CSFS - DANO

Community Fire Plan

A Part of the National Fire Plan

LA PLATA COUNTY

National Fire Plan
La Plata County
Community Fire Plan

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This Community Fire Plan was developed from October 2001 to March 2002. Contained in this document are recommendations for making La Plata County a safer place to live by reducing catastrophic wildfire risk. Many individuals and organizations gave input. Their time is appreciated.

The Community Fire Plan will only be successful with the participation of the communities in La Plata County and through keeping strong partnerships between all the players. Similar yet individualized plans are in place for the counties of Southwest Colorado and can be obtained by calling Mike Preston at the Office of Community Services -- Fort Lewis College: phone 970-565-8525 or email: mpreston@co.montezuma.co.us

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National Fire Plan -- La Plata County Community Fire Plan

Introduction

La Plata County, Colorado is home to 42,506 residents and is situated in the southwest corner of Colorado. The county encompasses 1.08 million acres and is a region with stark striking landscapes ranging from high alpine peaks and meadows in the north to arid plateaus, sage plains and mesas in the south. Land use, by acreage, is as follows:

Type of Ownership	Number of Acres
Private	461,185
San Juan National Forest	396,050
Bureau of Land Management	21,823
State of Colorado	23,287
Southern Ute Indian Tribe	179,055
Ute Mountain Ute Indian Tribe	1,685
Total	**1,083,085**

There are a number of entities involved in fire prevention and firefighting in La Plata County including:

Bureau of Indian Affairs (BIA)
Bureau of Land Management (BLM)
Colorado State Forest Service (CSFS)
La Plata County (LPC)
Local Fire Departments
United State Forest Service (USFS)

All of these organizations work with each other and community partners to share resources and information. Over the years strong partnerships have developed related to fire prevention demonstration projects, firefighting, public education and accessing resources such as equipment, grants, and training. It is in the spirit of these partnerships that this National Fire Plan -- Community Fire Plan (CFP) was developed and that its recommendations will be carried out.

Growth is a significant issue for the county affecting all aspects of catastrophic wildfire prevention and mitigation. The population of La Plata County is growing at an average rate of 3% each year. From 1993 to 1999, 2,895 new lots were created through major and minor subdivisions. Since 1978, over 11,000 residential structures have been placed throughout the county. Newcomers from all over the world find the environs of this place desirable for home building in vegetation, that, in many places is at great risk for catastrophic wildfire. It is against this backdrop of a rapidly urbanizing community that this CFP was developed. Since the Colorado State Forest Service ranks Southwest Colorado as one of the three most at-risk areas of the state, this effort is timely.

Summary Recommendations -- La Plata County Community Fire Plan

Recommendation #1

Continue to develop and refine the *Wildfire Hazard Assessment and Map* for use by fire management agencies, La Plata County, and communities across Southwest Colorado.

Recommendation #2

Encourage and support the implementation of a community-led and community-driven Fire Council in La Plata County that could carry out collaborative projects. The Council would be comprised of the local Fire Department Chiefs, the US Forest Service, Southern Ute Indian Tribe and BIA fire management officers, the Colorado State Forest Service, BLM, La Plata County officials, and representatives from potentially affected stakeholder groups such as realtors, insurance agents, environmental organizations, and homeowner associations, etc.

Recommendation #3

Develop and carry out grassroots, neighbor-to-neighbor public education strategies in areas identified as high risk in the CFP planning process and through the *Wildfire Hazard Assessment and Map* project.

Recommendation #4

Initiate fire prevention and mitigation projects on federal lands identified in the CFP planning process after appropriate review processes are completed, and assist other fire managers with fire management activities in their jurisdictions. These projects will be carried out by the United States Forest Service and Bureau of Land Management, in partnership with local communities, the local Fire Departments, the Colorado State Forest Service, and the Bureau of Indian Affairs.

Recommendation #5

Continue working collaboratively across jurisdictions to explore and possibly implement county policies that would lessen the chances of catastrophic wildfires on private lands, and lands in the urban interface.

Recommendation #6

Implement demonstration projects that will give communities and neighborhoods a visual picture of fire wise strategies, combining these projects with public education meetings and campaigns.

