

# 2004-2019 Tree Felling Accident Analysis



**October 2019**



**Figure 1 – This "Word Cloud" was generated using the injury descriptors from the 53 incidents included in this analysis. The size of a word indicates its relative frequency.**

This *Tree Felling Accident Analysis* was completed by the Wildland Fire Lessons Learned Center (LLC) at the request of the Chief, NPS Fire and Aviation Management, and Director, USDA Forest Service Fire and Aviation Management. This report is one of nine actions specified in the 2019 Hughes Fatality Joint Corrective Action Plan. The corrective action that generated this report reads: *"Propose all wildland fire tree and chainsaw related accident reports since 2004 be reviewed, associated recommendations evaluated for redundancy or conflict, and the current implementation status of recommendations to assist in setting priority actions to reduce similar incidents."* The LLC produced this report as requested, explaining "it is important to note that the vast majority of 'recommendations' listed in reports are aimed at individual firefighters or local organizations. There is no practical way to track down any sort of 'implementation status' on these types of recommendations."

Both the Chief, NPS Fire and Aviation Management and Director, USDA Forest Service Fire and Aviation Management, are in agreement and accept that this *Tree Felling Accident Analysis* meets the intent of action tasked to the LLC.

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# 1. Background

This report is the part of the [Hughes Fatality Corrective Action Plan](#). This Background section describes the tasking for this analysis from the Corrective Action.

**Table 1 – The “Business Need,” “Project Objectives,” and “Parameters” from the Hughes Fatality Corrective Action Plan.**

<b>Business Need</b>	Serious injury and death from incidents related to trees and/or chainsaws are a near yearly occurrence within the wildland fire community. As part of the Corrective Action Plan stemming from the death of Captain Brian Hughes, the National Park Service Chief of Fire and Aviation and the United States Forest Service Director of Fire and Aviation recognized the need to evaluate past accident reports in an attempt to reduce the chances of similar accidents occurring again.
<b>Project Objectives</b>	The overall objective is to reduce chainsaw operator injuries and fatalities. To aid in this objective this project will review all wildland fire tree felling related accident reports and associated recommendations since 2004 in order to accomplish the following: <ol style="list-style-type: none"><li>1. Identify recommendations across reports that are similar;</li><li>2. Identify recommendations across reports that conflict;</li><li>3. Where possible, determine implementation status of recommendations;</li><li>4. Determine similarities between incidents and highlight problem areas that are not identified in recommendations;</li><li>5. Report on any findings that may increase the margin of safety in relation to tree felling operations.</li></ol>
<b>Parameters</b>	<ol style="list-style-type: none"><li>1. Only review reports where any component of a tree felling operation was underway to include size up, lay prep, and cutting operations.</li><li>2. Any mechanism of felling operation is included.</li><li>3. Chainsaw fueling is not a component of this review.</li><li>4. Do not review “struck by” incidents where a felling operation was not underway, i.e. limbs falling after a bucket drop, etc.</li></ol>

## 2. Introduction

The information in this report comes from documented tree felling incidents meeting the criteria outlined in the parameters above.

- Incident reports come from various agencies.
- These incidents occurred from 2004 through October 2019.
- The dataset includes 53 incidents.

These incident reports are available from the Wildland Fire Lessons Learned Center’s (LCC) [Incident Review Database](#).

Specific to Project Objective 3 “where possible, determine implementation status of recommendations” it is important to note that the vast majority of “recommendations” listed in reports are aimed at individual firefighters or local organizations. There is no practical way to track down any sort of “implementation status” on these types of recommendations.

In only four instances (Grant West, Dutch Creek, Strawberry, and Ferguson) are there specific recommendations including responsible parties and due dates. Tracking the status of those recommendations is beyond the expertise/capacity of the LLC. It is suggested this task be completed in a separate effort.

