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Final Close-Out Report

Enhancing Efficiency in Poudre Fire Authority's Wildland Urban Interface Operations

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Executive Summary

As fires and values at risk in the wildland-urban interface (WUI) have grown, so have Poudre Fire Authority's (PFA) training and capabilities in the wildland arena. The number of WUI fires receiving multiple unit responses has dramatically increased in the last decade. To meet the evolving demands of the WUI, time and resources must be carefully managed. To that end, this study seeks to:

1) Identify the best practical method for determining fire danger in PFA's district
2) Identify areas for improvement in PFA's WUI response
3) Develop the means to model potential fire behavior under severe case conditions
4) Identify potential options for improving PFA's WUI response

The findings of this study are based on interviews with PFA personnel, PFA case studies, analysis of fire and weather records, and GIS based fire behavior modeling.

A number of potential initiatives are briefly outlined. They are designed to reduce the impact of WUI fires on the rest of the system and include:

1) Use of a fire danger rating system
2) Preparedness and proactive staffing
3) Standardized wildland fire response
4) Clear benchmarks for returning on-shift crews to the system
5) Use of on-call wildland assistants
6) WUI preplans

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1. INTRODUCTION

1.1 Purpose of this Study

An increase in building of residences in the wildland-urban interface (WUI) has coincided with a period of relatively dry climatic conditions over the last decade. This corresponds with an increase in the number of wildland and WUI fires that have required multiple units to respond. As the demand for Poudre Fire Authority (PFA) to respond on these incidents has increased, so have issues regarding readiness, response, and system coverage.

The goal of this study is to develop a foundation for guiding proactive planning, preparedness and response to enhance the cost effectiveness and service level in the WUI. The ultimate intention is improved performance at a reduced strain to other PFA operations.

Objectives:
1) Identify best practical methods for determining fire danger in PFA's district.
2) Identify areas for improvement in PFA's wildland/WUI response.
3) Develop the means to model potential fire behavior under severe case conditions.
4) Identify potential options for improving PFA's wildland WUI response.

1.2 Background

Poudre Fire Authority (PFA) has been in the business of fighting WUI fires since its inception. In any given year, PFA can expect to see over 20% of its fire calls reported as wildland. The department's progressive nature was reflected in the creation of the wildland fire out-of-district team in early 1990's and the wildland-urban interface team in the late 1990's. These teams play a crucial role in ensuring safe and proficient service in the WUI through training and preparation. Fires that challenge initial attack, especially those that grow into type III incidents, demand increased attention.

The year 2000 was a watershed for wildland fire management throughout the nation and PFA was no exception. In April, PFA responded to the Davis Ranch Fire that scorched 125 acres at a cost approaching $1000 an acre. PFA was involved from start to finish in the 10,600 acre Bobcat fire which cost over $3,000,000 (Hubbard, 2001).

Following the nationally catastrophic 2000 fire season, the federal government created a National Fire Plan and revamped its fire policy. The Colorado State Forest Service penned a report to the governor on WUI which sited as its number one recommendation, "strengthen local capacity in wildland fire preparedness, suppression, and mitigation (Hubbard, 2001)." PFA responded by making the wildland "red card" mandatory for all of its firefighters and increasing its readiness for extended incidents.

1.3 Fire Occurrence Profile

This data consists of those fires reported as burning in grass, shrubs, forest, or other vegetation. The terms "vegetation fire" and "wildland fire" are used interchangeably. This study defines fires with a response of over three units or over eight firefighters as "class 2," while fires with over five units responding are termed "class 3." Fires with less than three responding units or eight or less firefighters would be considered "class 1" fires and are not emphasized in this study.

In the examination of multiple unit fires, incidents occurring in PFA's urban center are excluded. The intent is to focus on those fires with the true characteristics and growth potential of wildfire. This will also help eliminate structure responses to otherwise small and innocuous vegetation fires. The reason

for using the number of responding units is partly to serve as a proxy for acreage, which PFA has only recently been tracking. The number of responding units may also be a truer measure of a fire's impact on the fire department's system as a whole.

Several data gaps exist. All records for 1992 are missing. Monthly records for 1997 are missing. Fire records for 2000 only went through-mid June. Comparing 2000 with other years, an estimate for total fires in 2000 was generated. With the missing data from 1992 and 2000, figures for "large" fires fall short of their actual occurrence.

With an average of 135 vegetation fires per year in for the last decade, wildland fires represent a significant portion of PFA's fire calls.