Recommendation #7

Support and advertise the existence of private contractors who can carry out fire wise prevention projects on homeowners' properties.

Recommendation #8

Continue to build, create and strengthen partnerships to carry out this CFP among federal, state, and local governments and agencies, and with private sector entities and non-profits.

Recommendation #9

Encourage the development of private, small diameter wood products processing businesses.

La Plata County -- Community Fire Plan: Firefighting and Prevention Capacity

Prevention and firefighting in La Plata County is done by the following entities:

On Private and State Lands fire protection is provided by the fire districts of: Upper Pine, Los Piños, Fort Lewis Mesa, and by the Durango Fire and Rescue Authority (includes Hermosa Cliffs and Animas Fire Districts, the City of Durango Fire Department, and Mercy Medical Center's paramedics.)

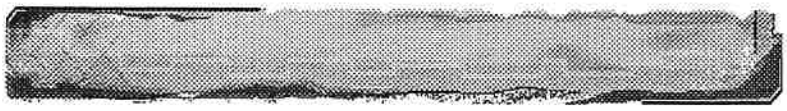
Increased demand on already stretched budgets and volunteers is evident as the county's population climbs. The Animas District, which is La Plata County's largest, logged 78 calls in 1978; 800 calls in 1999; and an estimated 1,000 calls in the year 2000. Adequate funding is needed, and, is usually contingent on bond issues passing. Several of the fire districts have seen failed bond issues recently but the Animas District did receive a funding increase in 1995. Recruiting volunteers for fire districts is increasingly more difficult.

In 2001, the fire districts that melded into the Durango Fire and Rescue Authority did so under a joint services agreement that, in essence, consolidated the districts into one entity. This move created greater efficiencies in the system, reduced service redundancies and territorial discrepancies while also reducing response times.

The Colorado State Forest Service (CSFS) fire programs provide effective readiness, and response and suppression of wildfires. This organization's greatest emphasis is on prevention and mitigation to lessen the chances of catastrophic wildfires on state and private lands in Colorado. The CSFS's activities include:

a) promoting fire mitigation projects;
b) assisting county governments in assessing wildfire hazards; and
c) sharing information with diverse audiences on the importance of mitigating hazards on their forested lands to help protect lives and property.

The CSFS leads efforts such as Fire Academies and Fire Conferences – avenues for sharing new information and training fire professionals in the most up-to-date techniques. The CSFS also distributes fire equipment and grants, trains personnel, and carries out "on the ground" projects.



On Tribal Lands the Bureau of Indian Affairs provides wildland fire protection on tribal lands. With La Plata County's southern portions being dotted and interspersed with private, federal, tribal and state lands, coordination between fire fighting entities is imperative.

On Federal Lands the Columbine Ranger District and the San Juan Resource Area of the Bureau of Land Management cover La Plata County. The Columbine District and has one engine with a crew of five, and a new nine-person fuels reduction crew. A new 20 member San Juan Interagency Hot Shot Crew will be stationed in Durango but will work elsewhere across the nation. They are considered a national resource and will be assigned to priority fires outside of La Plata County. A new position has been created at the San Juan Public Lands Center to work on goals and projects identified in the National Fire Plan -- Community Fire Plans.

The Durango Interagency Fire Dispatch Center helps to make fire response quick and effective. The USFS, BLM, Bureau of Indian Affairs, Mesa Verde National Park and CSFS each contribute staff and resources to operate the full-time facility – located in the San Juan Public Lands Center, 15 Burnett Court, Durango. And finally, a new air tanker base is scheduled for completion at the La Plata County airport in 2002 that will improve the firefighting capabilities in the region.

La Plata County -- Community Fire Plan: The Process

In order to complete the La Plata County Community Fire Plan, the following steps were taken:

- The *Wildfire Hazard Assessment and Map* project was created by Dr. Bill Romme, a professor at Fort Lewis College (now at Colorado State University) and several of his colleagues. This mapping project is an initial strategic planning tool that can help Fire Departments, federal fire management officers and La Plata County officials better identify areas that are high risk for catastrophic wildfires. In March 2001, meetings were held in Durango and Bayfield to unveil the project and seek citizen input about wildfire.