### 3. Intent

The intent is for this report to provide context around the conditions present when those in our workforce are injured or killed in the process of falling trees. To the extent possible, we aim to identify focus areas for continued efforts related to safer work practices. Recommendations are often (but not always) included as part of incident reports. With this effort we seek to identify themes surrounding those recommendations. We will identify both commonalities and conflicts when comparing incident condition and recommendations. All of these efforts are intended to inform and improve existing and future efforts related to tree felling in the wildland fire service.

### 4. Comparison of Tree Accident Reports

The following themes are identified and discussed in this section:

#### A. The Tree

- Tree Falling as Intended
- Predicting Tree Reactions
- Hung-Up Trees

#### B. Hazard/Risk Mitigation

- Helmets
- Two People at the Base
- Area Control
- Escape Routes

#### C. Training

- Accidents During Training
- Improving/Altering Training

### A. The Tree

#### *Did the Tree Fall as Intended?*

**53% of the time, the tree fell in the intended direction.**

It is often assumed that most tree falling accidents occur when a tree does not fall in the intended direction.

This is a significant finding to consider when evaluating recommendations related to improving directional falling skills such as lining-up face cuts and leaving proper holding wood. Efforts focused on improving directional falling skills would not address **half** of the conditions related to individuals being struck by trees

during falling operations. Recommendations related to improving work area control, risk assessment, and tree conditions would get closer to addressing factors involved in these instances.

So how did people get struck in these instances?

#### **The Tree Hung-Up**

- 8 instances of felled tree getting hung-up—the tree strike occurring in the process of cutting hung tree.

#### **Workers in the Fall Area**

- 6 instances of workers in the fall area struck by felled tree.

#### **Portions of the Felled Tree**

- 5 instances in which top broke out came back.
- 2 instances of a limb falling from tree being cut.
- 2 instances in which the butt end or entire tree came back.

#### **Separate Tree (other than felled tree)**

- 3 instances of being struck by separate tree after felled tree hit the ground.
- 2 instances of being struck by a limb or top from separate tree.

#### **Unexpected Fall Direction**

Also of note, the tree falling in an unexpected direction only accounted for 30% of the tree strike instances.

Expected 53% + Unexpected 30% = **83%**

The remaining 17% of accidents occurred primarily in the following ways:

- Limbs or top falling during size-up and preparation (no cutting taking place).
- Limbs or top falling during cutting operations (prior to tree falling).

These instances took place with recent or active fire in the tree.

### ***Predicting Tree Reactions***

**28% of the time, the tree impacted another tree during its fall—including 2 of the 8 fatalities.**

In the instances reviewed, trees being felled often came into contact with other trees as they fell.

This percentage alone is not really significant. However, the difference between the predicted falling sequence and the chain of events that actually occurs is significant. Often, the expectation is that the felled tree would “push through” the branches of another tree. Instead, what often occurs is:

- The top breaks out and comes back.
- The felled tree gets hung-up.

- The butt end bounces or swings back toward the stump.

The top of the felled tree broke out and came back in 10 instances.

- 6 times the top of tree broke as it contacted other trees.
- 4 times the tree was hung-up when the top broke out.

Also of note, in 7 of these 10 instances, the sawyer was struck in their escape route.

**19% of the time, the top broke out and came back—including 2 of the 8 fatalities.**



*Figure 2 – This tree fell in the direction intended, but the top broke and came back. To read about this incident, see this report [Whitewater Tree Strike](#).*

**Of all the reports that included recommendations, 21% of the reports recommended enhancing training related to tree conditions (like rot) and species-specific traits.**

## ***Fatalities***

This dataset included eight fatal incidents:

- [Grant West Prescribed Fire Fatality](#)—2004
- [Volusia County Fire Training Incident](#)—2007
- [Dutch Creek Tree Felling Fatality](#)—2008
- [Freeman Reservoir Fatality](#)—2009
- [Incident 398 Tree Strike Fatality](#)—2013
- [Strawberry Fire Tree Strike Fatality](#)—2016
- [Lolo Peak Fire Tree Strike Fatality](#)—2017
- [Ferguson Fire Tree Strike Fatality](#)—2018

The average is one fatality every two years.