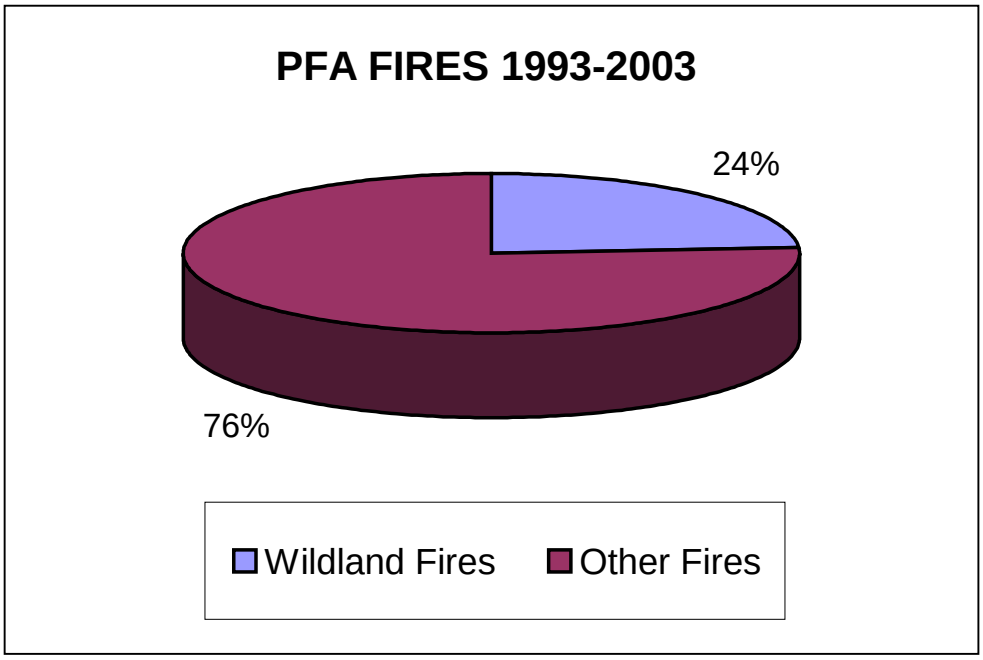


Figure 1.1 Wildland fires comprise a significant portion of PFA's total fire call load.

Reviewing a 2002 study that considered data from 1986 through 1999, one immediately sees the bimodal distribution of distinct spring and summer fire seasons.

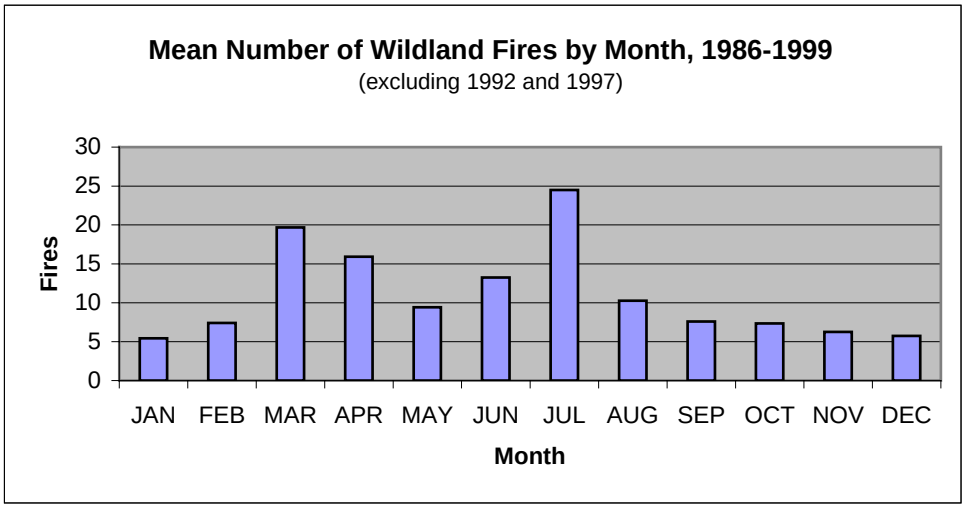


Figure 1.2 Wildland fires show a bimodal distribution, peaking in March and again in July.

When considering multiple unit fires outside of PFA's urban area, one sees a similar two season distribution. When examining only the larger class 3 fires the spring season is much less distinct.

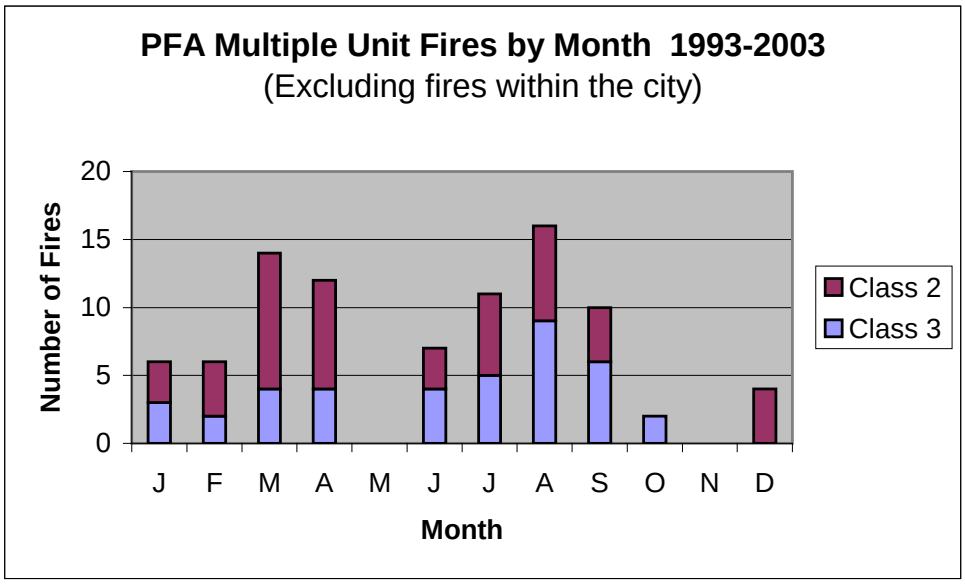


Figure 1.3 The two categories of multiple unit fires displayed by month.