- Also, as a part of the *Wildfire Hazard Assessment and Map* project, a questionnaire was sent to over 1,000 residents of the county to gather input. See Appendix A for a sample questionnaire.

- The USFS and BLM Fire Management Officers, working with the Fort Lewis College – Office of Community Services and all the local Fire Chiefs, spent a number of months creating a map of high-risk priority areas. This mapping process produced a set of projects that will now be considered for controlled burns and other fire mitigation strategies by the

USFS and BLM in the future. It also includes priority areas of high concern identified by each Local Fire District.

- A survey was sent to all the local Fire Chiefs seeking their input about wildfire issues, equipment and training needs, and further collaboration strategies to increase effectiveness in dealing with wildfires.

- Key informant interviews were conducted with stakeholders and this CFP was sent out in draft to seek input and changes.

Goals of the National Fire Plan

- ensure firefighting resources;
- rebuild communities damaged in past year's fires and rehabilitate fire-damaged ecosystems;
- thin vegetation in areas where private development adjoins public lands; and
- work with local residents to reduce fire risk and improve fire protection.

Action Strategies for Achieving These Goals

- developing this Community Fire Plan, and implementing it;
- using the work produced by the *Wildfire Hazard Assessment and Map* project;
- carrying out community meetings and a survey;
- conducting public education; and
- strengthening collaboration between La Plata County, the local Fire Districts, USFS, BLM, BIA, CSFS, and communities.

La Plata County -- Community Fire Plan: Goals

#1) *Increase* La Plata County's capacity to identify high-risk areas and work to prevent catastrophic wildfire on those lands.

#2) *Improve* the effectiveness of fire prevention public education by taking current education efforts to personal, grassroots and neighborhood level(s.)

#3) *Decrease* fire risk in the urban interface(s) by implementing key projects identified in the CFP planning process.

#4) *Increase* the number of homeowners implementing fire wise strategies.

#5) *Continue* to support the myriad partnerships between communities and local, state and federal agencies to lessen the chances of catastrophic wildfire in La Plata County.

"Resource managers have been dealing with the management problems created by the intermingling of wildlands with interspersed and adjacent development for years. What has changed is the dimensions of the conflict in these wildland urban interface situations. As more and more people move to woodland environments to capture social and natural amenities, conflicts are becoming more intense, more complex, and more visible than before. A growing consensus has emerged that wildland issues have become the most contentious and problematic issues for forest managers. "

- *Fire Hazards at the Urban-Wildland Interface: What the Public Expects* (Comer, Gardner, & Taylor.)

La Plata County -- Community Fire Plan: Recommendations

In order to carry out the goals just mentioned, the CFP recommends the following:

Recommendation #1

Continue to develop and refine the *Wildfire Hazard Assessment and Map* for use by fire management agencies, La Plata County, and communities across Southwest Colorado.

A very exciting tool is emerging in La Plata County that could have significant impacts on the ability of local, state and federal fire management officers to lessen the chances of catastrophic wildfires. The tool is the *Wildfire Hazard Assessment and Map* for La Plata County, Colorado. This project was launched in 2001 headed by Dr. Bill Romme, an ecologist from Colorado State University formerly of Fort Lewis College, along with other colleagues from the University of Colorado and Prescott College (see Appendix B for their full report.) This first-of-its-kind mapping project is distinct and includes variables not looked at before by similar wildfire hazard assessments.

> "Our BEHAVE (a fire behavior modeling system) simulations indicated that the environments likely to produce the most damaging and uncontrollable fire behavior are those with (1) steep southerly slopes and (2) oak, ponderosa pine, or piñyon-juniper vegetation. Unfortunately, these are some of the most popular locations for building homes, because of the views and greenery that they afford."
>
> - *Wildfire Hazard and Assessment Map* for *La Plata County Colorado* (see article in Appendix B)

Once completed, the assessment could have two broad applications:

a) resource managers and fire control officers can use the assessment map to identify areas of highest priority for mitigation treatments on public and private lands to reduce wildfire risk; and
b) land management agencies and County officials can better target public education to include those areas deemed most acute for fire risk.