## ***Hung-Up Trees***

**19% of the time, the sawyer was working on a hung-up tree—  
including two of the eight fatalities.**

Several reports addressed the complexity of hung-up trees and made associated recommendations.

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### **Specific Recommendations**

*“Provide additional training for cutting hung trees in the S-212 curriculum or in the Advanced Feller courses...*

*Emphasize the size-up process of cutting a hung tree, including the evaluation of escape routes.”*

### **[Strawberry Fire Fatality Learning Review](#)**

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In these reports, much of the discussion around hung-up trees revolves around two major points:

- Hung-up trees require a specific skillset different from standard tree size-up and complexity analysis.
- The commonly held attitude around “once you put a saw in the tree, you have to get it on the ground” may hamper our ability to accurately assess hung-up trees.



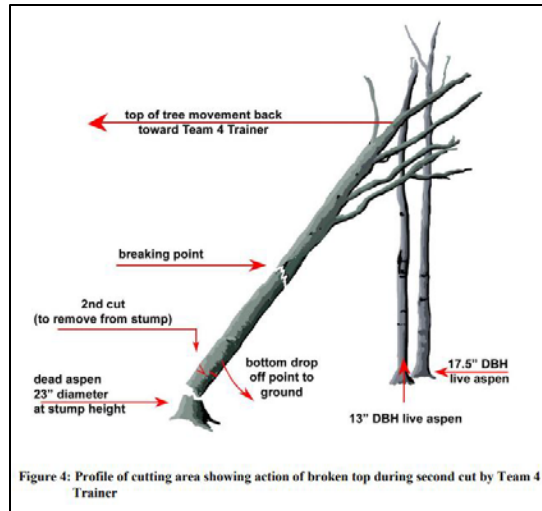


Figure 3 –Tree diagram from the [Freeman Reservoir Fatality Report](#).

### Example Discussion

*“However, we need to remember that it is very possible for felling situations to start out as a very simple operation that can go slightly awry and, thus, radically elevate the complexity. This calls for an entirely new evaluation, the result of which may be outside the skill or comfort level of the faller.*

*We need to be aware of the culture of ‘completeness’ that exists on the fire line—whereby the spirit of ‘finishing the job’ often times pushes sawyers out of their comfort zone to get a hung tree to the ground—to ‘erase’ the ‘mistake.’”*

*Our ranks must be able to temper the overwhelming urge to rush in to put that hung tree down onto the ground. The tree’s change in position/condition may have radically elevated the complexity far beyond our experience/qualifications.”*

### [Gap Fire Tree Strike](#)

**“You can’t leave a tree alone once you’ve put a saw in it.”**

**Quote from faller struck by tree.**

**[Faller Hit by Tree Shrapnel RLS](#)**

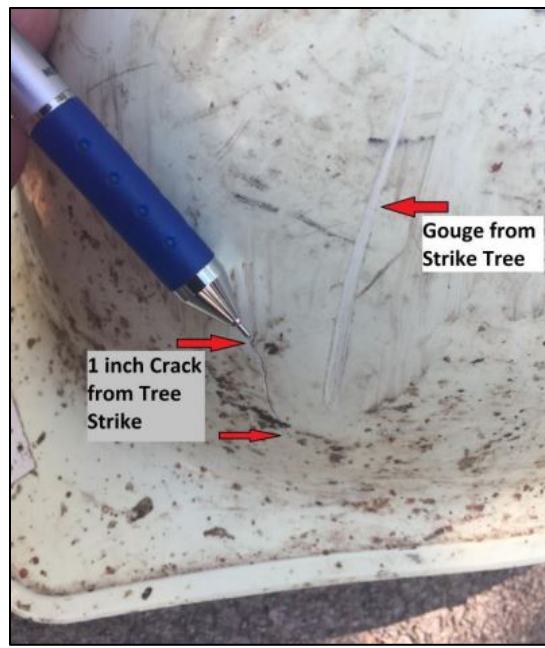
## B. Hazard/Risk Mitigation

### *Helmets*

**51% of the time, the incident involved a direct helmet strike.**

Helmets are mentioned in over half of the accident reports.

