injured on the fireline, and four (4) others in camp.

Ages of those injured ranged from 16-66 years old. Females hurt on the fireline were 24-30 years old (with one unknown age), and those injured in camp were 18, 19 and 66 years old (with one unknown age). Males injured on the fireline ranged from 18-52 (with 9 ages unknown); six (6) of the twenty-five injuries on the fireline occurred on those individuals 18-20 years of age. Of the 10 camp injuries to males, ages ranged 16 - 50, with four (4) of the injuries occurring to those males 16-17 years of age.

Type 1 crews reported only 2 injuries on the Valley complex, working a total of 1417 person-days. This injury frequency rate of 1.41/1000 person-days worked is slightly lower than the rates experienced on the Clear Creek fire, in much more demanding terrain.

VII. Review of Hypothesis

At the start of this study, three hypothesis were identified:

Hypothesis #1: Injuries to wildland firefighters are associated with:

- D. Type of Crew/Individual
- E. Number of days on the fire
- F. Number of hours on shift

Hypothesis #2: the frequency of injuries is positively correlated with environmental factors (steep slopes, loose footing, tripping on ground fuels, etc).

Hypothesis #3: There is an inverse relationship between the risk of injury and the differing levels of firefighter fitness.

Because of the incomplete and inconsistent information extracted from the ICS and Medical forms, as well as the Privacy Act concerns that caused some vital information to be "redacted", it was not possible to completely analyze all the data presented in the context of the 3 hypotheses proposed at the beginning of this study.

That being said, there were some opportunities to test our hypotheses against the data, and the following describes our findings, compared to our original expectations:

Hypothesis #1: it was not always possible to track specific injured firefighters to a specific crew, and so determining that the number of days on a fire before an accident occurred was relevant to the injury was not possible. Similarly, the lack of detailed information on the Medical reports prevented us from establishing the time of the injury in nearly all the events, and so we were unable to prove or disprove this hypothesis. The data did allow us to stratify injuries by type of crews and individuals. Although the 2 fires reported only a total of one hundred twenty one (121) reportable

accidents, there was some evidence that T-1 crews experienced injuries at a much higher frequency rate than did some of the T-2 crews. This could be a reflection of the more difficult fireline assignments that are normally given to T-1 crews. T-2 crews from different agencies and organizations (Fed, State, Private and Military) were more difficult to analyze, for a number of reasons. Military units provided their own medical support, and did not use the established ICS reporting system to document injuries. There may have been an under-reporting of injuries among private crews because of concerns about raising the costs of Workman's Compensation for specific companies, but this remains unproven.

Hypothesis #2: the data appears to support the hypothesis that injury frequency is correlated with environmental factors such as steep slopes. Trips/slips/falls was the most frequently occurring cause of injuries, with events happening both in the fireline among experienced firefighters, and in the camp setting among support personnel.

Hypothesis #3: the proof that there is an inverse relationship between the risk of injury and differing levels of firefighter fitness remains unproven. The existing three (3) levels of the Work Capacity Tests (Arduous, Moderate, and Light) are based on the ICS position filled by an individual. All on-the-ground firefighters (T-1 crews, T-2 Crews, and many line-going "Overhead" positions) all require the "Pack Test", carrying a 45 pound pack for 3 miles on flat ground in less than 45 minutes. This is simply a "Pass/Fail" work capacity test, and no attempt is made to differentiate between T-1 and T-2 crews. While it is generally known that T-1 crews usually conduct physical fitness training for one (1) hour daily during non-fire periods, and T-2 crews generally do not, the hypothesis is affected by other factors such as difficulty of assignment that cannot be measured in this study.

VIII. Recommendations

While this study only looked at two large fires that burned in Idaho and Montana during the 2000 fire season, they were representative of the large wildfires that burn across the US each year, and the firefighting resources that work on them. Based on our findings, the following recommendations are offered to the wildland fire community in order to help reduce injuries that occur both on the fireline and in the fire support functions:

1. Even though all individuals working as firefighters must pass the Work Capacity Test at the "Arduous" level on a yearly basis, additional work hardening efforts such as those used by the Type 1 Interagency Hotshot Crews should be encouraged among all firefighters. Although they often are assigned to the most rugged terrain and the most difficult firefighting areas, their injury rate reflects the excellent physical conditioning that they emphasize during non-fire workdays.
2. Additional emphasis should be focused on the Incident Base Camp environment, and the crews and support personnel working there. Injury frequency rates among the camp crews are higher than for fireline personnel, and while they may not seem to be as serious in nature, the frequency could also lead to increased severity of the injuries. Incident Management Teams should consider a Safety Officer with specific responsibilities in the Incident Base Camp when large numbers of incident support personnel are assigned.
3. The injuries in the fire camp setting reflect a possible need to have a minimal fitness level for all individuals who go on fires in any capacity. Falling appears to be the greatest risk to camp workers, and may be reflective of short-term or long-term fatigue.

