United States Department of Agriculture

United States Department of Interior

The Strawberry Fire, Great Basin National Park, August 2016

Strawberry Fire Fatality

Learning Review Report

Accident Date: August 13, 2016; Learning Review Board Date: February 15, 2017

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IN MEMORIAM

JUSTIN BEEBE

Justin Randal Beebe was a man of great character and humbleness. He lost his life on August 13, 2016, while cutting a hazard tree during suppression efforts on the Strawberry Fire, Great Basin National Park, Nevada. Born in Bellows Falls, Vermont, Justin grew up with a strong connection to people and a deep love of the natural world. In high school, he excelled at soccer, hockey, and sugaring of maple syrup. Justin sought challenges and pushed himself to achieve his goals, becoming a team member of the Lolo Hotshots in 2016. We remember Justin for his quiet and generous nature, a kind and thoughtful manner, an always-positive attitude and friendly smile, and that tireless work ethic. He was a simple man with large dreams who will be forever missed by all who knew him.

-Timothy Laroche and Shawn Faiella

STRAWBERRY FIRE FATALITY

THE INCIDENT

Late in the afternoon on August 13, 2016, as crews worked the Strawberry Fire within Great Basin National Park (GRBA) in Nevada, radio traffic cut through the air. During a discussion on the division tactical channel (Tac) about a hose lay, Sacramento Interagency Hotshot Crew (IHC) Superintendent, Morgan, said to his division supervisor trainee, "Jamie . . . hold on." A medical incident announced on the Lolo IHC crew channel kicked Morgan into emergency mode, and he directed his nearby EMTs to provide medical assistance.

Just a few seconds earlier, Lolo IHC Saw Team 2 had caught a glimpse of Saw Team 1 Sawyer, Justin Beebe, falling a leaner. One sawyer recalls, "It just didn't look like it was going the way you thought it'd go." Grabbing their packs, Saw Team 2 started toward Justin's location and heard the crack of the emergency call—a falling snag had struck the sawyer on Saw Team 1. Shortly after, a radio transmission calling for a short-haul extraction and air ambulance medivac went over the airwaves.

Simultaneously, Lolo IHC Superintendent, Logan contacted Division A Supervisor, Parker, with an emergency message: *One of his sawyers had been struck by a snag*. Parker immediately made the official request for a short-haul ship to the Strawberry Incident Command Post Communication Center. Working two radios at once, Parker maintained contact on both Tac and Command, breaking into a sprint toward the accident scene.

On scene, the two members of Saw Team 2 found Justin lying on his right side with his head downhill, lodged up against a green tree. Justin's partner cradled his head to maintain his C-spine and establish an airway. Suspended horizontally over Justin was the *strike tree*. Morgan and Logan arrived shortly. After assessing the situation, Morgan assumed command of the incident within an incident (IWI) while Logan focused on Justin's care. A large boulder obstructed clear access to Justin, frustrating those trying to provide necessary aid. The sawyers from Saw Team 2 cut through the top of the *strike tree* and threw it to the side so Logan could shove the boulder away from Justin. Morgan coordinated operations with the Incident Command Post (ICP). Logan started medical assistance but stepped aside when three EMTs from the Sacramento crew and two Lolo IHC EMTs arrived and began CPR.

Parker, an Advanced EMT, arrived on scene with additional medical personnel and began directing the overall medical response. Logan, determining that the medical response was well underway, headed off the mountain to be at the hospital when Justin arrived. Morgan sent in a second request for a short-haul extraction and an air ambulance and provided the Medical Incident Report (9-line). Justin's condition was "Urgent-Red." CPR was in progress, and immediate evacuation was required.

Despite the many responders' best efforts, Justin Beebe died from injuries sustained when the tree he was falling struck him while working on the Strawberry Fire near Baker, Nevada. The following report describes events leading up to Justin's death. This report is the product of an interagency Coordinated Response Protocol Team (CRP) that convened in Ely, Nevada, on August 16, 2016, under a delegation of authority from the USDA Forest Service and the National Park Service. As part of the CRP, a Learning Review Team conducted multiple site visits, interviewed personnel, and reviewed supporting materials such as photos, maps, qualification records, and dispatch logs. Additionally, the team synthesized dialogue from a peer focus group and an academic review to develop four themes that help make sense of the events. The intent of this effort is to encourage conversations around these themes within the wildland-fire-environment context. Wildland firefighting agencies can use this information within the

backdrop of past similar accidents to evaluate practices and identify learning tools for the next generation of firefighters.

BACKGROUND

GREAT BASIN NATIONAL PARK

Congress established the Great Basin National Park (GRBA) in 1986 to protect 77,100 acres of the Southern Snake Range of Nevada. In addition to an extensive cave system, GRBA protects the 13,000-foot high Wheeler Peak, sagebrush-steppe habitat, rare plant and wildlife species, and thousands of years of human habitation. Public lands administered by the Bureau of Land Management (BLM) and the Humboldt-Toiyabe National Forest surround the park. Since 1986, 68 fires have occurred in the park, 86 percent of which were lightning-caused (like the Strawberry Fire) and 14 percent were human-caused. The Strawberry Fire of August 2016 was the largest fire of record in the park and the first fire managed by a Type 2 Incident Management Team (IMT) within the park.

FIGURE 1: GREAT BASIN NATIONAL PARK AREA MAP

LOLO INTERAGENCY HOTSHOT CREW

Leadership on the Lolo Interagency Hotshot Crew consists of one Superintendent, one Assistant Superintendent, three Squad Leaders, and four Senior Firefighters. Just prior to departure for the Strawberry Fire, a Lolo Senior Firefighter accepted an assignment as a Crew Boss Trainee, creating an opening for Firefighter Justin Beebe to join Saw Team 1. Justin's previous saw experience, including hardwood logging in Vermont combined with skills demonstrated during his re-certification in May, positioned him for the assignment as sawyer. On the Strawberry Fire, Justin would get his chance to run a saw on a Hotshot Crew Saw Team.

The 2016 Lolo Hotshot Season

Early April: Classroom training and field refreshers that include daily physical training, scenario-based fire simulations using sand tables, chainsaw maintenance, crew cohesion drills, and case studies.

Mid May: Readiness inspections resulting in availability for national responses.

May: Project work in Lolo National Forest (prescribed burns, handline construction, and chainsaw refreshers).

June: Assigned to a fire located in Canada that was not physically demanding but contributed to crew cohesion.

July and early August: Multiple call outs to fires within Montana.

STRAWBERRY FIRE

First reported at 1230 on August 8, 2016, the lightning-caused Strawberry Fire started approximately five miles west of Baker, Nevada, within GRBA and eventually spread onto adjacent BLM-managed land. Initial reports put the fire at about 15 acres. Due to high winds, the fire grew to approximately 4,600 acres within 48 hours. A Type 3 Incident Management Team (IMT) managed the fire the first night, but the acting Park Superintendent quickly ordered a Type 2 IMT. On August 10, Great Basin IMT 7 was in-briefed and took control of the fire at 0600 on August 11. The NPS, Ely District BLM, and the White Pine County Fire District signed the Delegation of Authority identifying two primary objectives for the team:

- Minimize impacts to the community of Baker as well as NPS infrastructure, including roadways, structures, and other visitor and administrative facilities.
- Protect sensitive species habitat, in particular Sage Grouse and Bonneville cutthroat trout.

The operational emphasis on August 13 was to continue direct attack on the north, east, and west flanks of the fire to protect critical Sage-Grouse habitat and high-tension power lines. On the fire's south flank, the objective was to continue to assess opportunities to keep fire out of Mill Creek to protect Bonneville-cutthroat trout habitat. By late afternoon on August 13, the fire had burned approximately 4,603 acres with 59 percent containment involving 434 personnel.

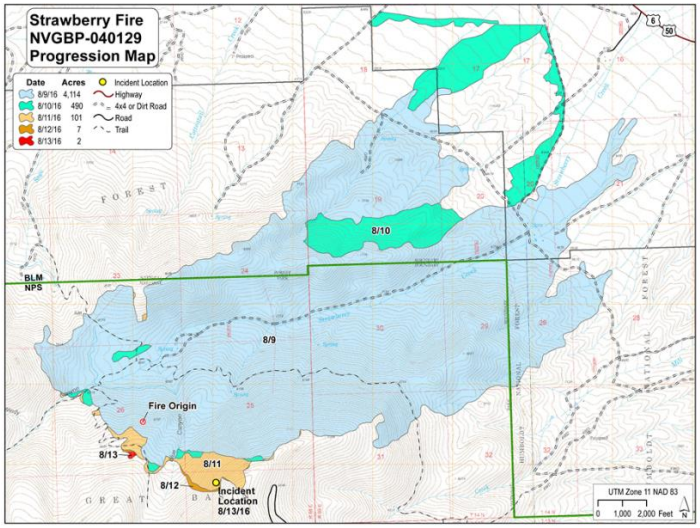

FIGURE 2: STRAWBERRY FIRE PROGRESSION MAP

THE STORY

AUGUST 10, 2016

On August 10, Lolo IHC arrived at the BLM office in Ely, Nevada, received fire information, and then travelled to the Incident Command Post (ICP) outside of Baker, Nevada. They proceeded to Strawberry Helibase where they met with Division A (DIV A) Supervisor Trainee, Jamie, to gather more information on their initial fireline assignment on Division Z (DIV Z), located on the western side of GRBA where fire movement was progressing into the park. The crew then spent the remainder of the shift securing a partially cold fire edge by using a combination of cold-trailing[1] and handline construction. The Lolo IHC and the Vegas Valley Veteran's Fire Corps crew[2] completed approximately two miles of fireline on DIV Z that day.

AUGUST 11, 2016

At approximately 0600, Great Basin IMT 7 formally assumed leadership on the Strawberry Fire and increased the number of divisions from two (A and Z) to five (A, D, K, T, and O). Lolo IHC Superintendent, Logan, met with DIV A Supervisor Parker to discuss tactics, logistics, and values at risk, which included powerlines, the town of Baker, park infrastructure, and natural resources of concern. The day saw minimal fire growth with the exception of a notable 100-acre run (nicknamed "the pooch") on the southeastern portion toward the bottom of the Blue Canyon area. As this unfolded, the IMT discussed tactical alternatives for this section of the fire.

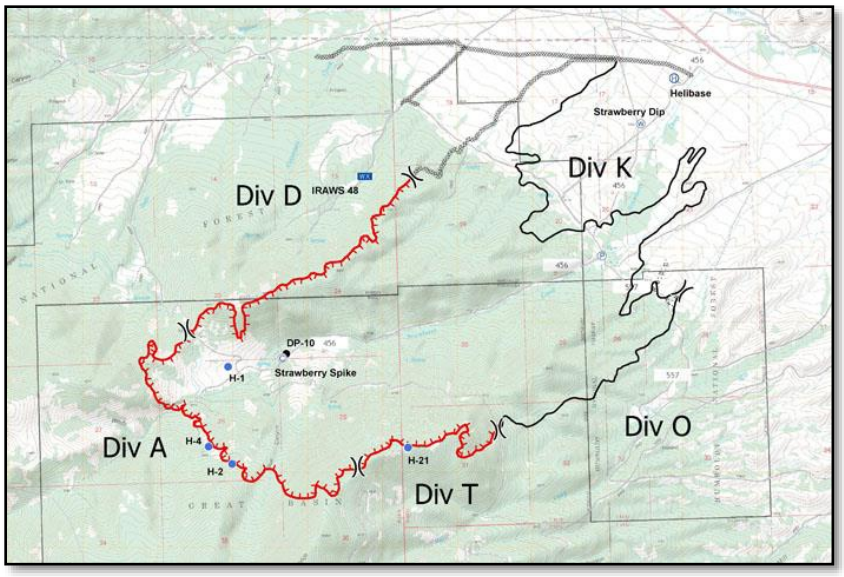

FIGURE 3: STRAWBERRY FIRE OPERATIONS MAP FOR AUGUST 11, 2016

In discussion with a Resource Advisor (READ), leadership decided to minimize impacts to Strawberry Creek because the waterway sustains Bonneville cutthroat trout. Multiple READs worked with Jamie to transplant as many trout as possible out of Strawberry Creek. Lolo IHC continued working the fireline with the Veteran's Fire Corps crew and Cherokee IHC. Together, they discussed options for logistical support via helicopter as the crews worked to secure

[1] Cold-trailing is a method of controlling a partly dead fire edge by carefully inspecting and feeling with the hand for heat to detect any fire, digging out every live spot, and trenching any live edge.