While this project currently now covers La Plata County, the results and methodology can serve as examples and a model for future fire risk assessment and mapping throughout the region, and maybe even the State of Colorado. Indeed, the La Plata County Comprehensive Plan, adopted in December 2001, states:

> *"The 2001 wildfire risk assessment provides La Plata County with invaluable information that can be used during the development review process to ensure wildfire risk in developing areas can be minimized."*

Wildfire Hazard Assessment and Map: The Model

The project involves creating maps by assembling topographical data including slope and aspect from the USGS, vegetation data, and fuel models. These data were input into BEHAVE, the widely used mechanistic fire behavior model, to produce the maps in the *Wildfire Hazard Assessment and Map*.

The ultimate product of the *Wildfire Hazard Assessment and Map* project are maps that show wildfire hazard from three perspectives: a) spread rate; b) flame length; and c) total potential heat release. The maps show where these three parameters are most risky. For example, heat release tends to be especially high in the central portion of the county. The greatest simulated flame lengths tend to be in the southern and central portions of the county, including the central zone (where development is also very dense.) The greatest occurrence of moderate and high spread rates is also in the central zone.

For a more detailed discussion of methodology and analysis, go to Appendix B where you will find the paper written by Dr. Romme and his colleagues. The actual maps are available through the USFS.

Wildfire Hazard Assessment and Map: Summary Conclusions

The initial results of this work were released in June 2001 to local fire management officials. Two major areas of improvement were recommended as follows:

a) the maps needed to show a greater fire risk in the ponderosa pine and piñyon-juniper forests; and
b) southern aspect tends to burn more vigorously than northerly aspects -- the maps did not reflect this phenomenon.

Since June, both of these areas of improvement have been dealt with in a second iteration which was released in November 2001.

The project shows that environments likely to produce the most damaging and uncontrollable fire behavior are those with:

a) steep southerly slopes; and
b) oak, ponderosa pine, or piñyon-juniper vegetation.

The scientists note that, unfortunately, these vegetation types are also the most popular places where new developments are occurring. This is evidenced by their findings that the greatest portion of the county having the greatest risk is the central zone which also contains the major subdivisions of: Shenandoah, Durango West, Rafter J, Edgemont Ranch, and the Grandview area, plus numerous subdivisions on the northern portion of Florida Mesa. Other areas of high risk noted were areas such as Falls Creek and the Dry Side.

***Wildfire Hazard Assessment and Map*: Survey**

In the Spring of 2001, a Community Survey (see Attachment A) was sent out to over 1,000 La Plata County residents and homeowners. While the response rate was low (62), there was some interesting information reported from questionnaires returned:

- The majority were "very concerned" about the risk of wildfire in Southwest Colorado.
- The majority were "very concerned" about potential damage from wildfires to property in the residential area where they live.
- Most felt "moderately well informed" about strategies and techniques that could be used to protect homes or business from natural wildfire.
- Most felt that the federal land agencies, local government and fire protection organizations are "moderately well prepared" to address the wildfire risks they believe exist in their neighborhood or community.
- Respondents felt that there is a high responsibility on citizens to reduce wildfire risk on their properties in relation to government responsibility. Most said it was either 60% or 80% private property owners' responsibility – with the remaining percentages being the governments' responsibility.
- The number one action taken to reduce risk was trimming branches on the lower parts of trees followed by constructing a non-combustible roof, clearing properties of combustible materials, and removing wood piles near homes.

***Wildfire Hazard Assessment and Map*: Refining the Model**

While this *Wildfire Risk Assessment and Map* project can be used for initial strategic planning purposes in La Plata County and is an emerging invaluable tool, to further utilize the model the following steps are recommended and need taken:

- refinement of the fuels and vegetation maps (e.g. perhaps through aerial photographs);
- improvement of the precision as to the location of homes and other structures; and
- identification of community and cultural values that need protection beyond homes (e.g. historic sites, watersheds, viewsheds, and wildlife habitat.)