IX. Future Study Needs/Opportunities

As the complexity of the wildland fires in the U.S. increases, there is a growing concern about the loss of experience in the firefighting workforce. The need for better information and analysis about injuries and those that are injured is essential if we are to provide firefighters a safe workplace and reduce lost time accidents.

Because large wildland fires occur across the US nearly every year, there are ample opportunities to improve our knowledge base about wildland fire accidents:

1. Work with the major wildland fire agencies to conduct future studies in other geographic areas to parallel the work done in this study;
2. Reach agreement with Agency fire and administrative personnel so that specific, necessary demographic information (age, gender, agency/crew, etc) is not removed from research material before it is forwarded on for future studies;
3. Develop a cooperative agreement that allows future researchers to be physically present in Incident Base Camp Medical unit facilities on large, long-duration fire incidents. This will enable these researchers to conduct oral interviews which may provide more in-depth information about the effects of shift length and fire assignment tour length relative to injury occurrence;
4. Study other large, long-duration fire events (such as Oregon's "Biscuit Fire" in 2002) for comparable data with the finding developed from this study with similar resource types assigned.
5. A study is needed that will allow researchers to conduct in-depth follow-up interviews with injured firefighters to ascertain the effects of short-term and season-long fatigue on work performance and injury frequencies.

X. References

To Be Added for FINAL

XI. Appendices

1. Types of Resources
- 2A. Type of Injuries
- 2B. Location of Injury
3. Clear Creek Data Sheets
4. Valley Complex Data Sheets
5. ICS Forms

Appendix 1: Type of Resource

Crew - Type 1: an 18-20 person group, working together season-long, under the same leadership. Typically referred to as a "Hotshot Crew", they are used on the more difficult portions of the fire to construct fireline using hand tools and power saws. 80% of the crew must have at least one season of previous fire experience.

Crew - Type 2: an 18-20 person group that is organized for a specific fire/incident, but does not work together all season. These crews are usually assigned to less difficult portions of the fire, but may occasionally work in areas usually assigned to Type 1 crews. Type 2 crew consist of Agency employees (US Forest Service, National Park Service, State Forestry organizations), Private Contract crews, Native American crews, and specially organized crews such as the Snake River Valley firefighters (Hispanic farm workers, organized by the Bureau of Land Management in Vale, Oregon). 40% of the crew must have at least one season of previous fire experience.

Overhead - individual firefighters and support personnel (planning, administration, logistics, communication, medical, etc.) that are not assigned to a specific 18-20 person crew, but rather to an Incident Management Team, or assigned to a specific incident.

Engine Crew - individual firefighters that are assigned to work directly on a vehicle that is configured for wildland fire suppression efforts, including water tanks, pump, hoses, hand tools and other miscellaneous equipment. Engine crewmembers must pass the work Capacity test at the "Arduous" level. Much of their fire suppression work is in close proximity to roads.

Camp crews - support personnel that work in the camp environment, passing out supplies and equipment, building sign boards, and providing other "common labor" as needed. These individuals are not trained as firefighters, have to minimum work capacity test level, and may be as young as 16 years old (i.e. Job Corps enrollees). They do not use any power tools.

Appendix 2A: Type of Injury Codes

01	Slip/Trip/Fall
02	Puncture
03	Cut - Hand Tool
04	Cut - Power Tool
05	Impact - Falling Object
06	Impact - Rolling Object
07	Burn
08	Strain
09	Fracture
10	Inhalation
11	Bee Sting
12	Cut/Scratch - Other
13	
14	
15	
16	
17	
18	
19	
20	Other Unspecified Injury

Appendix 2B: Location of Injury

- 01 Head
- 02 Eyes
- 03 Neck & Throat
- 04 Chest
- 05 Back
- 06 Arm
- 07 Wrist
- 08 Hand
- 09 Pelvic area
- 10 Leg
- 11 Knee
- 12 Ankle
- 13 Foot
- 14
- 15
- 16
- 17
- 18
- 19
- 20 Other - undefined