[2] The Veterans Fire Corps is a conservation service program that offers opportunities to veterans for employment while completing fire mitigation on public lands and earning certifications and experience. The Vegas Valley Veteran Crew is a Type 2 IA crew hosted out of the BLM Southern Nevada District in Las Vegas, Nevada, since 2012.

the fire edge. All the while, heavy helicopters were dropping water in DIV A and DIV T to limit fire movement near Blue Canyon. Cherokee IHC was successful in controlling fire activity in an area nicknamed the ”ski run,” an open expanse in the forest with a significant elevation drop located to the west and below Helispot 2.

FIGURE 4: STRAWBERRY FIRE WITH THE "SKI RUN" IN CENTER OF PHOTO

Throughout the day, Logan scouted potential work areas and observed the 100-acre Blue Canyon run. During aerial reconnaissance, Parker and Jamie discussed the amount of dead standing trees, considering options such as allowing time to burn or permitting the snags to fall on their own. Logan, Parker, and Jamie agreed to monitor this fire behavior for 24 hours to evaluate options while Cherokee IHC tied their handline up to the top of the “ski run.” Lolo IHC secured their handline and readied to move to a new location. The 100-acre run led to a request for another Type 1 crew, filled by Sacramento IHC on the August 12. That night, Lolo IHC, along with the rest of DIV A and some former DIV Z members, camped at the newly established Strawberry Spike Camp near Drop Point 10.

August 12, 2016

In camp on August 12, the crews received maps, Incident Action Plans (IAPs), and meals from the ICP. Logan and the Lolo Assistant Superintendent set out early to scout the fire. They had two goals: to determine the workload and to examine the terrain where work was likely to occur.

It became clear that “the pooch” on the southernmost edge of the fire required attention. “The country was steep but workable with a pace that was slow and steady,” remembers Logan. By shift’s end on August 12, Lolo IHC reached the lowest part of “the pooch.”

> ***The ground was decent at the bottom of the drainage, then got bad mid-slope, then super-bad towards the top.***
>
> **- Lolo IHC Superintendent**

Logan traversed side slope and uphill to DIV T to tie-in with the Geronimo IHC Superintendent. They agreed that the terrain was workable and they would join forces on the following day to support DIV A once they received concurrence from the DIV T Supervisor. Mid-afternoon, Logan walked back towards the lookout point and met Morgan. Parker, Jamie, and a Cherokee IHC crew boss trainee also participated in this meeting. They agreed cold-trailing, clearing snags, and going direct with the eventual support of a hose lay were appropriate for the conditions and decided on a strategy for the August 13 operational period. In the morning, Sacramento IHC would continue

from the point where Lolo IHC finished. Lolo IHC would continue securing their piece of handline while Cherokee IHC would cover the area stretching back towards the "ski run." Finally, Geronimo IHC would approach from the top of DIV T to construct handline and install a hose lay near the top of DIV A.

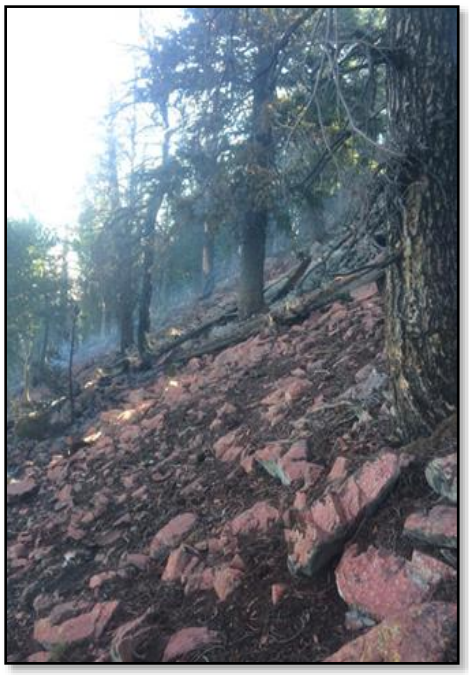

FIGURE 5: REPRESENTATIVE TERRAIN, GROUND COVER, AND PRESENCE OF RETARDANT ON DIV A

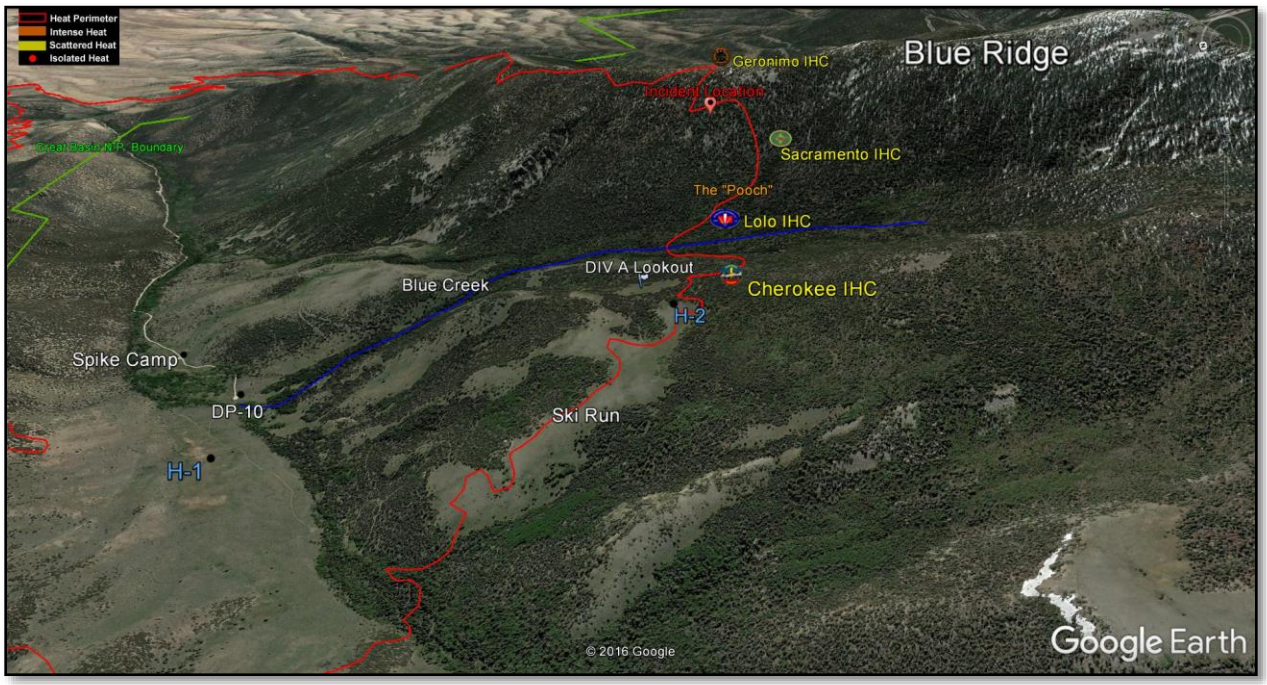

FIGURE 6: MAP SHOWING CREW LOCATIONS ON AUGUST 13, 2016

AUGUST 13, 2016

The day began with a radio briefing at 0700 from ICP along with the delivery of IAPs, maps, and meals. The line Safety Officer assigned to DIV A addressed safety issues for 15 to 20 minutes, following his usual practice of reminding everyone to review the Medical Incident Report (commonly known as the 9-line[3]) located in the IAP, as well as the Incident Response Pocket Guide. Morgan was first to leave camp to gauge the terrain where the crews would be working. He estimated the hike from spike camp to the work area would take approximately one hour because of the 1,000-foot elevation gain. Logan hiked up with his crew around 0720 and then met with Morgan on the hillside later that morning. At that time, they reaffirmed their decision to go direct. Logan then walked to the top of Blue Ridge and noticed a lack of burnable vegetation, an abundant amount of rocky talus slopes, and little ground fuel. "It would have been hard to get a blackline on top of that ridge with the lack of fuel," he noted. A Geronimo IHC captain notified Morgan and Logan that DIV T Supervisor approved their movement into DIV A to help tie in the handline.

> ***There was no ego up there.***
> **- DIV A Supervisor Trainee**

The crews worked together to connect their pieces of handline, gradually working upslope. The teamwork exhibited between the four crews was exceptional. An IHC superintendent thought they would probably be able to tie in the handline by day's end. Around 1400, Logan and Morgan met near the crest of Blue Ridge to call a Squad Boss on the crew channel to request two saw teams to their location near a rocky, steep, scabby piece of ground at around 10,000 feet. The teams would remove snags to reduce potential torching until additional people and water arrived. Parker knew that Logan and Morgan were together near the crest of the ridge, so he began his ascent from the bottom of Blue Canyon to meet face-to-face.

FIGURE 7: DETAIL OF TERRAIN WHERE SAW TEAM 1 WAS WORKING

[3] **9-line** - a tool used to request medevac support. Technically, the tool is titled the "Medical Incident Report." This report was added to the 2014 version of the Incident Response Pocket Guide (IRPG) (pg. 108). The report has 9 lines, so the tool is still frequently referred to as the 9-Line.

Lolo Saw Teams 1 and 2 made the 500-foot elevation climb in approximately a half hour and then stopped for a break before returning to work. After receiving Logan's instructions to secure the fire's edge by falling snags and removing the hot ends of logs, the crews took up positions approximately 50 to 60 yards side hill from each other. Saw Team 1 took the edge of the black while Saw Team 2 worked the interior of the black. The area was smoky and the burn was patchy, resulting in poor visibility that made finding the edges of the burn challenging.

Saw Team 1 continued removing snags and cutting the heavy logs into smaller pieces ("bucking up the heavies") to stop fire spread. They took turns cleaning up cutting debris ("swamping") and operating the chainsaw. They changed places when the current sawyer's tank ran empty, permitting them to cut as a team for most of the day.

THE ACCIDENT

As Saw Teams 1 and 2 proceeded up the hill, Saw Team 1 encountered a large, fork-topped green Douglas fir (hereafter referred to as the *support tree*) with two Engelmann spruce snags leaning into and hung up in it. The sawyers conducted a quick size-up on the tangled tripod of trees. The Lead Sawyer suggested cutting the larger of the two snags (18 inches diameter at breast height (dbh) and 45 feet in length) out of the *support tree* from an uphill position. They then moved uphill a safe distance, clear of the work area, and dropped their packs nearby. (Note: This was a standard operating procedure for the Lolo Hotshots when falling trees.) Justin went back down to the snags where he started cutting and dropping the smaller of the two snags. That snag came out of the support tree and fell uphill safely and without incident. The larger snag (hereafter referred to as the *strike tree*) was leaning into the forked top of the *support tree* and was burning at the stump. Justin positioned himself on the uphill side of the *strike tree* and began to remove the lower limbs. He proceeded with a top-to-bottom cut in an effort to "step it down" out of the *support tree*. Justin then commenced a series of cuts using the top and bottom of the bar to set the tree into motion.

Once the lower five feet of the *strike tree* broke free, the rest of the *strike tree* quickly swung towards and down slope of the *support tree*. In direct response to this movement, the top of the snag pivoted violently out of the fork of the *support tree* in a side-hill direction. All of this happened very quickly. Justin was swiftly distancing himself cross slope and slightly downhill across very rocky terrain, still carrying his saw. Approximately 15 feet away from his cutting position, he was struck on the top of his hard hat about 2/3 of the way up on the falling *strike tree*. Saw Team 1 Lead Sawyer estimates the entire sequence of events from first saw cut to the strike took less than a minute.