The Colorado State Forest Service deems southwest Colorado as one of the top three areas of greatest risk for wildfire so this emerging scientific tool is a valuable resource for predicting, mitigating and preventing catastrophic wildfire.

Recommendation #2

Encourage and support the implementation of a community-led and community-driven Fire Council in La Plata County that could carry out collaborative projects. The Council would be comprised of the local Fire Department Chiefs, US Forest Service, Southern Ute Indian Tribe and BIA fire management officers, the Colorado State Forest Service, the BLM, La Plata County officials, and representatives from potentially affected stakeholder groups such as realtors, insurance agents, environmental organizations, and homeowner associations, etc.

It is recommended that this Council be formed in the year 2002. This Council needs to not duplicate current efforts, add value, and bring new voices and interests to the table with local Chiefs and federal FMO's. To "jump start" the process, it is recommended that representatives from a successful Fire Council (such as Boulder or Prescott) be recruited to do a workshop on their efforts.

Example Councils
Source: www.firewise.org

Here are some quick examples of showcase communities that have established Councils which could be used as models:

- **Prescott, Arizona:** The Prescott Area Wildland/Urban Interface Commission includes five jurisdictions including the City of Prescott, Yavapai County, the Central Yavapai Fire District, the Arizona Department of Forestry, and the United States Forest Service. A memorandum of understanding guides their work. The Commission advises the cooperating agencies; identifies, develops and prioritizes wildfire issues; develops plans and makes recommendations to appropriate levels of government; takes on citizen education initiatives; and provides all agencies with a quarterly report of their activities.

- **Big Canoe, Georgia:** This is a development of 900 high-dollar homes on 10,000 acres. The Georgia Forestry Commission has worked with their Fire Safety and Security Committee to implement fire prevention strategies such as evacuation protocols, development expansion planning, pruning fuel loads, marking roads more appropriately, creating a quarterly magazine for homeowners and getting better equipment for fire-fighting.

- **Jefferson County, Alabama:** This community formed the Wildland/Urban Interface Advisory Board to prevent as many disasters in the urban interface as possible. Not only are firefighting entities and governments represented but so are realtors, insurance agents, developers, landscape planners, the transportation department, home builders, and residential inspectors. They have done many things such as conducting cross training sessions, and designing door hangers, brochures and hazard rating forms plus other educational projects.

- **Boulder, Colorado, Incline Village, Nevada and Flagstaff, Arizona** were noted in the planning process as being models and are being researched.

"Only through a cooperative effort among these entities and with the citizens of these communities can the multi-faceted challenges posed by development of the wildland areas in the Prescott basin be addressed. In view of these considerations, these entities desire to establish an enduring basis for such cooperation and assistance and therefore enter in this Memorandum of Understanding." - Prescott Area Wildland/Urban Interface Commission's purpose statement

Recommendation #3

Develop and carry out grassroots, neighbor-to-neighbor public education strategies in areas identified as high risk in the CFP planning process and through the *Wildfire Hazard Assessment and Map* project.

La Plata County is fortunate to have several public education tools already in place including:

- A brochure that the County planning department is developing called "*Knowing Your Wildfire Neighbor.*"
- *Family Emergency Preparedness Guide*, Department of Local Affairs (DOLA), a booklet handed out at the La Plata County Building Department that contains information about wildland fires.
- Firewise Construction: Design and Materials – Peter Slack, a manual that is available at the La Plata County Building Department.
- Educational materials and presentations developed by the Colorado State Forest Service.
- A 15 minute video, "Protecting Your Home from Wildfire," a partnership of the City of Durango, La Plata County, the San Juan National Forest and the Colorado State Forest Service.
- Mass media publications produced by the San Juan Public Lands Center and Colorado State Forest Service such as "*Living with WILDFIRE in Southwest Colorado,*" a newsletter published in the summer of 2001 with more to be released this year.

With these mass public education tools in place, a need has been identified to "get more grassroots"...making public education a personal, relationship-building and neighborhood process. Often, the question arose in the planning process:

> *With all this public education being done, why aren't more homeowners taking more actions to reduce their risk?*

While the answers to this question can be elusive, in the CFP process, it was decided that a series of targeted public education meetings will be held over the next year. These meetings will be carried out by any combination of: Federal Fire Management Officers; the Bureau of Indian Affairs; public education personnel of the San Juan Public Lands Center; Colorado State Forest Service; and/or local Fire Departments.