When charting all fire business over time, neither structure fires nor vegetation fires display any independent trend over the last decade.

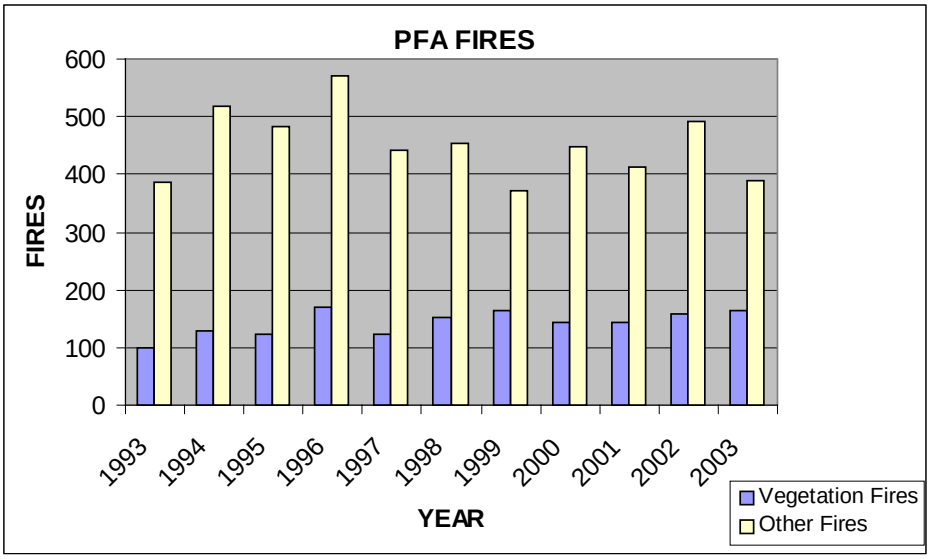


Figure 1.4 Neither wildland fires or other fires display a distinct independent trend over the last decade.

In contrast, one can see an increase in multiple unit vegetation or wildland fires. This is especially noteworthy where fires with over eight units responding are involved. (1997 is missing detailed data, 2000 is underreported)

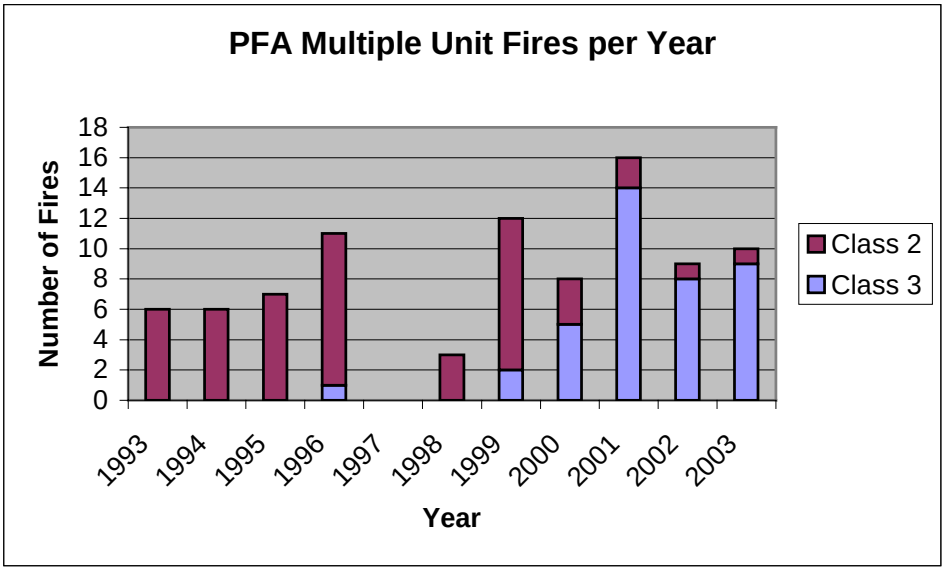


Figure 1.5 Multiple unit responses to PFA wildland fires have generally increased over the last decade. 2000 is underreported.

1.4 Analysis of Wildland Fire Occurrence

Wildland fires in PFA's district generally occur in distinct summer and spring seasons. While total wildland fire occurrence has not increased over the last decade, fires with multiple units responding have seen an overall rise. Whether this is as a result of changes in fire behavior or in response protocols is undetermined, but it does represent an increased impact to PFA's system.

2. FIRE DANGER RATING

The federal fire services compare historic climatic conditions and fire occurrence and growth to aid in establishing a "most efficient level" (MEL) of funding. The National Fire Danger Rating System (NFDRS) is used to help determine staffing levels, response levels, and fire restrictions. The danger rating employed by the local USFS district is intended for use at higher elevations and more forested conditions than much of PFA's district. It is also only operational during the typical fire season for those areas, missing PFA's second busiest WUI fire month.