Saw Team 2 was taking a short break approximately 50 to 60 yards from Saw Team 1. As they watched through scattered timber, they caught a glimpse of the *strike tree* as it fell. One sawyer remembers thinking "It didn't look like it was going the way you thought it'd go." As they threw on their packs to help, they heard Saw Team 1 Lead Sawyer calling to them, then heard him declare a medical emergency on the Lolo crew channel as he reported that a falling snag had struck a member of Saw Team 1 and requested a short-haul extraction and air ambulance medivac on crew net. Morgan, in the middle of a conversation with Jamie, heard the medical emergency report on Logan's radio. While Morgan directed his EMTs to support Saw Team 1, Logan contacted Parker on Tac to report the injury of one of his sawyers. In turn, Parker notified Strawberry Incident Communications on Command to declare a medical emergency and request activation of the short-haul ship. Parker received a second radio from a Sacramento IHC crewmember so he could listen to Tac and Command simultaneously as he scrambled as quickly as possible toward the accident scene.

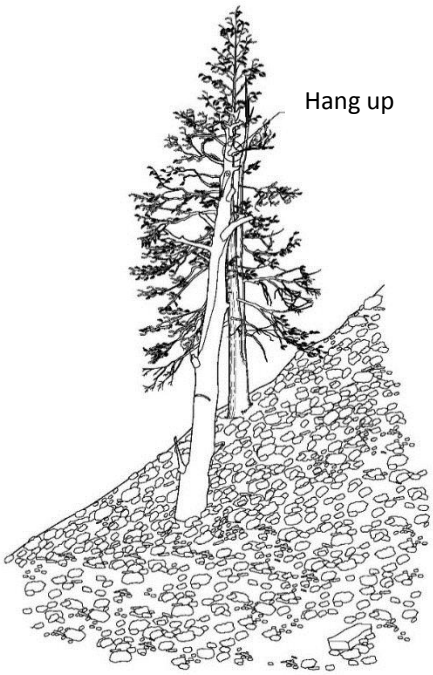

FIGURE 8: DETAIL OF *STRIKE TREE* AND *SUPPORT TREE*

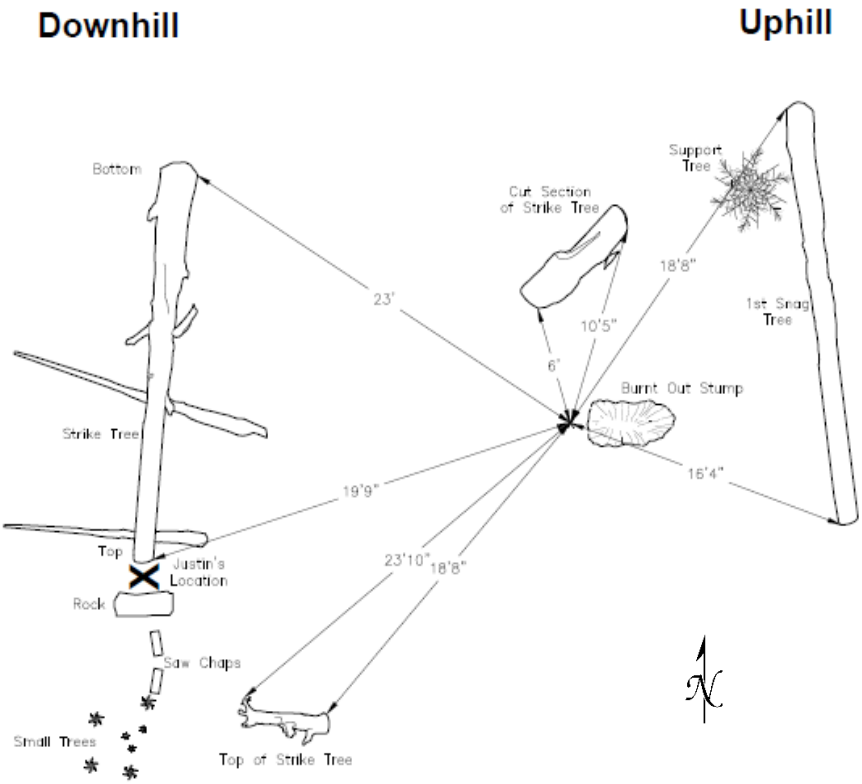

FIGURE 9: VIEW OF THE ACCIDENT SCENE LOOKING DIRECTLY DOWN FROM THE TOP. MEASUREMENTS COME FROM LAW ENFORCEMENT STARTING AT THE STUMP HOLE WHERE THE *STRIKE TREE* ORIGINATED AND SHOWING THE FINAL RESTING PLACE OF THE *STRIKE TREE*.

On scene, Saw Team 2 found Justin lying on his right side with his head downhill, lodged up against a green tree. Justin's partner cradled his head to maintain his C-spine and establish an airway. Suspended horizontally over Justin was the *strike tree*. Morgan and Logan arrived shortly. After assessing the situation, Morgan assumed command of the incident within an incident (IWI) while Logan focused on Justin's care. A large boulder obstructed clear access to Justin, frustrating those trying to provide necessary aid. Saw Team 2 cut through the top of the *strike tree*, caught it, and threw it to the side so Logan could shove the boulder away from Justin. Morgan coordinated operations with the Incident Command Post (ICP). Logan started medical assistance but stepped aside when three EMTs from the Sacramento crew and two Lolo IHC EMTs arrived and began CPR.

Parker, an Advanced EMT, arrived on scene with additional medical personnel and began directing the overall medical response. Logan, determining that the medical response was well underway, headed off the mountain to be at the hospital when Justin arrived.

Morgan made a second request for short-haul extraction and air ambulance. He also delivered the Medical Incident Report (9-line). Justin was unconscious and his status—according to the 9-line—was "Urgent-Red," which means that there was a life-threatening injury and evacuation was needed immediately.

By 1615, news of a serious injury had spread across the mountain. Seven trained medical personnel and medical equipment from DIV A and T arrived on scene. Personnel moved Justin a few feet uphill to a more level spot to place him into a traverse rescue stretcher (TRS). By 1620, a paramedic arrived at the scene and administered Advanced Life Support (ALS) drugs.

Helicopter 551 and crew lifted from Strawberry Helibase with the rescue helicopter configured to insert rescuers via rappel, which is this crew's standard configuration.[4] On-scene responders also learned an air ambulance from Nephi, Utah, was en route to the Strawberry Helibase.

By 1625, Helicopter 551 (H551) arrived at the scene, and consistent with protocol, conducted a high- and low-level

A Contingency Plan Unfolds

As the crew of Helicopter 551 prepared to depart Strawberry Helibase for the short-haul mission, Jamie contacted Morgan to see if they wanted additional medical gear at the accident scene. As a member of a short-haul helitack crew, Jamie knew that a single "chip light" would cause termination of the mission. (A chip light is a detection system in a helicopter's transmission that comes on when it detects metal in the transmission oil. It requires an instant mission abort and return to base for inspection.) Extra medical gear was at Helispot 2 (H2) and ready to be moved via longline. This could prove critical if the helicopter was unable to complete the short-haul. Morgan indicated that he did indeed want the additional gear.

Jamie communicated with Helibase on a tactical frequency (not the command channel cleared for emergency traffic) and requested medical gear from H2 for the accident scene. Helicopter 5CH, previously performing bucket work at the time of the accident, returned to Helibase and was available to do the medical gear sling mission. Qualified helitack from Cherokee IHC were available to hook the load. Immediately after H551 lifted for the short-haul mission, 5CH configured for a longline mission and departed Helibase for H2, configured with a 100-foot line and remote hook.

After determining the exact location of the accident scene, 5CH made the decision (before even arriving at H2) to come back to Helibase for a 150-foot line. About 1635, 5CH again lifted off from Helibase headed back to H2 with the longer line. While en route to H2, they received confirmation that sufficient medical gear was already on scene and aborted the contingency mission.

[4] The Yosemite NP helicopter (551) is unique among federal short-haul ships because it inserts rescuers via either rappel or short-haul. All other federal short-haul programs insert rescuers solely via the short-haul line.

reconnaissance of the area, a key component of which is looking for a landing zone. When no suitable landing zone was located, they initiated the rappel insertion of rescuers. Helicopter 551 was in contact with the IWI IC Morgan and informed him of the plan to insert rescuers via rappel. Although winds in the area shifted constantly throughout the day, personnel determined helicopter power was sufficient to initiate rappel operations.

Just as the lead rescuer prepared to step out onto the helicopter's skid, the wind shifted 180 degrees, changing from the nose of the aircraft to the tail. The pilot decided to abort the rappel mission due to these changing conditions. The spotter directed the lead rescuer to de-rig her rappel device. He then dropped the left-door rope to the ground. Helicopter 551 left the scene around 1632 to land at Helispot 1, where they reconfigured for a short-haul insertion of rescue personnel.

As the rappel rope hit the ground, the firefighters attending to Justin were surprised and dismayed. They expected to hook him up because he was packaged and ready to fly in the TRS and did not realize that the rappel mission had been aborted and that the crew needed to reconfigure for a short-haul. Morgan and the H551 pilot maintained communications; however, the extensive activity surrounding the medical response and the short-haul air asset maneuvering for extraction resulted in anxiety and confusion on the ground when the rope was dropped and the helicopter departed the scene.

Over the next 15 to 20 minutes, several events occurred simultaneously:

- CPR was in progress and continued. An established airway allowed medical staff to use a bag valve mask and 100 percent oxygen.
- It was acknowledged that additional medical gear and supplies, including an AED, were located at the Strawberry Helibase.
- Formulation began for a tentative contingency plan (see sidebar box) to sling additional supplies to the scene via another helicopter.
- Additional paramedics and EMTs were on their way to the scene on foot.
- Communication from the scene to the Medical Unit Leader back at the ICP provided status reports on Justin's condition.
- The Medical Unit Leader contacted the emergency room physician at the William Bee Ririe Critical Response Hospital and Rural Health Clinic in Ely, Nevada, to inform him of the medical emergency.
- All non-medical crew personnel on scene worked to clear a trail through the rocks to the short-haul extraction site.
- Sawyers mitigated several snag hazards at the short-haul extraction site and then built a level pad.

Almost 20 minutes after aborting the rappel mission, Helicopter 551 returned to the scene at 1655 and inserted two rescuers on the end of the short-haul line. The helicopter then returned to Helispot 1 to wait while the crew prepared Justin for extraction. Already inside the TRS, he was placed in a rigid litter with his IV line, medications, and O_2 bottle and then secured in a Bauman Bag[5] for transport. Medical personnel continued CPR and other Advanced Life Support (ALS) actions during preparation for extraction. The emergency room physician maintained communication with the Medical Unit Leader at the ICP, who relayed information to the medical personnel on scene over the radio because of lack of cell phone coverage. When safely secured for transport, firefighters on scene moved Justin across the newly created trail to the short-haul extraction site. At this point, 15 trained medical personnel were on scene.

At 1716, Helicopter 551 returned to pick up Justin and two rescuers on the short-haul line for flight to Helispot 1. Rescuers cannot perform CPR while in short-haul transport. An H551 crewmember received Justin and the two

[5] A Bauman Bag provides a single-point suspension for lifting a patient during a hoist or short-haul evacuation. Possessing fixed length straps, the bag immobilizes and protects accident victims and maintains stability in flight. It can be used with backboards, litters, and similar equipment.

rescuers at Helispot 1 where they moved Justin into the helicopter. CPR resumed and continued while Helicopter 551 flew to Strawberry Helibase, arriving about 1731. Meanwhile, the air ambulance helicopter from Nephi landed at Strawberry Helibase and was ready for Justin's arrival. Justin remained inside the ship while Helicopter 551 shut down.

The Lead Rescuer gave a medical report to the flight nurse who then completed an examination of Justin. The air ambulance crew ran through their protocols, including an EKG strip. The air ambulance crew pronounced Justin dead at 1746 after consultation with the ER physician in Ely. In total, Justin received CPR for approximately 75 minutes. The Medical Examiner's report received on October 18, 2016, indicated death was a result of blunt-force head injuries.