The meetings will be utilized to directly interface with neighbors and neighborhoods in the highest risk areas identified on the map (see Appendix D.) The agenda will be teaching fire wise strategies, educating participants on risks to their homes and properties, and the reasoning behind their risk categorization. Also, ways to make their properties safer will be covered. The meetings will be creative and tailored to each Fire District – and even communities within each District.

Recommendation #4

Initiate fire prevention and mitigation projects on federal lands identified in the CFP planning process after appropriate review processes are completed, and assist other fire managers with fire management activities in their jurisdictions. These projects will be carried out by the United States Forest Service and Bureau of Land Management, in partnership with local communities, the local Fire Departments, the Colorado State Forest Service and the Bureau of Indian Affairs.

Federal Projects

The following projects were identified for treatments in 2002 and 2003 by the USFS and BLM (see map in Appendix D):

Bull Canyon,	Rx burning
Logchutes	Rx burning
Sauls Creek	Mechanical
Spring Gulch	Rx burning
Falls Creek	Mechanical
Mitchell Lakes	Rx burning
Deep Creek	Rx burning
Wickenson Mountain	Rx burning
Hermosa	Rx burning
Lange Canyon	Rx burning
Little Bear Creek	Mechanical
HD Mountains	Mechanical
Electra Lake	Mechanical
Vallecito	Mechanical
Red Creek	Mechanical
Forest Lakes	Mechanical
Perrins Peak	Mechanical
Mayhan	Mechanical
Edgemont	Mechanical
Timberline Ridge	Mechanical and Rx burning

This list of projects is currently undergoing the required scoping, planning and environmental assessment phases required by federal law and implemented through the United States Forest Service and Bureau of Land Management.

Local Fire Departments "Areas of High Risk and Concern"

The following areas of La Plata County are deemed as "areas of high risk and concern" by the Fire Departments' Chiefs. Each area is ranked in order with "1" being the highest concern (see map in Appendix D):

Animas Fire District (now Durango Fire and Rescue Authority)

1 -- Timberline, Valley Vista, Songbird, Wildwood
2 -- Sailing Hawks and Jacob's Cliff
3 -- Every Green Valley
4 -- Falls Creek Subdivision
5 -- Trappers Crossing
6 -- Artesian Valley Ranch, Squaw Apple Estates, Chastain

Fort Lewis Mesa Fire Department

1 -- Lands surrounding Vista de Oro
2 -- Eastern lands at entrance to La Plata Canyon
3 -- lands directly east of Cougar Mesa and Hesperus Land and Cattle Co.

Hermosa Cliffs Fire Department (now Durango Fire and Rescue Authority)

1 and 2 -- directly west and north of Electra Lake
3 -- lands near the Columbine and Lake Purgatory Subdivisions
4 -- Rockwood Subdivision
5 -- Rockwood Subdivision -- Tamarron

Los Piños Fire Department

1 -- Candaleria Heights
2 -- Rancho Florida
3 -- Rivers End Estates and Florida River Ranch
4 and 5 -- Sundance Hills +
4 and 5 -- Lands directly southwest of Ignacio at the northwest intersection of Highway #318 and #172
6 -- Lands in and around Tucker Subdivision &
Lands south of the Ignacio Pump Station and north of Piñon Mesa Ranches

Upper Pine River Fire District

1 -- Forest Lakes
2 -- Enchanted Forest, Tween Lakes, Cherry Valley Estates
3, 4, 5 -- Ragsdale, Texas Creek Ranch, and Timberdale Ranch
6 -- Homestead Ranches
7 -- Pine Springs Ranch
8 --Deer Valley
9 -- Piney Woods

The La Plata County Fire Chiefs are currently in the process of refining and further categorizing this list in terms of the actions their departments will take at these locales -- taking into consideration criterion such as slope, accessibility, and data that is produced by Dr. Romme's *Wildland Hazard and Assessment Map* project. This process is ongoing.