2.1 Methods

Fire Family Plus is a standard computer program used to analyze historic fire and weather data. In an extremely time consuming process, PFA fire records were converted for use in this program. Weather data from the Redstone Canyon weather station was then imported. Unlike the federal agencies which only catalogue weather data for the summer fire season, PFA has recorded year round data. Logistic regression and the chi-square goodness-of-fit test are among the statistical tools that the program uses to determine the best fire danger index. Fire Family Plus also has features to aid in setting staffing and response levels dependent on the chosen index.

2.2 Fire Danger Rating System

The USFS uses energy release component (ERC) as a measure of fire danger. Rather than assuming that this was the best indicator for fire danger in PFA's jurisdiction, fire family plus was used to ferret out the best match. The 2002 study found that the 10 hour fuel moisture was the best measure for overall vegetation fire occurrence. As 10 hour fuels dry to 8%, the probability of a fire is about 25%. Once the 10 hour fuel moisture is below 6%, there is a 50% chance of fire occurrence (figure 2.1).

When considering only the multiple unit fires outside of the city, 10 hour fuel moisture was a good indicator for the summer season, but 1000 hour fuel moisture was the best year round index (table 2.1). It should be noted that the data set for multiple unit fires is small and therefore can be significantly affected by inconsistencies in record keeping. Nevertheless, case studies illustrate that the statistical findings have empirical merit.

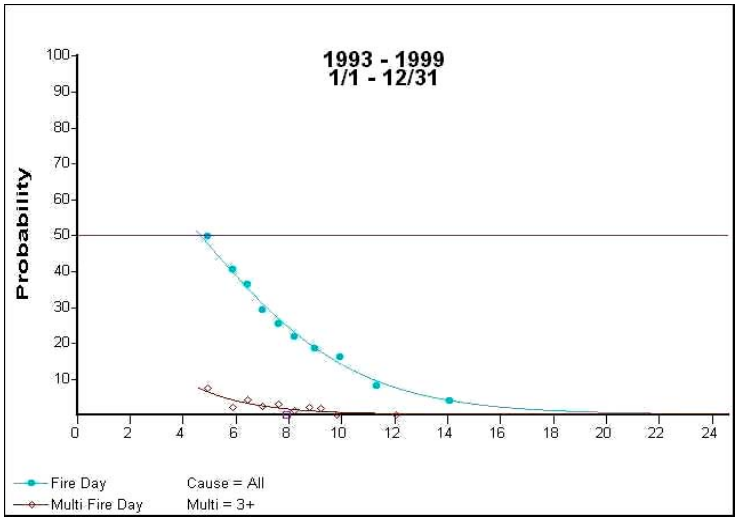


Figure 2.1 Probability of fire occurrence vs. 10 hr fuel moisture for all PFA fires. As the 10 hr fuel moisture drops to 5%, probability of a wildland fire approaches 50%.

	Years	Fire Days	R^2	X^2	p-value
10 hr all fires	86-99	453	0.97	0.85	4.1
1000 hr, class 2&3 fires	93-03	77	0.93	2.9	0.94
1000 hr, class 3 fires	93-03	36	0.92	3.8	0.80
10 hr class 2&3 fires Summer	93-03	77	0.93	1.8	0.94
10 hr class 3 fires Summer	93-03	36	0.93	1.6	0.82

Table 2.1 1000 hr fuel moisture proved the best statistical fit as an overall fire danger index for multiple unit wildland fires in PFA's district.

Fire Family Plus can help break a climatic indicator into levels (usually five) of severity to help gauge fire danger. Prior to examining case studies, Fire Family Plus was used to help set thresholds for these levels. The subsequent examination of five significant fires revealed a general consistency with these levels.

Fire Danger Level	1000 hr fuel moisture	10 hr fuel moisture
1	39%	28%
2	20%	22%
3	15%	12%
4	11%	6%
5	8%	4%

Table 2.2 Fire Family Plus was used to set sample fire danger levels based on 1000 hr and 10 hr fuel moistures.

Another valuable indicator of high fire danger is the red flag warning. According to National Weather Service records, there were 49 red flag warning days from 1993 through 2003 in PFA's area. PFA had fires on 49% of these days, with multiple fires on 20% and class 2 or 3 fires on 12% of these warning days.

2.3 Analysis of Fire Danger Rating

PFA does not currently employ a fire danger rating system in a consistent proactive manner. In the future, response or staffing levels may be based on the subjective discretion of the battalion chief, the USFS fire danger rating when available, red flag warnings, or a set of indices specific to PFA. 10 hr and 1000 hr fuel moisture showed the strongest statistical correlation to fire occurrence in the district. This information can be rapidly available from the Redstone Canyon weather station. An example of a customized high fire danger threshold might be when 1000 hr fuel moisture are below 11% and gusty winds or dry lightning are predicted.

3. CASE STUDIES

PFA has a solid safety and performance record on wildland fires. Nevertheless, it is incumbent upon the department to glean lessons from each incident, the more salient of which are discussed below. These case summaries are based on fire reports and interviews with battalion chiefs, officers, and firefighters who responded to these incidents. It should be noted that these incidents were predominantly mutual aid outside of PFA's district. They were selected for their instructional value and their threat to structures.

Four out of five of these incidents had 1000 hr fuel moistures that fall into the extreme category set by the Fire Family Plus decision point tool. The same is true for 10 hr fuel moistures, and every fire had at least one of the fuel moistures in the extreme category.