INCIDENT TIMELINE

Time 8/13/2016	Activity Medical Activity Aviation Activity	Medical Personnel on Scene
1600	Medical emergency declared. Sacramento IHC Sup requested Sacramento IHC EMTs to report to scene.	
1601	Short-haul and medivac (air ambulance) requested.	
1602	Lolo IHC Saw Team 2 arrived on scene. Pulse was indeterminate.	
1605	Lolo and Sacramento Superintendents arrived on scene. Lolo Superintendent began assisting medical response.	
1610	Lolo Superintendent directed Sacramento Superintendent to assume Incident Commander (IC) role for the incident within an incident (IWI).	
1610	Three Sacramento EMTs and two Lolo IHC EMTs arrived on scene. First report that CPR was underway.	
1611	DIV A Supervisor, who is also an Advanced EMT, arrived on scene and assumed direction of medical response. Airway established with oropharyngeal airway (OPA).	
1612	IWI IC requested a short-haul and air ambulance. Medical Incident Report (9-Line) described Justin as unconscious and urgent (red) transportation needed.	
1615	Lolo IHC crew members arrived on scene with trauma kit including bag valve mask and traverse rescue stretcher. Justin moved to a more level location nearby to continue medical response.	
1620	Line Medic (1 Tango), a paramedic, arrived on scene and administered drugs.	
1622	Air ambulance helicopter launched from Nephi, UT.	
1623	H551 launched from Strawberry Helibase, rigged for rappel mission and equipped to follow up with short-haul.	
1624	Line Medic (2 Tango), a paramedic, arrived on scene.	
1626	H551 on scene, rigged for rappel mission to deliver two medical rescuers, did recon and prepped for rappel.	
1632	H551 terminated rappel mission due to unfavorable winds. H551 went to H1 to reconfigure for short-haul.	
1635	Line Medic (3 Alpha), a paramedic, arrived on scene.	
1647	MEDL contacted ER Physician Rollins at Hospital in Ely, NV, to convey situation. Line Medic (4 Tango), an EMT, arrived on scene.	

Time 8/13/2016	Activity Medical Activity Aviation Activity	Medical Personnel on Scene
1655	H551 inserted two rescuers by short-haul to prepare Justin for extraction.	
1659 to 1716	H551 rescuers continued packaging Justin for extraction by short-haul and then moved him to a nearby location.	
1709 (approx.)	MEDL discussed with ER Physician Rollins: a. CPR had been underway for 40 minutes. b. short-haul extraction meant 10-15 minutes without CPR. c. whether time of death should be called. d. recommended Justin's transport to helibase, then run an EKG.	
1714	Discussion between on-scene medics and MEDL after receipt of information from ER Physician resulted in concurrence to extract Justin using short-haul.	
1716	H551 returned to scene, picked up two rescuers with Justin, then conducted short-haul to H1.	
1718	Air Med 13 (air ambulance) landed at Strawberry Helibase.	
1721 - 1727	At H1, Justin was moved inside H551 and CPR was restarted. H551 lifted off en route to Strawberry Helibase.	
1731	H551 landed at Strawberry Helibase with Justin still on board. Air ambulance personnel ran EKG that indicated no signs of life.	
1746	Patient death declared in consultation by telephone with ER Physician.	

Sensemaking Discussion

The loss of a firefighter has profound reverberation throughout the wildland fire community and beyond. The far-reaching impact of a tragic event provides significant opportunity for reflection, understanding, and change, both personal and organizational. The purpose of the sensemaking discussion is to facilitate learning and encourage continued dialogue surrounding the key themes derived from this incident. Sensemaking refers to how people select what seems important to attend to and how this influences their actions. In order to understand why actions and decisions made sense at the time, we evaluate the context in which participants performed those actions and made those decisions. This discussion does not provide hard and fast answers and lessons. Rather, the intent is to help readers to make sense of the incident by understanding the conditions surrounding this fatality. Ultimately, continuous safety improvement as individuals, teams, and the greater wildland fire organization is the goal.

Four themes stood out from this incident: risk management, saw operations, human dynamics, and short-haul rescue/recovery. Risk management is a broad concept encompassing a wide range of processes, practices, and meanings. We use it to talk about the trade-offs made between engaging and not engaging and between risk to personnel and values at risk. A tree that he was cutting struck Justin. Therefore, making sense of this incident means making sense of the individual, organizational, and environmental conditions influencing those conducting saw operations. Human dynamics is a category of conditions related to being human. These human attributes both enable us to successfully adapt and make us vulnerable within our dynamic operational environment. Finally, this incident provides significant potential for learning about short-haul medical response and evacuation.

Improvements to risk management and employee safety ultimately result from every wildland firefighter's engagement in learning from tragic events, discussing hard truths, and promoting ongoing discussions.

Theme 1: Risk Management

The community of practitioners within the wildland fire community continues to build and learn about the balance between recognizing risk to firefighters and managing that risk. The Strawberry Fire strategy discussion is similar to discussions about risk management on other fires.

How Did Fire Leaders and Agency Administrators Address and Manage Risk on the Strawberry Fire?

The fire started on August 8, 2016. The Acting Park Superintendent contacted BLM and NPS Pacific West Regional (PWR) Deputy Fire Management Officer (FMO). A BLM Type 3 Incident Management Team initially managed the fire under a mutual aid agreement. This team coordinated the initial attack with the Acting Superintendent and PWR Deputy FMO. They discussed the importance of the safety of the firefighters, park staff, and visitors. On August 8, the primary focus involved campground evacuations and visitor safety. BLM was concerned with preserving a fire-threatened high voltage power line within BLM lands. Agreeing with the initial concerns for firefighter and public safety, the NPS expanded the discussion about other values at risk adjacent to or near the fire area. The values at risk considered in the response-strategy development included the following: Bonneville cutthroat trout (BCT) and associated habitat; Sage Grouse and associated habitat; Bristlecone pine; the community of Baker; and various NPS infrastructure such as campgrounds and historic structures. To protect these values, they decided to suppress the fire. That decision led to the use of a Type 2 IMT and over 400 firefighters on this incident.

On August 9, GRBA staff and a PWR agency representative briefed the returning Park Superintendent, who then assumed Agency Administrator (AA) responsibilities for the duration of the fire.

During the afternoon of August 10, the NPS Park Superintendent and members of his staff as well as BLM staff in-briefed with Great Basin Team 7, a Type 2 IMT. The NPS expanded the values at risk discussion with the IMT as reflected in the delegation of authority. The team took command of the fire at 0600 on August 11, 2016.

On August 11, the Park Superintendent attended the 0600 morning briefing and a planning meeting at 1900 with the team. The Superintendent attended all subsequent morning briefings and evening planning meetings and discussed fire strategies with the IC concerning indirect and direct attack. Discussions regarding safety of both aerial and ground containment occurred before adopting a final containment strategy. The number one priority for the fire was to minimize exposure to firefighters and aviation assets.

On the evening of Friday, August 12, the IMT presented its strategy to the NPS and BLM Agency Administrators (AAs) following the evening planning meeting. The strategy contained several options ranging from direct to indirect tactics depending on weather and fire conditions.

- Primary (P): If conditions allow direct attack, the strategy will be to flank the fire until crews are able to go across the head of the fire on the south end. The control objectives for this strategy include holding the fire north of Blue Ridge to keep it from becoming established in Mill Creek where the Bonneville cutthroat are and holding the fire along the flanks before it gets into Strawberry Creek.
- Alternative (A): Continue direct attack on the flanks. If crews are unable to hold Blue Ridge because of active fire growth at the head, indirect strategies may include the following options. Use an old flume as well as portions of the road going up to Wheeler Peak as indirect lines for a burn-out operation. Construct additional indirect handline higher up along Blue Ridge to Bald Mountain. Construct indirect handline down the west side of Bald Mountain following old avalanche chutes into Strawberry Creek. The total acreage included in the alternative strategy was much larger than the primary strategy.
- Contingency (C): Focus suppression efforts on the protection of outlying ranches and park infrastructure, including campgrounds on Wheeler Peak Road, Park Headquarters, the Visitor Center, and park residences. This strategy would also support use of indirect burning from roadways and natural barriers.
- Emergency (E): In the event that the fire blows up, use a defensive strategy of point protection of park infrastructure and ranches with assistance from White Pine County and Ely BLM.

The NPS and BLM AAs agreed to this strategy and were hopeful that the primary plan would be successful given that fixed wing retardant drops earlier on August 12 held the fire to Blue Ridge. Large and very large (DC-10) air tankers pre-treated the main ridge in Division T. In Division A, single engine air tankers pre-treated the side ridge going down into Blue Canyon/Strawberry Creek. The retardant was holding the fire, and there was no substantial fire growth on that day.

Discussions were consistent throughout the course of the fire between various levels and included safety-hazard mitigation considerations. Examples include morning briefings between IHC Superintendents and their crews and fireline discussions among leaders and Division Supervisors and crewmembers. A common theme for all conversations was the priority placed on minimizing exposure to firefighter and aviation assets. It was also clear to the Learning Review Team that there was agreement on the strategy and the planned tactics to maintain focus on that priority. *This plan of attack made sense to the AA, the IMT, and the firefighters on the ground.*

Safety and Efficiency Trade-offs

Managing risk on wildland fires may be understood by all involved at a very generic level, but the perception and acceptance of risk may differ at all levels of the fire management team, the hosting unit, and the public. An individual employee may be willing to accept a greater amount of risk than the level of risk the supervisor is comfortable with him or her accepting. This is the work as practiced versus the work as perceived. An employee's natural tendency may be to work in a manner they consider more efficient, which may lead to short cuts that trade safety for efficiency. The drive to work faster, quicker, or easier can take over.

When a fire starts and initial attack (IA) resources conduct initial assessments, Agency Administrators must decide how to best mitigate risk to firefighters and other resources. The NPS/BLM-coordinated leadership decision to order a Type 2 IMT is a behavior of managing risk in an increasingly complex environment. This decision model brings in people with specific skills and experience who can help guide the fire's management. Line officers and AAs work with IMTs to develop a plan to ensure firefighters will be as effective as possible at managing risk while finding safe means to suppress fire in dangerous and complex environments.

As soon as the decision is made to suppress a wildland fire, firefighters are placed in a hazardous environment. While this is considered "all in a day's work" for fulltime firefighters, particularly Hotshot Crews, do managers have a full understanding of the tasks to be performed or situations firefighters confront to accomplish the work assigned to them? Are managers fully aware of the complexity in each specific instance or context of the fire environment, potential hazards on the fireline, and how those hazards can change quickly as weather or other conditions alter?

Additionally, the definition of "acceptable level of hazard" varies greatly based on experience and exposure to fire management. This gap may be widest between the AA and the firefighter. The AA makes a strategic decision regarding the wildfire, which leads to tactical action, which then drives firefighters to take specific actions; these actions determine the exposure level to hazards in each specific incident, shift, or task. To work toward reducing this gap, the AA may order an IMT to manage the fire. However, there is also a gap in risk perceptions between firefighters, IMTs, and Division Supervisors. It is even common for firefighters within the same crew to hold different "risk thresholds." This gap results from differences in training, experience, the degree of association with past incidents, and each individual employee's personal make-up.

Every crew or engine will have a unique understanding of risk associated with fireline hazards. If two crews are working together to suppress the same piece of fireline, their hazard assessment may be similar, but the hazard mitigation could be very different. One crew may assess and then mitigate the hazards associated with a snag by falling the snag while the other crew may assess and then mitigate the snag by flagging and avoiding the hazard altogether. Both actions to mitigate the risk can be appropriate, but the determination of the hazard mitigation may differ by each crew or individual firefighter. This creates inconsistent tactical and hazard-mitigation decisions even if the risk management process by both crews is sound and consistent.

A means to narrow the perception gap, regardless of between which group it occurs, is through solid interpersonal relationships and trust building. There can be great benefit in more communication among the sub-communities within the greater wildland fire community. Relationships build trust. Relationships take time. Relationship building is an art, not a science.