Several of the reports included statements from those struck, such as: “My hard hat saved my life” or “My PPE did what it is designed to do.”



*Figure 4 – Helmet damage photo from the [Jade Creek Fire Tree Strike RLS](#).*

The frequency of our helmets getting struck by trees is also significant when considering some of the repeated recommendations.

**Of the reports that include recommendations, 24% recommended research and development related to wildland fire helmets.**

This tends to support the notion that we as a community want to know if there are helmets in existence (or ones that could be developed) better suited to the conditions faced by wildland firefighters.

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

Recommendation from the [Strawberry Fire Fatality Learning Review](#)

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### ***How Many Under the Tree?***

**42% of the time, the person struck was not cutting—including in 5 of the 8 fatalities.**

An often debated topic is the practice of having more than one person at or near the base of the tree during falling operations.

Of the instances where someone other than the chainsaw operator was struck during falling operations, three categories existed:

- In 10 instances the tree struck a person at or near the base of the tree (swamper or trainer).
- In 8 instances the tree struck a person in the work area but not involved with the felling.
- In 4 instances the tree or a portion of it fell during size-up or preparation, hitting a person involved with the felling operation.

Few reports directly tackled the topic of having multiple people at the base of the tree. When this was mentioned, it was talked about as part of risk assessments, such as the following:

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#### ***Deliberate Decisions Must Be Made***

*“Agencies and contractors vary in their policies/requirements regarding preferences for using one or two people at the stump while falling. Serious consideration needs to be given for each tree. Certain situations may be unsafe to have both people near the stump during the back cut. Other situations may see enhanced safety by having two people there. Each situation needs to be thought out. Deliberate decisions must be made. Especially when in acknowledged ‘high risk’ situations, keep all unnecessary personnel well back from the falling area.”*

#### **Faller Hit by Tree Shrapnel**

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Several reports mention the need for consistency in NWCG-sponsored saw training as well as increased emphasis on risk assessment.

Either way, the numbers suggest careful consideration of the benefit vs increased exposure of another person present at the base of a tree felling effort.

## ***Safe Distance Compliance (Area Control)***

**24% of the reports recommended somehow improving safe work distance and compliance.**

There were 9 instances of individuals being struck by trees while working within the fall zone.

- In 6 instances the tree fell as intended.
- In 3 instances the tree fell in an unintended direction.

In either scenario, reports recommend improving work area control through:

- Improved risk assessment training.
- Standardizing guidance or policy.

Several reports acknowledged the dilemma regarding production (efficiency) as well as complacency or “risk creep.” Most reports repeated well known standards of “2½ tree lengths” and “the faller must control the area.”

## ***Escape Routes***

**40% of the time, the person struck was *in* the traditional escape route—including in 5 of the 8 fatalities.**

The traditional tree felling escape routes are at 45-degree angles away from the intended falling direction.

These 21 instances were primarily occasions where the tree did not fall in the intended direction. This brings up the notion that tree felling escape routes are designed for when things go according to plan. Arguably, when escape routes are most needed (when the tree falls in an unintended direction) traditional escape route use may not be as reliable as we presume.

Twelve different reports address escape routes directly. Recommendations typically fell into two categories:

- ***Before escaping*** the stump, take time to **confirm the direction** the tree is falling—then decide which way to go.
- **Prioritize quick escape** along traditional pre-determined routes to safe areas (refuge trees).

**Recommendations related to escape routes included directly conflicting guidance.**

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*“...take the extra couple of seconds to make sure you know the direction the tree is committing itself to, then escape.” [Crystal Lake Tree Felling](#)*

*“...get away from the stump as fast as you possibly can.” [Whitewater Tree Strike](#)*

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**The [Lolo Peak Fatality Field Report](#) takes on the Escape Route dilemma most directly:**

“The practice of utilizing 45-degree escape routes was developed under the assumption that everything goes according to the plan, allowing a Sawyer to safely move away from a tree and avoid any kickback that might occur. However, if a tree fails to fall in the intended direction, it is falling in an unpredicted manner, making it almost impossible to pre-plan a suitable escape route.