3.1 Summary of Case Studies

Davis Ranch Fire

Date: April 26-28, 2000	Max Temp: 75 F	1000hr: 11%
PFA Units: 4 (estimated)	Max Wind: 5-7 mph	10 hr: 4%
Acreage: 125	Fuel Models: 9, 10	Min RH: 9-14%

The Davis Ranch Fire (a.k.a. Buckhorn-Davis Ranch) of April 2000 illustrated the need to be able to respond to wildland fires outside of the "normal" fire season. Likewise, PFA requires the ability to independently assess fire danger during times of the year when the United States Forest Service (USFS) has shut down its prediction services.

Lessons
1) There is a need for PFA to be able to anticipate and respond to forest fires during the spring, prior to the standard "fire season."

Bobcat Gulch Fire

Date: June 12-19, 2000	Max Temp: 78-81 F	1000hr: 8%
PFA Units: 15 estimated	Max Wind: 10-15 mph	10hr: 2%
Acreage: 10,599	Fuel Models: 9, 10	Min RH: 15%

Bobcat Gulch was PFA's first experience with an incident escaping initial attack and growing to a type I incident. The department's maximum ability to aid cooperators was tested over these six days. Out of this incident grew the push to cross-train every PFA firefighter in wildland firefighting. Overnight packs were put together for station 7 units to allow personnel to remain on an incident for extended periods when needed. Attempts were made to standardize PFA's response and ability to replace on-shift crews with wildland team members. Glitches in this system continue to impact the department.

Lessons
1) Large fires burning from the west into PFA's jurisdiction pose a significant potential threat.
2) All PFA firefighters should be red carded as wildland firefighters.
3) PFA should have a consistent and reliable system for relieving on-shift crews with wildland team members for extended incidents.

Weaver Ranch Fire

Date: October 31, 2001	Max Temp: 61-70 F	1000hr: 7%
PFA Units: 15	Max Wind: 34-60 mph	10hr: 5%
Acreage: 1200+	Fuel Models: 1, 3, 5	Min RH: 34%

This incident was a grass and brush fire driven by extreme winds. PFA responded on this mutual aid fire with Wellington FPD as Larimer County units responded to a separate fire in the southern part of the county. This is perhaps the best documented of PFA's wildland fires, with an after action review highlighting the following:

Lessons:
1) Resource staging and deployment must be better coordinated.
2) PFA personnel must have the proper PPE.
3) Radio communication must be coordinated and issues with 800 MHz vs. VHF for mutual aid response resolved.
4) PFA still lacked an adequate system for relieving on-shift crews.
5) Command and control was lacking. A PFA chief officer should respond to events of this complexity and may require and aid. A stationary incident command post must be established.
6) Additional overhead resources (strike team leaders and division supervisors) should be provided as soon as possible.
7) Grass fires represent a significant risk to firefighter safety that PFA must not overlook.
8) PFA should be capable of responding to growing wildland incidents without the assistance of Larimer County resources.

Cloudy Pass Fire

Date: July 25, 2003	Max Temp: 91F	1000hr: 7%
PFA Units: 13	Max Wind: 14 mph	10hr: 3%
Acreage: 60	Fuel Models: 2, 10	Min RH: 20%

This is the only case study to occur entirely in PFA's district. Accounts indicate a number of successes with this operation. The initial response and tactical assignments were efficient and successful. The command structure was generally effective and the transition of command to the

county smooth. Radio communications continued to be problematic and the secondary response piecemeal.

Lessons
1) PFA was able to respond to an emerging incident that threatened structures with a sound command structure and tactical assignments.
2) Radio communications and the relief of on-shift companies, while improved, could still be made more efficient.

Buckhorn Creek Fire

Date: November 11, 2003	Max Temp: 91F	1000hr: 7%
PFA Units: 7 (estimated, no report)	Max Wind: 14 mph	10hr: 3%
Acreage: 125	Fuel Models: 2, 10	Min RH: 20%

This late season fire forced the evacuation of 60 homes. The initial request from Larimer County for mutual aid was unclear as to what resources were needed. PFA initially attempted to respond with volunteer units, and station 7 was immediately told to prepare to respond. Station four units were dispatched approximately forty minutes after the initial request by the county, and an overtime crew on Engine 37 was dispatched ahead of Engine 7. Prior to arriving at the incident, PFA units were able to form up as a strike team under the leadership of a chief officer. The PFA units were assigned protect structures ahead of the fire. There were several times when the strike team was stopped on a narrow road, crowded together in low visibility conditions, but was nevertheless able to fulfill its assignment safely.

1) Lack of clear communication from Larimer County can result in delayed initial response.
2) The procedures for responding to rapidly growing mutual aid wildland fires remain inconsistent.
3) A stationary ICP and the organized arrival of PFA units as a well led strike team enhanced safety.
4) Additional overhead personnel would be helpful for organizing PFA's response, assisting the responding Battalion Chief, providing additional supervision, or providing reconnaissance.