Risk management goes beyond the fireline, and even though fireline hazards may not cause injury or death, values at risk are considered during a strategic decision process. The political, historic, or economic impacts of fire occurrence may drive perceptions regarding the importance of identified values. We wonder if the pressure to protect some resources results in increased risk to firefighters. Protecting values at risk should be the cornerstone in the development of objectives, which in turn, determine tactical direction.

Recently, firefighters have been much more likely to engage in risk assessment and risk-management discussions related to the values they are asked to manage, as well as provide input into strategies and tactics proposed to accomplish fire-management goals. Anecdotal information indicates firefighters feel they are safer and more supported in voicing their concerns than in the past. However, there remains room to improve openness in communications when planning fire events.

There may be another lens through which the wildland fire community can examine risk management. Academic reviews of the Strawberry Fire indicate it may be useful to distinguish risk management from uncertainty management. During fire events, people are likely making risk-management decisions based on probabilities and possible outcomes they assume are "givens" when, in reality, there is much greater uncertainty that must be continually managed.

Theme 2: Saw Operations

Discussion of Complexity

Justin was qualified as a B-Faller. The felling operation in which he was engaged was within the scope of a B-certified sawyer. His crew, other saw-team members, and Justin believed he was qualified to cut this tree. Nothing indicates that their process or reasoning was misaligned with what is normal. Saw-certified members of the Learning Review Team, including B and C Fallers, concurred that they would have attempted this falling operation.

According to his saw partner's account, Justin felt comfortable cutting the tree. Apparently, the tree did not behave as Justin thought it would. This situation of being carded, comfortable, and surprised is not only common but is exemplified by the frequently expressed notion that "everyone has a tree story," meaning that nearly every sawyer is surprised by a tree at some point in his or her career. Sawyers face a complex array of situations ranging from the large conifer-graced slopes of the Pacific Northwest to the rolling hardwood forests of the East Coast, all of which are affected by fire, insects, and disease to some degree. Sawyers must assess and understand the hazards and balance that assessment with the value of the work to be completed. Furthermore, sawyers are expected to turn down an assignment if it is "too risky" or "unsafe." The reality is many of the hazards are uncertain and not fully understood. Three critical questions emerge from this conversation:

1. Do sawyers have the tools necessary for success?
2. How does one effectively measure subjective ideas such as "too risky" and "unsafe"?
3. How does the wildland fire system prepare sawyers to engage in this kind of decision-making?

A relatively new Forest Service national policy, issued on July 19, 2016, attempts to address some of these needs by identifying complexity as a means of rating rather than the traditional size classification. Specifically, in reference to this incident, it more accurately defines a "leaner" and a "lodged tree."[6] Additionally it redefines B Sawyer based on complexity rather than simply tree size.[7] The Learning Review Team recognizes the importance of policy shifts in meeting the demands of a complex environment. However, these shifts must be paired with other facets in order to provide our sawyers and supervisors with the tools necessary to meet the needs of the complexity they face.

Motivation to Engage

In addition to the high degree of subjectivity and variability involved in how sawyers evaluate risk and reward, there are obvious and hidden conditions influencing perception, decisions, and actions. These conditions are both common throughout the community and highly individualized. Therefore, a great deal of variation exists regarding how sawyers perceive and assess risk.

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[6] ***Lodged Tree (hung tree***) – A tree leaning against another tree or object that prevents it from falling to the ground. ***Hung tree removal is considered a complex cutting operation*** and should be carefully planned. Proceed carefully and consider other removal methods as an option for safe removal. **Lean** – Refers to the directional tilt of a tree away from its vertical position in relation to the intended lay of the tree. Many times two lean forces may be in play in the same tree. Lean is described as head lean, back lean, and side lean.

[7] **B Sawyer – Felling and Bucking**- – An intermediate sawyer who may independently fell, buck, and limb any size material in ***moderately complex*** situations. This person may saw at the next higher level under the immediate supervision of a sawyer qualified to supervise the work (FSM 2358.1, ex. 02). This person may also conduct classroom and field training for A and B Sawyers (IQCS 1 and 2) with prior written approval from the Saw Program Coordinator.

Sawyers engage in a given operation for a number of reasons. Tactical goals are generally the primary component of any decision to cut a tree. In this particular case, the hung-up tree posed a threat to fireline personnel in the area, and the burning tree had the potential to spread burning embers or contributing to torching. These two facts provide sufficient motivation to cut the tree. There is a level of self-actualization and pride when cutting a highly technical tree. It is like many things we do that are higher-than-normal risk and take higher-than-normal skill. A sawyer accepts a degree of exposure when taking on a complex challenge.

Another reason sawyers choose to cut trees has to do with the need to gain experience. Running a chainsaw—like much of the work in wildland fire—is fundamentally a hands-on activity. You can study it in a classroom or read about it in a book; however, to grasp what a chainsaw truly can and cannot do and how trees and chainsaws interact, you need to run a saw. As sawyers gain experience, they tend to progress from relatively low-complexity operations to those that are more complex. Sawyers gain higher qualifications through experience. Experience is critical to any sawyer, and experience is gained with each tree cut and through continually stretching to gain greater competency. This experience was likely important to Justin because he was very interested in being on a Lolo Saw Team. Running a saw is a sawyer's opportunity to demonstrate skill necessary to obtain membership in a particularly capable and elite tribe—the hotshot sawyer tribe.

Additionally, the wildland fire community has recently moved away from the use of professional fallers. Hotshot crews now do the bulk of wildland fire falling operations. By doing this we have shifted risk from full-time professional fallers to firefighters and further provided motivation to engage.

Can We Say No To a Tree?

As sawyers approach a tree to size it up, they have inherited all the higher-level decisions placing them in the position of assessing a hazard tree for removal. On the Strawberry Fire, many people had a role in determining the need to cut the tree that struck and killed Justin. He alone was closest to the task and had the best information to make the decision. The sawyer has both the most information about the tree and the most pressure to perform. Asking sawyers to say "no" is not as straightforward as it may seem.

A great example is the adage, "Once you put a cut into a tree, you own it." No matter your skill level as a sawyer, most sawyers have found themselves at a point in the cutting procedure where they are at the very edge of their current skill set. Have we as a community enabled our sawyers to walk away if they determine that is the best course of action? Alternatively, have we created a climate that prompts them to finish the cut based on their sense that they now "own the tree"? How does the culture shift toward one where sawyers are not obligated to continue cutting when they are unsure, uncomfortable, or feel at risk? How do we encourage sawyers to seek help or to flag it off and walk away?

Theme 3: Human Dynamics

Accidents and Humans

Fatal accidents all have at least one common element—some type of human interaction. Certainly, the Strawberry Fire is not unique in this respect. An accident review seeks to understand the systems employees operate within as well as the nature of human dynamics as people interact with each other and the system in which they work.

Human dynamics is a broad category of exploration related to individual and social human characteristics and their influence on decisions and actions. Human dynamics both influence and are influenced by the creation and maintenance of culture, which is defined as a set of basic assumptions that have been developed or discovered that have worked well enough to be considered valid by a particular group (Schein, 1984). We "see" culture in the particular norms and beliefs expressed by individuals within a particular group. Individual and cultural influences

affect how individuals, groups, and societies perceive, behave, and interact. The human dynamics that were influential to the Strawberry Fire were not unique to the Strawberry Fire, this crew, or these individuals. Justin was not under abnormal pressures relating to human dynamics, but the human dynamics influential to the incident provide context to that day.

It is precisely because the human and cultural conditions in this incident *were* normal that they are such valuable currency for learning beyond this incident. The conditions influencing decisions and actions of individuals from Justin to agency leadership during the Strawberry Fire are the same ones influencing the decisions and actions on an incident today. Including human dynamics in this report may imply judgment, but that is not the intent. In fact, learning from the human dynamics influential to this incident requires we purposefully avoid judging human dynamics simply as good or bad. In this case, learning does not come from suppressing the influence of human dynamics; it comes from recognizing its influence in our team and in ourselves. Human dynamics are neither good nor bad, and they are not going away. Learning comes from reflection and acknowledgement of the influence of human dynamics. We do not need to fix them; we need to acknowledge them. Read the following with that in mind.

Human Dynamic Context

Inter-crew Dynamics: Although the four IHC crews (Lolo, Sacramento, Cherokee, and Geronimo) hadn't worked together before, their Superintendents had been talking together while on the hill and communicated between each other about the day's plan for their work. They all agreed the plan to go direct was appropriate. They agreed this was appropriate Hotshot ground, and they agreed on tactics for the day.

- What are the underlying assumptions about Hotshot ground?
- What is accepted, and what is an IHC's role?
- What are the cultural rewards and consequences of building fireline or not?

Intra-crew Dynamics: The Lolo Hotshots had their own crew dynamics. Their philosophy was to train their members to be future fire leaders and to train them to be thinking firefighters. According to the Lolo IHC Superintendent, the crew was beginning to "really gel" as a team about three weeks before the incident. Crewmembers felt pride in being able to work where others cannot—i.e., working in "Hotshot country."

- How does pride influence our willingness to accept assignments?
- How do we best use pride?

It became clear through the Learning Review Team's interviews with the crewmembers that the Lolo Hotshots like their work and have a high retention rate from year to year. They have a reputation of high team and individual performance. Among individuals on the Lolo Hotshot crew, there is a general sense the members want to be a part of the team. They share a sense of belonging and purpose and feel they are part of something bigger. They have a lot of experience in the work and take on only a few new members as a matter of course each year. They feel a sense of pride within their team.

- Do you like your job?
- How do we use this to our benefit?
- How does a love of what you do influence what you are willing to do to keep doing it?
- How influential do you think the desire to be a part of the team" is on our willingness to accept risk?
- How does pride and the desire to "be a part of the team" influence our perception of the risks we accept?

Individual Dynamics (Justin): As the Learning Review Team became more familiar with the person Justin was, through interviews with people who knew and worked with him, we began to see him as a personable and affable

man—an enthused achiever with a personal drive to demonstrate his skills and talents. He was self-motivated, capable, and filled with excitement about working on a Hotshot crew. He had a strong desire to be part of the team.

- Have you ever met a firefighter that fits this description?
- Do we equate "being capable of the work" with acceptance into the culture, with fitting in?
- What are the challenges and opportunities related to this powerful influence?

While the above dynamics are more or less common to most crews and crewmembers, there was a unique condition specific to this assignment. Justin had recently joined Saw Team 1, having previously demonstrated he was a capable sawyer. On the Strawberry Fire assignment, he filled a position vacated when a regular saw team member accepted an assignment as Crew Boss Trainee. By filling in on Saw Team 1, Justin was demonstrating his skills for a possible saw position in the future.

- How much of our job is an evaluation for either a position or acceptance within the community?
- How do we best utilize these evaluations?
- How can we help those under evaluation to learn?
- How much risk are we willing to take on when under evaluation? Does this differ once the evaluation is through?

Our Belief in Control

To the leaders and firefighters all working toward a common goal of managing this fire, the Strawberry Fire represented normal work. However, it was not normal to lose a firefighter because of working towards this common goal. This challenges us both as individuals and as a wildland fire culture because if this was "normal," how did we experience such a tragic outcome? This sentiment reveals an individual and cultural assumption about our level of control over our environment. From the national offices on down through the Park Superintendent, Incident Management Team, Division Supervisors, Crew Supervisors, and to Justin and his saw partner, there was a belief in our ability to recognize and mitigate hazards while weighing the remaining risks against the value of our intended actions. These beliefs assume a high degree of control to accurately perceive and control our environment, when in fact because of the combination of the uncertainty inherent in our system and our limitations as humans, there is much beyond our ability to control.

- How much control do we really have?
- How could we change our risk management strategies to include the presence of uncertainty?
- Are the conversations with your crew/unit different if you cannot say, "Stay safe out there"?
- Would we be willing to accept assignments if we started each day off by saying, "There is no completely safe way to accomplish this task"? Does what we are doing justify the level of the risk we are taking on?"