In focus group discussions with subject-matter experts, it was recognized that it is not always in a Sawyer’s best interest to limit themselves to these two escape routes. Limiting the number of escape routes may reduce the margin for success. The reality is, tree felling is dynamic and ultimately requires more flexibility to escape a falling tree than two escape routes afford.

1. Is it a possibility that the accepted strategy of defining two escape routes at 45-degree angles from a Sawyer’s location provides a false sense of security to the Sawyer?

Habitual training influences action taken during a ‘fight or flight’ response such that people often resort to the training practices they have received or practiced most frequently. In most cases, that training will yield successful outcomes, reinforcing its use the next time. However, there will be times in a Sawyer’s experience where their training does not match the situation being faced.

2. What are the trade-offs of training people to engage in routine behavior vs. training them to assess things in the moment (pre-planned escape routes vs. assessing the tree’s falling direction before deciding on an escape route)?”

### ***Improving Risk Assessment***

**79% of the reports recommended improving risk assessment.**

Operational recommendations were primarily aimed at two groups:

- Supervisors/Overhead
- Fallers

Recommendations aimed at overhead focused on risk analysis of falling assignments relative to the overall mission (reducing exposure).

**Two questions from the [Lolo Peak Organizational Learning Report](#)**

1. How can we address the perceived cultural “need” for Hotshot Crews to “stay busy” and feel useful when they have completed an assignment, especially when another assignment has not yet been identified?

2. Have you ever given a Hotshot Crew a tree felling assignment that you wouldn't have given to an Engine crew or Type 2 Crew just because they have more experience? If so, does utilizing a more specialized crew actually reduce the exposure to risk?

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**Recommendations aimed at fallers' focused risk analysis as it relates to individual tree size up:**

*"Consider the species of tree in the size-up process and how the species will potentially affect the falling operation (i.e. oak trees are relatively heavy and have more brittle wood)."*

**Remote Area Falling Accident**

*"When a brittle tree is felled into another tree it can snap off. The pieces can fly back in the direction of the sawyer. If this is likely to happen, a 'No Go' decision may be appropriate."*

**Faller Hit by Tree Shrapnel**

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Organizational recommendations called for more focus, training, and a standardized process related to risk assessment.

**Recommendations from the Strawberry Fire Fatality Learning Review**

*"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 U.S. 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 U.S. Forest Service guidance on saw operation complexity for use in Service or across agencies."*

## **C. Training**

### ***Accidents During Training***

**13% of the time, the tree strike happened during training—  
including in 2 of the 8 fatalities.**

Seven of the recorded tree strikes occurring during training. Of these 7 training incidents:

- Two resulted in the trainer being struck in the escape route as the tree back fell.
- In three instances, workers in the falling area were struck while a sawyer trainee was cutting.
- Only one instance resulted in the sawyer trainee being struck.

- In one instance, the trainer took the saw to finish a cut started by the trainee. The tree hung-up and the trainer was struck while cutting out the hung-up tree.

Recommendations from these incidents focused on awareness of the potential for elevated risk during training and having proper medical plans in place. This again brings up the exposure involved with multiple personnel at the base of a tree.

### ***Improving/Altering Training***

**26% of the reports recommended improving faller training.**

Most of the lessons, advice, and recommendations captured in these reports are aimed at individual sawyers rather than agencies or oversight entities.

Reports that did have training recommendations focused on a single new course or updating existing training.

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#### **Recommendations from the [Ferguson Tree Strike Fatality](#)**

*“Propose to NWCG the development of an Advanced Wildland Fire Chain Saws training course...”*

*“...conduct an evaluation of the ‘Forest Service Chainsaw, Crosscut Saw and Axe Training-Developing a Thinking Sawyer’ course for applicability within the interagency community as an updated NWCG S-212, Wildfire Chain Saws, course.”*

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**21% of the reports recommended enhancing training related to tree conditions (like rot) and species-specific traits.**

Missing from the recommendations was any mention of a comprehensive curriculum overhaul resulting in a new series. Trying to incorporate all the lessons and recommendations from these reports would likely take this level of reorganization. This might look similar to the existing Leadership Curriculum (L-Series). It might also require continuing education.