3.2 Analysis of Case Studies

While PFA's response to growing wildland incidents has seen significant strides in recent years, there are several issues that continue to place an unnecessary burden on the system and the battalion chiefs. These issues can also hamper the effectiveness of PFA's response and include:

- **Initial Response.** Inconsistent response levels to growing wildland fire incident.
- **Returning Crews to the System.** Lack of clear and consistent bench marks for relieving on-shift crews with overtime crews or other agencies. This applies to both in-district and mutual aid incidents.
- **Secondary Staging and Deployment.** Inconsistent practices of staging and deploying reinforcement or relief units.
- **Command and Control.** Lack of adequate overhead early in emerging incidents, primarily for reconnaissance and strike team or division supervision.
- **Communication.** This continues to be an issue on several levels. Radio frequencies and bands, use of standardized wildland terminology, mutual understanding of cooperators capabilities and responsibilities at the company level have all been issues.

4. MODELING POTENTIAL FIRE BEHAVIOR

Until recently, fire behavior modeling was limited to generating tabular numerical outputs of potential fire behavior, given specific numerical inputs for fuels, weather, and terrain. In the last decade, advances in research and technology, and increased power of personal computers, has made it possible to model fire behavior over a landscape, and over time. Additionally, the two programs used for this project incorporate three different fire behavior models (surface fire spread, crown fire spread, and spotting) into one program. This allows the user to assess a full range of potential fire behavior in a relatively seamless manner, and in a spatially and temporally dynamic environment.

4.1 Methods

The five basic GIS inputs required for the analysis are elevation, slope, aspect, fuels, and percent crown coverage. These were developed from data provided by the Larimer County Wildfire Mitigation Coordinator using ArcView 3.2 with Spatial Analyst. GIS inputs were at a resolution of 10 feet (per pixel). The other inputs involve weather conditions. Two hypothetical sets of weather conditions were used for the analysis, capturing typical dry conditions during the two fire seasons PFA typically encounters – early spring, and summer. The key inputs are summarized below:

1) Early-season, pre-greenup	***2) Summer***
Max Temp 70F	Max Temp 85F
Min Relative Humidity 15%, Max RH (night) 30%	Min RH 15%, Max RH 80%
Winds 5 mph from the west	Winds 15 mph from the west

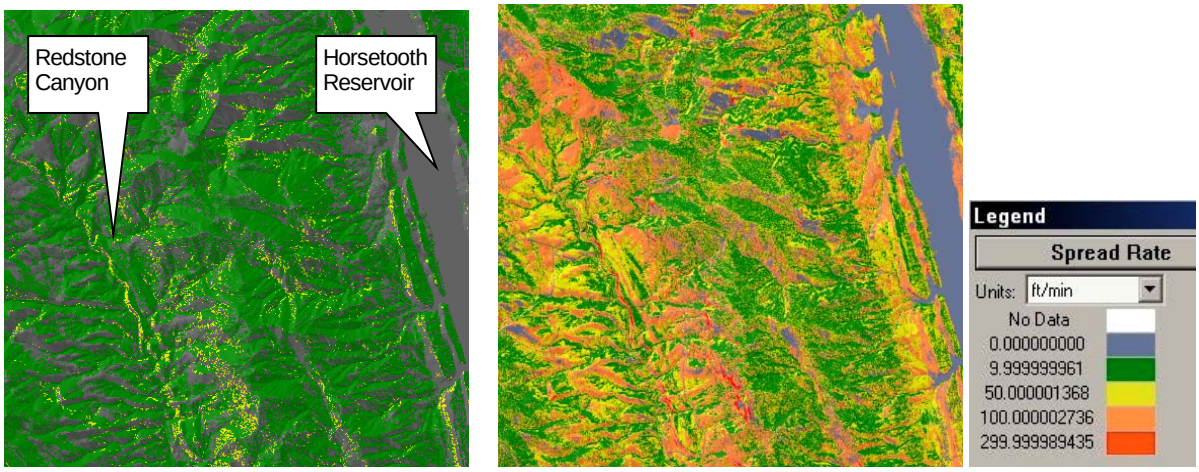
4.2 FLAMMAP versus FARSITE as Modeling Tools

There are two publicly-available software programs for modeling fire behavior over time and geographic area – FLAMMAP and FARSITE. Both use the same inputs and fire behavior models, and are intended to be "companion" programs. FARSITE models the spread of a wildland fire across a landscape, showing perimeter progression over time, and provides an assessment of how a fire would spread from a given ignition location. FLAMMAP models the potential fire behavior over an entire area, displayed as a map of potential intensity (flame length), rate of spread, or crown fire potential. FLAMMAP is the program used for the majority of work in this project.