Theme 4: Short-Haul and Transverse Rescue Stretcher (TRS) Utilization

Firefighters and crews on the ground, incident management teams, Agency Administrators, and others have expectations and assumptions about how emergency extractions such as short-haul extractions work, the timeframes associated with a short-haul, and how equipment such as a Transverse Rescue Stretcher (TRS) will be utilized in the extraction. However, these expectations and assumptions frequently do not match the timeframes and procedures actually practiced in a short-haul mission. This can (and did in the case of the Strawberry Fire) lead to high levels of frustration and anger around the procedures and length of time actually needed to perform an extraction in a medical emergency. It is important to note that the length of time it took to complete the short-haul mission on the Strawberry Fire likely did not affect the outcome.

After the snag struck Justin, an emergency medical response was immediately initiated. Knowing from the morning briefing that a short-haul helicopter was available on the Strawberry Fire; the rescuers requested a short-haul to

extract Justin from the mountain. The Lolo Hotshots also had a TRS available and used it. Based on what they "knew" (their assumptions and expectations) about using the TRS and short-haul missions, it makes sense that the crews expected the process of getting Justin off the mountain to go more quickly than it did. It also makes sense that they thought the helicopter would be able to hook up Justin in the TRS and fly him away. In actuality, the Yosemite National Park helicopter (H551) used on this incident is unique among federal short-haul ships because it is currently the only one that will insert rescuers via rappel. All other federal short-haul programs will insert rescuers via the short-haul line. H551 first arrived on the accident scene rigged to rappel, did their reconnaissance, tried to rappel in the rescuers but aborted due to shifting winds, and then went to a nearby location to configure for short-haul. This did not actually add significant time to the mission. However, to the people on the ground who did not understand the sequence of events to expect in this procedure, when H551 hovered to attempt to deploy the rappellers and then flew away, it appeared that the short-haul extraction was aborted, and each minute that passed was excruciating. They did not understand why the helicopter did not have the short-haul line attached to just come in, "hook Justin up" in the TRS, and fly him away.

Three main themes warrant discussion and clarification:

- What can you expect from a short-haul mission?
    - What are the timeframes and procedures associated with a short-haul?
- How can the TRS interact with short-haul operations?
    - Will a patient in a TRS be hooked directly to the short-haul line?
    - What equipment is compatible with other approved short-haul equipment?
- Short-haul is an effective tool but should not be used as a means to enable a particular strategy and/or tactic.

Short-Haul Expectations

From the interviews conducted, it appears there is a significant lack of understanding—from fireline and overhead-level firefighters alike—surrounding how short-haul missions work, how long they can take, and what people on the ground need to do after requesting a short-haul mission. There is an impression that short-haul missions are rapid, perhaps because they are described as "short" hauls. "Short" refers to the distance the patient and rescuer will be moved (a "short-haul" or a short distance)—NOT the timeframe needed to accomplish the mission. The aircraft and crew will launch and complete an aerial reconnaissance flight and will then depart the scene and find a suitable landing location to configure the aircraft for short-haul operations. The short-haul crew and pilot will undergo a risk management discussion. If a short-haul mission is determined to be necessary and feasible, the crew will complete aircraft and personnel equipment configuration. The aircraft will then leave the configuration site, go back to the accident scene, and insert the rescuers connected to the end of the short-haul line. On the Strawberry Fire, the short-haul process took more than 79 minutes from the first request to when Justin was on the ground at Strawberry Helibase. This was due in part to the rappel element of H551 protocol.

The expectations of those involved in this short-haul rescue—as well as other emergency rescues—represent a classic example of an efficiency/thoroughness dilemma. The folks on the ground who are tending to a fellow crewmember who is seriously hurt expect the rescue to be as fast as possible. They want efficiency.

The rescuers in the sky—who are very aware that they are flying in to the aid of a fellow firefighter—feel the pressure to be as fast as possible. However, they are also the ones now engaged in a complex, high-risk operation. They could well be the next victims. The rescuers recognize both of these pressures—get our fellow firefighter off the

hill—but do it in a way that does not add to the emergency. Be fast—but do it correctly and safely. When pressed on areas to "save time" on the short-haul, the rescuers were adamant about a few things, including the notion that they have to look after their own safety, even as they try to save a fellow firefighter. To do this, they rely on training and protocol. They act deliberately. They move and communicate intentionally. To outside observers, this may seem slow.

The Transverse Rescue Stretcher (TRS) and Short-Haul

There is an expectation that the TRS equipment can be "hooked" to a short-haul line. TRS gear can be—and has been—successfully used in wildland fire operations. However, a patient in a TRS cannot attach directly to a short-haul rescue line. The confusion regarding the TRS attaching to a short-haul rescue line may be linked to the outcome on the Freezeout Ridge Fire.[8] That extraction is a well-known example of TRS gear used with a helicopter, longline, and remote hook. It was NOT a short-haul mission. Nevertheless, many crews purchased TRS equipment based on the success at Freezeout Ridge. All equipment used in short-haul operations is approved by the appropriate agency (e.g., NPS, the Forest Service) Short-Haul Operations Committee. The Forest Service Technology and Development Center in Missoula (MTDC) evaluated and rejected the TRS for human external load operations as a stand-alone device but allowed that it may be incorporated with the Bauman Bag. A TRS is, however, an effective means to move an injured firefighter with ground-based rescue resources, such as to transfer the patient to the appropriate short-haul equipment and extraction location in an expedited fashion. The Bauman Bag supports and is compatible with a variety of common wildland patient packaging devices, including standard backboards, Stokes, and SKED litters.

Potential Short-Haul Effects on Strategic and Tactical Decisions

There is concern personnel may be making subconscious tactical decisions based on the availability of aviation assets, including short-haul resources. Short-haul, much like any other tool in wildland fire (i.e., fire shelters, medical providers, personal protective equipment, etc.), should *not* be part of risk management discussions where additional exposure to risk or hazards is undertaken due to the presence of a short-haul capable helicopter. The conversations that take place associated with certain assignments—particularly those that would require a short-haul in the event of an injury—are critical. Just as the availability of fire shelters should not influence strategy and tactics, the availability of an aviation resource, especially a short-haul capable helicopter and crew, should not influence strategy and tactics.

Short-haul availability did not play a role in risk management discussions and tactical decisions made on the Strawberry Fire involving the Lolo and Sacramento Hotshot Crews.

Summary of Recommendations

Themes 1 and 2: Risk Management/Saw Operations

1. Bolster the interagency chainsaw training curriculum and qualification tracking standards.

   - Provide additional training for cutting hung trees in the S-212 curriculum or in the Advanced Feller courses, including cutting procedures that do not use the conventional pie cut method (horizontal and sloping cut), back cut with a stump shot, and holding wood to determine direction. The increased complexity of this style of cut is due to uncertainty in the fall direction.
   - Emphasize the size-up process of cutting a hung tree, including the evaluation of escape routes. If we can increase the awareness of the complexity of cutting green- or dead-hung trees to all levels of sawyers, we will begin to address the gap of experience now existing among different experience levels of fellers.

[8] Go to http://www.wildfirelessons.net/orphans/viewincident?DocumentKey=1d7babd0-7a5e-4177-90b8-a6a08cda5536.

- During training and evaluations, emphasize the importance of intra-saw team communication in the risk-management process during saw operations to promote a culture where all firefighters are included in risk-management discussions.
- Evaluate ways to improve how sawyers communicate about the options available when given a cutting assignment, including whether to cut or to flag and make known.
- Expedite release of the newly developed US Forest Service guidance on saw operation complexity so that it can be included in seasonal saw refresher classes as soon as possible.
- NPS will evaluate the newly developed US Forest Service guidance on saw operation complexity for use in Service or across agencies.
- The US Forest Service will develop a consistent saw training tracking system (e.g., use IQCS as an interagency standard for saw qualification tracking).

Theme 2: Saw Operations

2. Personal Protective Equipment review.

- Conduct a comprehensive review of the wildland firefighting helmet—design, standards, and policy.

Theme 3: Human Dynamics

3. Initiate a general cultural change initiative that addresses the questions raised in the Human Dynamics section.

- Continue current efforts to create space for line officers and field-going personnel to discuss the gap between work as imagined (by management) and work as performed (by field-going personnel) with an emphasis on human-dynamics considerations. This can be carried out in pre-season meetings, tailgate safety sessions, Employee Engagements, or other venues.
- Continue current efforts and emphasize more strongly the need to create space for field-going personnel to engage each other in real-time in risk-management decisions, based on human dynamics considerations, throughout all levels of the incident hierarchy. The intent is to make human dynamics considerations available and emphasized on a regular and recurring basis. This could be accomplished by creating a guide intended to provide tickler topics for crews to use in conversations about how human dynamics might affect the way they make decisions and assess risk associated with their work. Such a tool could be easily carried to the field and would be used in the annual Fire Refresher Training or at Employee Engagements. These conversations will raise awareness in the firefighting community and provide firefighters and leaders a guided conversation around these questions about how human dynamics can drive actions.

4. Consider the automatic deployment of Peer Support/Critical Incident Stress Management dispatched from a regional or national level to take the responsibility off the Superintendent.

Theme 4: Short-Haul Operations

5. Provide clear, accurate, and concise information regarding the short-haul program as it relates to wildland fire.

- Increase the understanding by field-going personnel and IMTs of how short-haul extractions work: process, protocols, and timelines. Address content, including differences between long-line extractions and short-haul extractions. NPS will support interagency efforts in messaging and techniques relating to short-hauls.
- NPS will work to increase the understanding by interagency field-going personnel and IMTs of how short-haul, Rapid Extraction Modules (REM), and litter carry extractions work.
- Include description of how equipment such as a Traverse Rescue Stretcher (TRS), other stretchers, or backboards are used in the extraction and how crews should prepare an extraction site.

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SAFETY ACTION PLAN

The Forest Service and National Park Service process of reviewing an accident and identifying recommendations also includes follow-up action items. These recommendations relate to conditions present at the time of the accident that led to this tragic fatality. While some of these below are more closely associated, several important conditions were discovered throughout the course of this review that warrant additional follow-up. As agencies, we must give attention to all significant conditions present. For additional context for each recommendation below, please see the Sensemaking Discussion of the Strawberry Fire Learning Review Report.

Responsible Party	Begin by Date	Theme	Topic
USFS Deputy Chief, State and Private Forestry *NPS Division Chief, Fire and Aviation Management*	*May 1, 2017*	*Risk Management/ Saw Operations*	1. Bolster the interagency chainsaw training curriculum and qualification tracking standards. • Provide additional training for cutting hung trees in the S-212 curriculum or in the Advanced Feller courses, including cutting procedures that do not use the conventional pie cut method (horizontal and sloping cut), back cut with a stump shot, and holding wood to determine direction. The increased complexity of this style of cut is due to uncertainty in the direction of fall. • Emphasize the size-up process of cutting a hung tree, including the evaluation of escape routes. If we can increase the awareness of the complexity of cutting green or dead hung trees to all levels of sawyers, we will begin to address the gap of experience now existing between different experience levels of fellers. • During training and evaluations, emphasize the importance of intra-saw team communication in the risk-management process during saw operations to promote a culture where all firefighters are included in risk-management discussions. • Evaluate ways to improve how sawyers communicate about the options available when given a cutting assignment, including whether to cut or to flag and make known. • Expedite release of the newly developed US Forest Service guidance on saw operation complexity so that it can be included in seasonal saw refresher classes as soon as possible. • NPS to evaluate the newly developed US Forest Service guidance on saw operation complexity for use in Service or across agencies. • The US Forest Service will develop a consistent saw training tracking system (e.g., use IQCS as an interagency standard for saw qualification tracking).