Given the frequency of tree felling operations and the catastrophic nature of tree felling accidents, considering this approach may be warranted.

## 5. Access to the 53 Tree Accident Reports from 2004-2019

This section provides a list of the 53 accident incident reports used in this analysis and their dates. Embedded hyperlinks are provided to the reports.

- [Grant West Prescribed Fire Fatality](#)–10/2/2004
- [Missouri Ridge WFU](#)–9/6/2005
- [Rombo Fire](#)–8/14/2007
- [Volusia County Fire Training Incident](#)–11/27/2007
- [Dutch Creek Tree Felling Fatality](#)–7/25/2008
- [Camel Hump Falling Incident](#)–7/25/2008
- [Lime Complex Tree Incident](#)–7/26/2008
- [Rattle Fire Snag Incident](#)–9/10/2008
- [Freeman Reservoir Fatality](#)–6/26/2009
- [Little Grass Valley](#)–8/17/2009
- [Lynn Hollow Tree Incident](#)–11/7/2009
- [Dark Ridge Tree Felling Incident](#)–11/29/2009
- [Crandall Tree Felling](#)–9/14/2010
- [Buckhorn](#)–2/4/2011
- [Chittenden](#)–4/22/2011
- [Tree Falling Injury](#)–8/1/2011
- [Snow Gate](#)–8/25/2011
- [Crystal Lake Felling](#)–9/26/2011
- [Lockhead Felling Incident](#)–3/20/2012
- [Sunflower Felling](#)–6/6/2012
- [Chips Tree Felling Injury](#)–8/20/2012
- [Waterfalls 2](#)–9/1/2012
- [398 Tree Fatality](#)–8/1/2013
- [Bramblewood Fire Tree](#)–10/1/2013
- [Stanza Tree Strike](#)–1/25/2014
- [Quaking fire snag](#)–7/24/2014
- [Tree Shrapnel Injury](#)–8/9/2014
- [Bald Sister Fire Tree Strike](#)–8/14/2014
- [790 Fire Tree Strike](#)–9/2/2014
- [Kisatchie NF Tree Strike](#)–2/26/2015
- [Pine Fire Tree Strike](#)–8/10/2015
- [Remote Area Felling](#)–3/2/2016
- [RX Tree Strike RLS](#)–4/6/2016
- [Chamberlain Felling Injury](#)–7/1/2016
- [Strawberry Fire Tree Strike Fatality](#)–8/13/2016
- [Soberanes Fire Tree Felling Injury](#)–8/18/2016
- [Gap Fire Tree Strike](#)–9/7/2016
- [Fire Captain Hit by Tree](#)–10/11/2016
- [Prescribed Fire Tree Cutting Injury](#)–3/13/2017



- [Devils Lake Fire Hit by Tree](#) –8/1/2017
- [Lolo Peak Fire Tree Strike Fatality](#)–8/2/2017
- [Minerva Fire Hit by Tree](#)–8/4/2017
- [Jade Creek Fire Tree Strike](#) –9/2/2017
- [Whitewater Fire Faller Hit by Tree Top](#)–9/3/2017
- [Kelsey/Jones Fire Faller Hit by Branch](#) –9/23/2017
- [Toms Mill Fire Hit by Tree](#) –12/9/2017
- [377 Fire Falling Accident](#)–6/6/2018
- [Taylor Fire Hit by Tree](#)–7/22/2018
- [Ferguson Fire Tree Strike Fatality](#) –7/29/2018
- [Taylor Creek Fire Felling Incident](#)–7/29/2018
- [McLeod Fire Hit by Tree Top](#)–9/3/2018
- [204 Cow Fire](#)–8/29/2019
- [Lime Fire Hoist](#)–9/13/2019