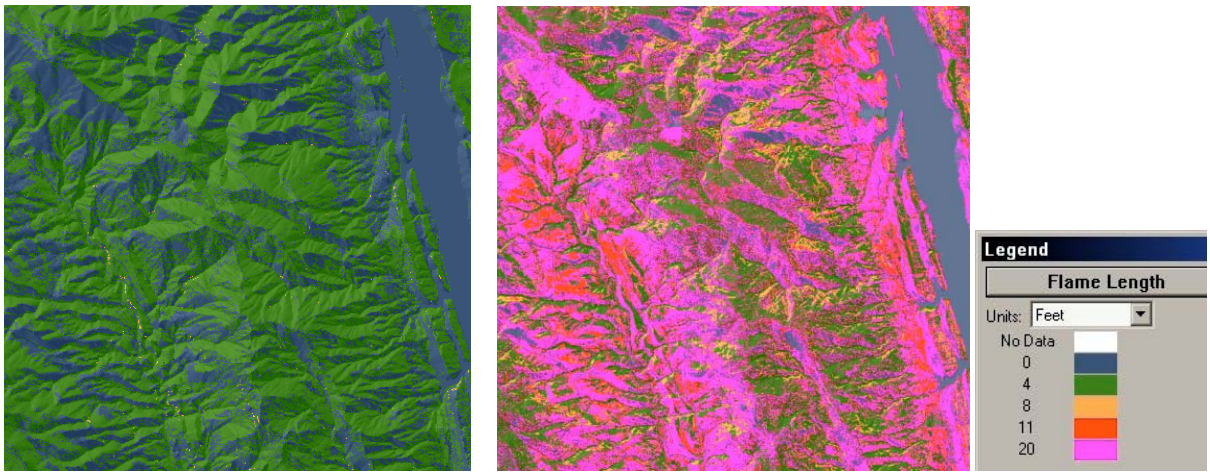
4.3 Mapping Potential Fire Behavior

For this assessment, the area immediately west of Horsetooth Reservoir was chosen. This area includes Redstone Canyon, and Horsetooth Mountain and Lory State Parks, and is representative of much of the western portion of PFA's jurisdiction, and includes a diversity of fuel types and terrain. Using the inputs described above, FLAMMAP generated maps of potential spread rate and flame length, and crown fire potential. These are shown below.

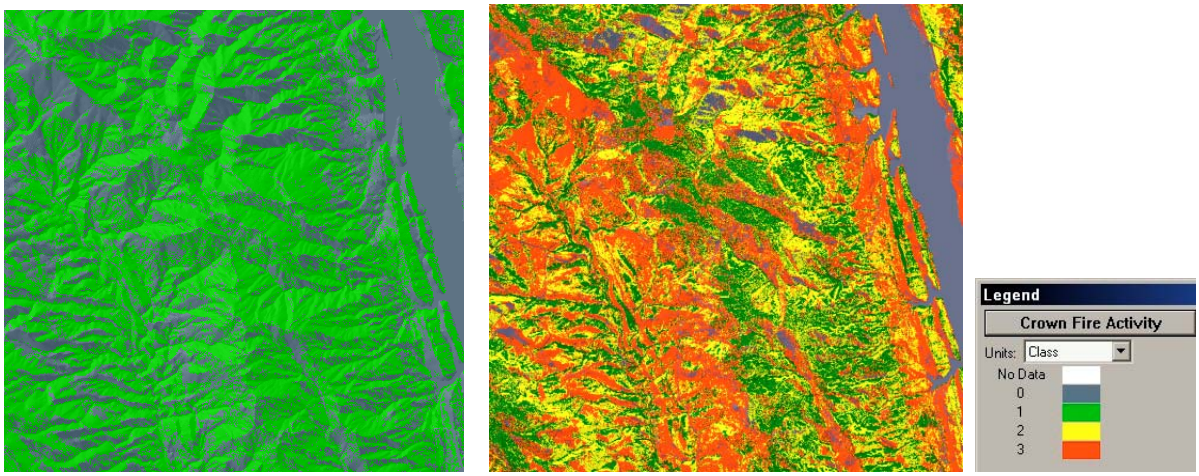
1) Early-season, pre-greenup **2) Summer**



Potential rate of spread (ft/min). A rate of spread of 80 ft/min corresponds to approximately 1 mph.



Potential flame length (intensity). Classes correspond to limits of effectiveness of suppression resources (4ft – hand crews; 8 ft – engines and dozers; control problems are likely above 11 ft).



Potential crown fire activity. Classes indicate no fire activity (0), surface fire only (1), passive crown fire (torching, 2), and active crown fire (3).

4.4 Results and Implications

The types of potential fire behavior maps that can be produced by FLAMMAP have a variety of potential uses in response planning. They can indicate the difficulty of control, given prevalent conditions. They can also indicate the number and types of suppression resources needed to control the fire within a certain area or at a given size. And they can be used to simulate the impact of defensible space and other hazard mitigation efforts on reducing a fire's potential destructiveness and difficulty of control.

It would be impractical to attempt to generate potential fire behavior maps for each day. However, a pre-made set of potential fire behavior maps that cover a range of potential conditions (average, bad-case, worse-case, and worst-case, for example) would provide a useful "field guide" and planning tool.

Further, having the input data (GIS layers and weather parameters) assembled ahead of time, FARSITE projections of a fire's potential spread in a given operational period can be quickly assessed for an extended incident. For example, if crews are unable to control a fire from a lightning strike in the first operation period and a critical fire weather day is forecast for the next day, the potential spread of the fire could be quickly assessed for setting priorities in suppression operations and determining evacuation needs and trigger points.

5. OPTIONS FOR THE FUTURE

5.1 Options for Improved Research

If PFA wishes to continue and improve statistical analysis of wildland fire occurrence and fire danger, several initiatives may enhance the efficiency and precision of the process.