Responsible Party	Begin by Date	Theme	Topic
USFS Deputy Chief, National Forest Systems.	*May 1, 2017*	*Saw Operations*	2. Personal Protective Equipment review. • Conduct a comprehensive review of the wildland firefighting helmet—design, standards, and policy.
USFS Deputy Chief State and Private Forestry	*May 1, 2017*	*Human Dynamics*	3. Initiate a general cultural change initiative that addresses the questions raised in the Human Dynamics section. • Continue current efforts to create space for line officers and field-going personnel to discuss the gap between work as imagined (by management) and work as performed (by field-going personnel) with an emphasis on human dynamics considerations. This can be carried out in pre-season meetings, tailgate safety sessions, Employee Engagements, or other venues. • Continue current efforts and emphasize more strongly the need to create space for field-going personnel to engage each other in real-time risk-management decisions, based on human dynamics considerations, throughout all levels of the incident hierarchy. The intent is to make human dynamics considerations available and emphasized on a regular and recurring basis. This could be accomplished by creating a guide intended to provide tickler topics for crews to use in conversations about how human dynamics might affect the way they make decisions and assess risk associated with their work. Such a tool could be easily carried to the field and would be used in the annual Fire Refresher Training or at Employee Engagements. These conversations will raise awareness in the firefighting community and provide firefighters and leaders a guided conversation around these questions about how human dynamics can drive actions.
NPS Division Chief, Fire and Aviation Management	*May 31, 2017*	*Human Dynamics*	4. Consider the automatic deployment of Peer Support/Critical Incident Stress Management dispatched from a regional or national level to take the responsibility off the Superintendent.

Responsible Party	Begin by Date	Theme	Topic
USFS Deputy Chief, State and Private Forestry *NPS Division Chief, Fire and Aviation Management*	*May 1, 2017*	*Short-Haul Operations*	5. Provide clear, accurate, and concise information regarding the short-haul program as it relates to wildland fire. • Increase the understanding by field-going personnel and IMTs of how short-haul extractions work: process, protocols, and timelines. Address content, including differences between long-line extractions and short-haul extractions. NPS will support interagency efforts in messaging and techniques relating to short-hauls. • NPS will work to increase the understanding by interagency field-going personnel and IMTs of how short-haul, Rapid Extraction Modules (REM), and litter carry extractions work. • Include description of how equipment such as a Traverse Rescue Stretcher (TRS), other stretchers, or backboards are used in the extraction and how crews should prepare an extraction site.

SAFETY ACTION PLAN SIGNATURE PAGE

USDA United States Department of Agriculture

United States Department of Interior

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APPENDICES

APPENDIX A: DETAILED SEQUENCE OF EVENTS

Around 1545, Saw Team 1 was nearing their tie-in point near a wet retardant line. As they followed the fire's edge into the bottom of a rock scree, they encountered a green Douglas fir (*support tree*), which was 22 inches in diameter at breast height (dbh) and 55 feet tall with two co-dominant tops (forked top) at an acute angle of around 5 degrees. This *support tree* had two buckskin (or barkless) Engelmann spruce snags wedged in the fork. Given the proximity to the fire's edge and smoldering near the bases of both snags, the team decided to fall the snags to mitigate both the potential for spotting and possible hazards for personnel working to secure the fire's edge. Justin removed his pack and placed it approximately a tree length uphill and to the east. This location was near the Lead Sawyer and offered a good lookout with protection offered by a large guard tree.

The first hung tree was a smaller snag on the upslope side of the Douglas fir *support tree*. It was attached to the stump and almost vertical with a slight uphill lean. Justin began cutting with an undercut and followed with a slicing back cut. The snag came out of the fir without incident and fell uphill in the intended direction.

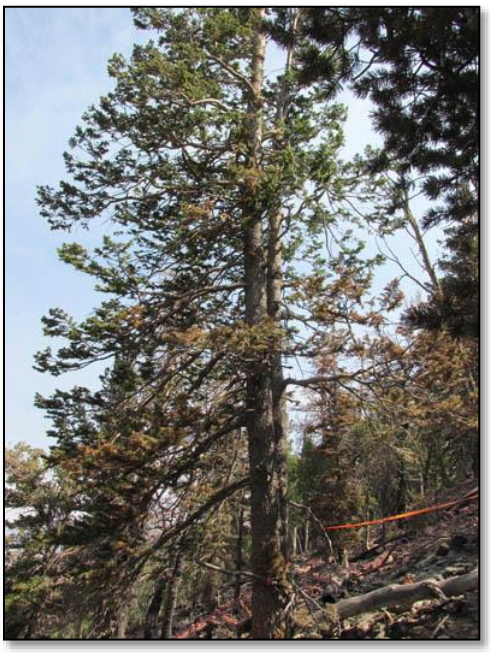

FIGURE A1: LIVE DOUGLAS FIR *SUPPORT TREE.*

FIGURE A2: TOP OF *SUPPORT TREE* SHOWING DAMAGE WHERE *STRIKE TREE* RELEASED.

He then began sizing up the second snag, or *strike tree*, another Engelmann spruce, roughly 18 inches dbh and approximately 45 feet tall on the west side of the *support tree*. In stark contrast to the smaller snag felled first, the *strike tree* had many large limbs along the tree's entire length. Many of these limbs were intermixed in the forked top of the *support tree*. The base of the *strike tree* was approximately 11 feet from the *support tree* and at approximately the same contour, resulting in a lean of approximately 20 degrees. As Justin was sizing up the *strike tree*, the Lead Sawyer recommended Justin stay on the uphill side of the *strike tree* while cutting. They did not explicitly discuss a specific escape route because nearly 360 degrees of cleared area was available if escape was necessary.

After cutting several lower branches on the *strike tree* to clear his work area, Justin established a cutting position on the uphill side of the *strike tree*. He began a slightly angled, top to bottom cut approximately waist high and cut through most of the *strike tree* (~90%) before the cut started to bind. Justin withdrew his saw before it became bound on this top cut.

As Justin was more comfortable using a Humboldt-style cut (face cut points to the bottom) when felling trees, he first introduced the saw to the snag's underside, using the bottom of his bar in an attempt to sever the remaining wood and "fencepost" the snag down. The orientation of this cut missed the mark due to placement and the awkward angle at which his bar was placed. He quickly corrected for this, turning his saw over and reintroducing the top of the bar into the same kerf, creating the appearance of a bore-in cut.

Realizing that his cut had missed the mark, he withdrew his saw and re-oriented it further down the log to the left in order to connect with his original downward cut and sever the snag. This re-orientation and cut-angle unintentionally removed a pie section of the log just below the original downward cut. This third attempt completed the cut through the snag, but due to the relatively shallow angle of the cut and end, bind pressure the snag still had not released. With a couple of coaxing nudges with the saw bar, the tree finally broke free and was set into motion.

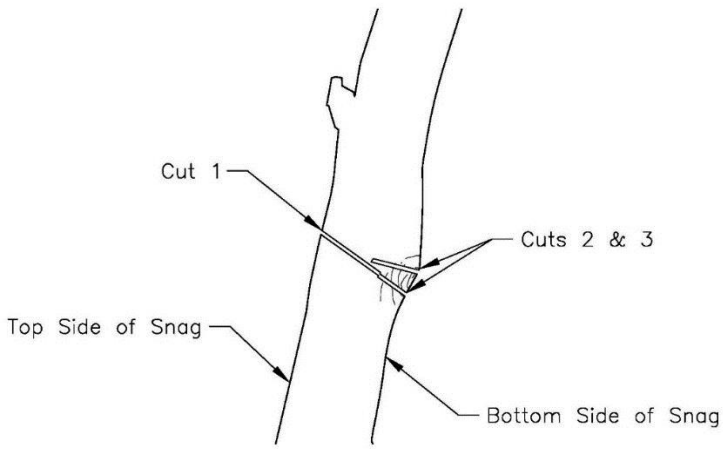

FIGURE A3: CUTS MADE INTO *STRIKE TREE*

FIGURE A4: BOTTOM OF *STRIKE TREE* SHOWING MULTIPLE CUTS.

FIGURE A5: CUT REMNANT FROM THE *STRIKE TREE* SHOWING CHAIN MARKS AND THE KERF.

The waist-high end of the stump of the *strike tree* fell to the ground cross slope toward the *support tree* and eventually rolled downhill. Justin likely anticipated the upper portion of the *strike tree* to fencepost into the ground, causing the top to break loose or requiring more cuts to bring the top to the ground. Instead, because it was still hung up in the forked top of the *support tree*, and because of the steep slope and the distance between the *strike tree* and the *support tree*, the upper portion of the *strike tree* was set into a pendulous, sweeping motion toward the *support tree*, much like a tetherball swinging towards its pole. The force of the swing broke the top of the *strike tree* out of the *support tree*.

As reported by the observing Lead Sawyer, Justin "had his back to the tree and never saw what got him." He seemed to be intent on getting distance from the snag and never determined the true direction of the fall. Due to the extremely rocky nature of this area, it would be likely that an escaping sawyer would have been very intent on watching his/her every step to avoid tripping.

The tree struck Justin on the top of the helmet as he attempted to move downhill toward the west on a cross-slope angle. The impact propelled him, and he came to rest beneath a mix of broken limbs, rocks, and the unbroken, yet slightly suspended bole of the *strike tree*. It is important to note that the tree never came to rest directly on top of him.

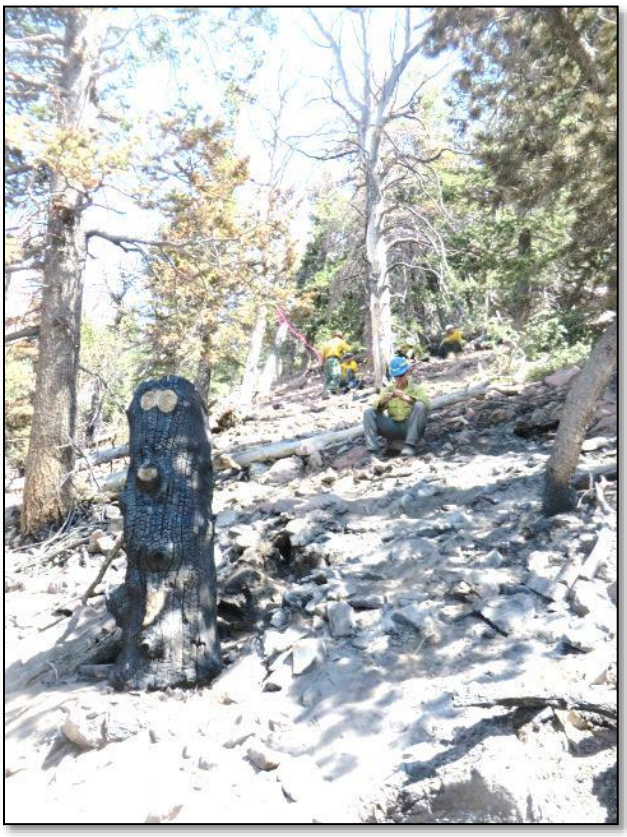

FIGURE A6: BOTTOM FIVE FEET OF *STRIKE TREE*, REPOSITIONED TO ITS LOCATION PRIOR TO CUT. THE *SUPPORT TREE* IS VISIBLE AT LEFT.

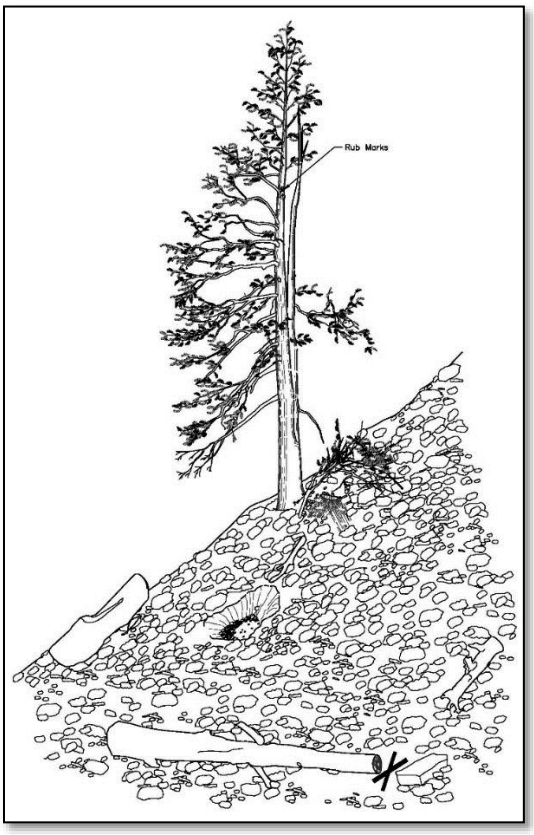

FIGURE A7: *SUPPORT TREE* STANDING WITH REMNANTS OF *STRIKE TREE* ON GROUND.