1) Improve Fire Reporting. Through educating company officers and slightly altering the report format, significantly more complete data can be collected. **This initiative is underway.**

2) Improve Access to Weather Data. By making the Redstone Canyon weather station data more readily and widely available to PFA personnel, the research process will become a more efficient and less burdensome to systems administrators. Problems with readily importing this data into Fire Family Plus need to be addressed. **This initiative is partially underway.**

3) Formatting Fire Database. The conversion of PFA fire records for use with Fire Family Plus is extremely time consuming. Making the PFA fire reporting system seamless with Fire Family Plus is unrealistic. Improvements can be made to the methods of converting this data.

5.2 Options for Improved Operations

The recognition of high fire danger and lessons from past fires are of little value if there is no organizational response. The dynamic nature of emergency services requires flexibility, but some increase in standardization and structure may be helpful. For each of the six following initiatives there is a wide spectrum of approaches. Each will vary in cost, complexity, and effectiveness. A cost – benefit analysis is not provided here, but this array of potential solutions is merely offered for consideration.

1) Fire Danger Rating System
Purpose: To enhance preparedness, response, and guide fire restrictions during times of high to extreme fire danger.

There is currently no uniform application or recognition of fire danger. One may receive a page regarding a red flag warning or a weather announcement on conference call. This approach may adequate for PFA's purposes. Other options include:

- Use of the USFS fire danger rating. This requires very little time and no cost to obtain. It is only available during the summer fire season and does not necessarily reflect conditions in our fire district.
- Application of a customized fire danger rating system. This will be more readily available when the Redstone Canyon weather station is converted to a satellite communications this year. Such a system would provide fire danger ratings during times of the year when the USFS does not. It would be specifically tailored for PFA's conditions and could be adjusted as needed. This more complex system might require minimal in-house training of some personnel.

2) Preparedness and Staffing
Purpose: To reduce the impact to the system of wildland and WUI fires during high to extreme fire danger.

A fire danger rating system is of little use if it triggers no actions. The level of fire danger may be used a trigger point for staffing or response levels. For example:

- On "very high" fire danger days an available rover might be assigned to Station 4 or 7 during the heat of the day.
- A page could be sent out for three off-duty firefighters ready to respond within twenty minutes should the need arise, the first opportunity at overtime granted in exchange for their preparedness.
- On "extreme" days one or two overtime firefighters might be brought in to bolster these stations from 12:00 to 18:00.
- On "extreme" or red flag days three wildland team members may be automatically paged if a fire breaks.

For smaller fires this might allow the engine to return to the system while the brush truck remains on scene with a couple of firefighters to complete mop-up or assist cooperators. For larger fires this would help by front loading initial attack resources.

3) Standardized Responses
Purpose: To assist initial attack IC's by reducing the amount of resource ordering necessary in the early stages of an incident.

Members of the WUI and some BC's have advocated this tack. This system would recommend a baseline response based on specific criteria in the same manner that automatic alarms and structure response are currently dispatched. **This initiative is underway.** See appendix for sample draft.

4) Benchmarks for Relieving On-shift Units
Purpose: To clarify and standardize the responsibilities and expectations for PFA on-shift units.

There is a wide variety of attitudes towards PFA's responsibilities in the wildland arena. When reflected in our response and performance on scene, such inconsistency can be difficult for BC's, CO's, and firefighters, let alone cooperators. Benchmarks might include:

- For fires where PFA is providing mutual aid, on-shift units will return to the system as soon as the incident is stabilized and cooperators are on scene.
- For fires in PFA's jurisdiction, PFA units will remain on-scene until the fire is mopped up.
- For incidents that will require longer than a three-hour commitment (at best estimate), volunteers or off-shift wildland team members will be paged to provide relief.

While these measures are often practiced, their application is somewhat inconsistent.

5) On-call Wildland Assistants
Purpose: To help unburden the BC and the system in general during growing wildland incidents.

Individuals may be called upon to assists in paging overtime resources, staging manager, reconnaissance, BC aid or other duties as assigned. This position can help free the BC for system management and IC duties. This position can also provide leadership on wildland incidents as needed and qualified. On smaller incidents, this person may remain on scene to assist volunteer or county resources while on-shift crews return to the system. When the out of district team is called up, this position may assist the Special Operations Chief to page and organize the crew.

There are several models that this position may emulate. This could be a voluntary on-call position like the Incident Representative program or a more reliable paid on-call position like the on-call investigator. Requiring substantially more commitment from PFA, the position could be an on-shift specialist like the FIC or even a 40 hour position.

6) WUI Preplans
Purpose: To provide engine companies with a formalized means of area familiarization, and create a resource for responding to incidents that escape initial attack.

As with structure preplans, this initiative could help identify access, emergency evacuation routes, community safety zones, and a myriad of hazards. The GIS fire behavior (Sec. 4) is but one tool that can help prioritize areas and illustrate what to plan for.

6. CONCLUSION

PFA has put a great deal of time, training, and funding into improving its WUI capabilities, and the results are noteworthy. Areas for improvement do exist. Tools such as the National Fire Danger Rating System and GIS based fire behavior modeling can be used to guide a variety of forward thinking initiatives. Such improvements should ultimately enhance the efficiency and effectiveness of PFA as a whole.

Supporting Documents

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