FIGURE A8: LOOKING DOWNHILL FROM BASE OF *STRIKE TREE* TO WHERE IT CAME TO REST, SUSPENDED ABOVE THE GROUND.

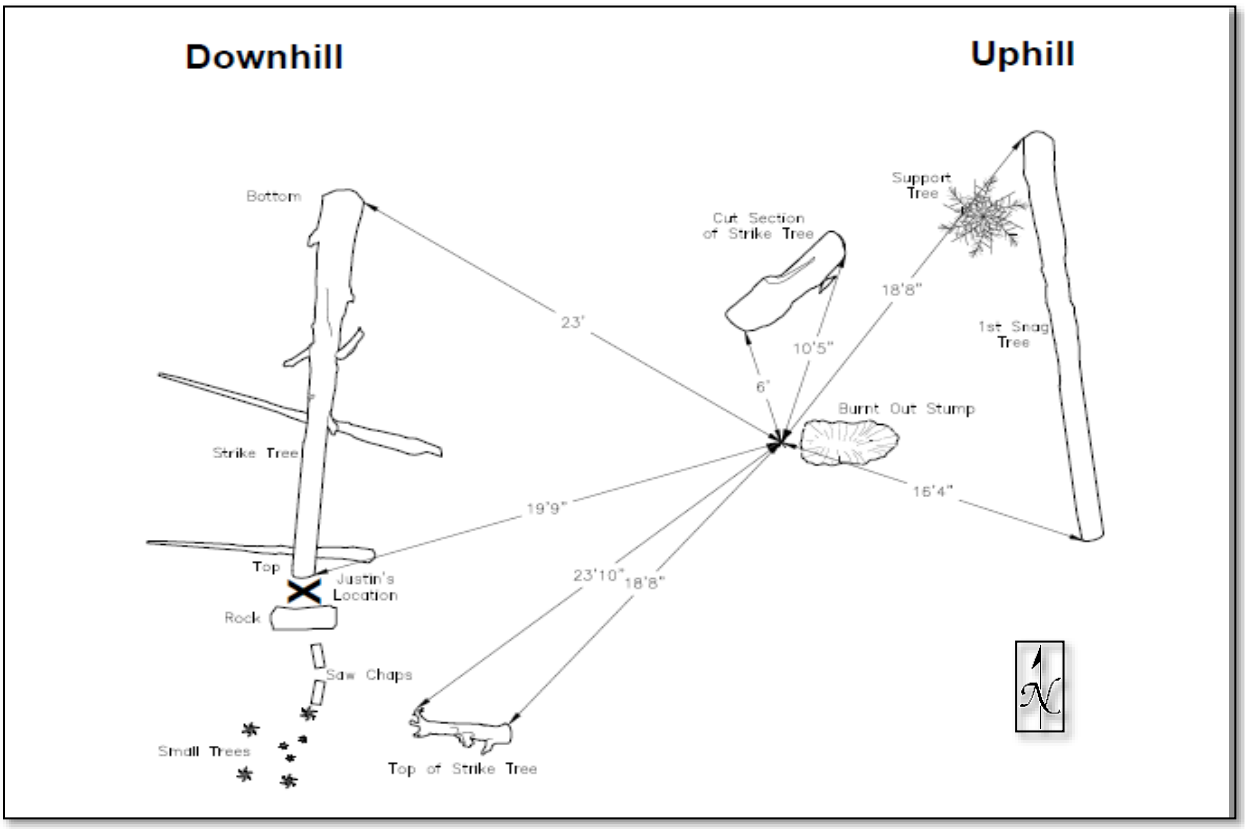

FIGURE A9: VIEW OF THE ACCIDENT SCENE LOOKING DIRECTLY DOWN FROM THE TOP. MEASUREMENTS COME FROM LAW ENFORCEMENT STARTING AT THE STUMP HOLE WHERE THE *STRIKE TREE* ORIGINATED AND SHOWING THE FINAL RESTING PLACE OF THE *STRIKE TREE*.

Appendix B: Detailed Timeline

This timeline has been pieced together using multiple sources (reports, crew logs, communications logs, interviews), which sometimes showed conflicting timestamps for the same event.

1600 – Medical emergency declared.

1600 – Sacramento IHC Sup requested Sac IHC EMTs report to scene.

1601 – Short-haul requested; Medivac (air ambulance requested).

1602 – Lolo IHC Saw Team 2 arrived on scene; tried to take pulse (indeterminate).

1605 – Lolo Superintendent and Sacramento Superintendent arrived on scene. Lolo Superintendent began to help with medical response.

1610 – Lolo Superintendent directed Sacramento Superintendent to assume Incident Commander (IC) role for the incident within an incident (IWI).

1610 – Three Sacramento EMTs and two Lolo IHC EMTs arrived on scene; first report that CPR is underway.

1611 – Division Alpha Supervisor (Advanced EMT) arrived on scene; took over direction of the medical response. Airway established with oropharyngeal airway (OPA).

1612 – IWI IC requested short-haul and air ambulance and delivered the Medical Incident Report (9-Line) of patient unconscious and urgent-red.

1615 – Lolo IHC crewmembers arrived on scene with trauma kit including bag valve mask (BVM), traverse rescue stretcher (TRS). Patient moved to more-level location nearby to continue medical response.

1620 – Line Medic 1 Tango (paramedic) arrived on scene with ALS drugs; began to administer them.

1622 – Air ambulance helicopter launched from Nephi, Utah.

1623 – H551 launched from Strawberry Helibase, rigged for rappel mission and equipped to follow up with short-haul.

1624 (approx.) – Line Medic 2 Tango (paramedic) arrived on scene.

1626 – H551 on scene, rigged for rappel mission to deliver two medical rescuers, did recon and prepped for rappel.

1632 – H551 aborted rappel mission due to unfavorable winds. H551 went to H1 to reconfigure for short-haul.

1635 (approx.) – Line Medic 3 Alpha (paramedic) arrived on scene.

1647 – MEDL contacted ER Physician at Hospital in Ely, NV; informed him of situation.

1647 (approx.) – Line Medic 4 Tango (EMT) arrived on scene.

1655 – H551 inserted two rescuers by short-haul to prepare patient for extraction.

1659 to 1716 – H551 rescuers continued packaging patient for short-haul extraction; patient was moved to nearby location for extraction.

1709 (approx.) – MEDL discussion with ER Physician regarding: (a) CPR has been underway for 40 minutes; (b) short-haul extraction means 10-15 minutes without CPR; (c) whether TOD should be called now; and (d) recommendation made to transport patient to helibase and then run an EKG.

1714 – Discussion between Medics on scene and MEDL relaying ER Physician discussion; concurrence by all to extract patient using short-haul.

1716 – H551 returned to scene; picked up two rescuers with patient; short-haul to H1.

1718 – Air Med 13 (Air Ambulance) landed at Strawberry Helibase.

1721 to 1727 – At H1, patient was transferred inside H551; CPR was restarted; H551 lifted off en route to Strawberry Helibase.

1731 – H551 landed at Strawberry Helibase. Patient remained onboard; air ambulance personnel ran EKG strip; no signs of life.

1746 – Patient death declared in consultation by telephone with ER Physician.

Appendix C: Helmet Report

The following report is based on interviews and visual examination of accident site photos and the helmet.

Helmet:

The helmet appears to be in serviceable condition at the time of the accident.

Make—Bullard Wildfire Series Fire Helmet
Model—FH911C
Date of Manufacture—November 2011
Certifications—NFPA 1977 Standard on Protective Clothing and Equipment for Wildland Firefighting, 2011 edition; ANSI/ISEA Z89.1-2009, Type I, Class E&G.

Shell Condition:

The helmet appears well used. There is no service date written on the helmet. It does not appear to be malformed as a result of impact. Scuffmarks are present, appear recent, and are most likely related to the impact of the tree. Two marks are located on the right front and brim of the helmet; one scuffmark is present on the left rear (Figure C1).

FIGURE C1: FRONT AND REAR VIEW OF HELMET SHOWING OUTER SHELL SURFACE SCUFFMARKS.

Suspension Condition:

The current condition of the helmet is consistent with that of a significant impact. The helmet has six (6) suspension keys that attach the suspension webbing to the helmet. These are designed to distribute the force of an impact over multiple points within the helmet. Five of the six keys are detached from their key slots, only the left side key remains in its key slot. The back right key is broken. Left side height adjustment tab is detached from its slot. The ratchet knob is missing. The helmet suspension webbing and stitching remain intact. (Figure C2)

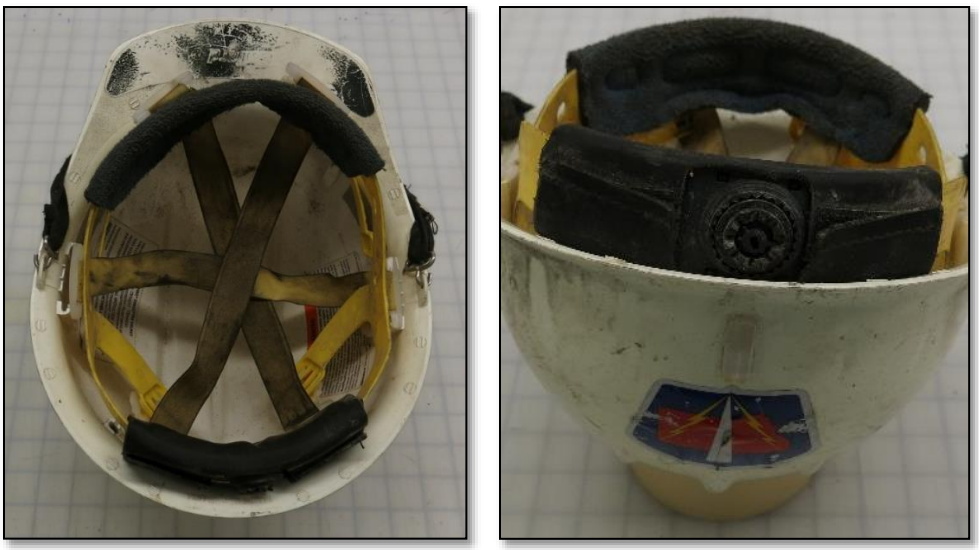

FIGURE C2: INSIDE VIEW OF HELMET SUSPENSION WITH DETACHED SUSPENSION KEYS. THE SUSPENSION RATCHET KNOB IS MISSING.

Helmet Protection Limitations:

Helmets that are certified to National Fire Protection Association (NFPA) 1977 "Standard on Protective Clothing and Equipment for Wildland Fire Fighting" and American National Standards Institute (ANSI) Z89.1 pass a battery of tests. Among those tests is the Force Transmission Test. This test emulates a brick falling one story onto a person's head. The test apparatus generates 54 joules of energy on impact to a helmet mounted on a head form. The head form contains a load cell that measures the energy transmitted to the spine. The pass/fail criteria for the test is an average value at the load cell that does not exceed 3780 Newtons (850 Pounds). Additional force is believed to cause vertebral damage. The impact of this tree was likely far greater than that, thus beyond the limitations of the helmet.

Suspension Damage:

It is not unusual for keys to become detached from key slots even during the standard test. However, detached keys do not constitute a failure of the test helmet. Detached keys can be compared to crumpled bumpers of vehicles subjected to impacts. Detached keys are a sign of significant impact. However, we could not quantify the actual total force that detached these keys.

Additional testing has been conducted in order to more fully understand helmet function when impacted with greater energy than the standard test requirements. With impact energy delivery of two to three times the standard energy, the force transmission can be tripled or even quadrupled, resulting in varying degrees of helmet suspension damage and far exceeding human spinal limitations. More research is needed to understand potential impact forces and any possible mitigation.