Bureau of Indian Affairs Projects

The BIA is currently carrying out fire mitigation and prevention efforts. The list of projects the BIA has prioritized to accomplish from 2001 – 2003 is as follows:

Meadow Brook in Ignacio
Ignacio Peak near Ignacio
Florida Mesa
Youth Camp near Chimney Rock
Aspen Springs (more on the next page)
Community Fire Plan – La Plata County

Hall Canon in Aspen Springs
Vega Redonda
Madrid Canyon
Mesa Mountain
Sandoval Mesa
Payan Canyon

Recommendation #5

Continue working collaboratively across jurisdictions to explore and possibly implement county policies that would lessen the chances of catastrophic wildfires on private lands, and lands in the urban interface.

La Plata County and the federal and state fire management agencies consistently report that they work well together. Representatives meet regularly and collaborate on a number of projects --- including the identification of treatment projects on federal lands that are adjacent to private lands.

The Colorado State Forest Service leads an effort in resource sharing called the Annual Fire Operating Plan which involves La Plata County and all the Fire Districts. The Plan describes agreements that are made related to funding, personnel power on fires, and equipment sharing.

Rapid development of private lands impacts all entities in myriad ways. The county's Fire Districts are asked to comment on proposed developments and their project design but typically do not play a role in determining the location of new developments. The location of developments impact Fire Districts' abilities to fight fires due to issues such as road and driveway design and maintenance, adequate road and residence signage, water availability, fuel loadings, and the building materials of the subdivisions.

The county's Fire Districts have endorsed the adoption of the 1997 Uniform Fire Code (UFC) that would give them broad authority -- more than now -- over building and subdivision design standards and fire hazard mitigation measures. It is likely that the districts will request that the Board of County Commissioners approve its adoption. Recently, the Durango Fire and Rescue Authority announced it would enforce a provision in the 1985 UFC that was adopted by the County relating to driveway design at new building sites.

It was noted in several conversations that with the high cost of living in Durango and the county, it is important to not over-regulate new building sites. The more requirements placed on new buildings, the higher the cost of construction.

Recommendation #6

Implement demonstration projects that will give communities and neighborhoods a visual picture of fire wise strategies, combining these projects with public education meetings and campaigns.

The following projects are considered to be likely demonstration projects for La Plata County as the residents have expressed a keen interest in mitigating their fire risk, and, the subdivisions are adjacent to public lands. These projects could be carried out with various sources of public and private funding.

- ▶ Forest Lakes subdivision –north of Bayfield
- ▶ Falls Creek subdivision – northwest of Durango
- ▶ Deer Valley Estates – east of Bayfield

Recommendation #7

Support and advertise the existence of private contractors who can carry out fire wise prevention projects on homeowners' properties.

There are various private contractors in La Plata County who can be paid to complete fire mitigation and prevention projects on homeowners' properties. These contractors are listed in Appendix C. Several issues emerged in talking with these contractors. The points are summarized below:

- the National Fire Plan, and any ensuing public education, need to continue to educate the public about the existence of these businesses;
- when the public education meetings take place in La Plata County, the private contractors should be invited and included;
- when homeowners utilize contractors, those contractors need to emphasize that the activity is an *ongoing* maintenance issue needing regular scrutiny and attention; and
- there is no quality control mechanism in place which can be problematic -- if one contractor completes a job that is sloppy, inadequate or in accurate, he/she gives the concepts of "fire wise" and creating defensible space a bad image.

Recommendation #8

Continue to build, create and strengthen partnerships to carry out this CFP among federal, state, and local governments and agencies, and with private sector entities and non-profits.

In carrying out this CFP, building and maintaining partnerships between the public and private sectors cannot be emphasized enough. Many strong links already exist in the county. These partnerships carry out effective public education; spawn action on the part of homeowners; get work done on-the-

ground, and bring together various interests to lessen wildfire risk. Several new partnership opportunities were found in the CFP planning which are notable:

Southwest Youth Corps

Southwest Colorado is lucky to have an active youth conservation corps, Southwest Youth Corps (SYC.) These youth are paid to do various public lands projects across the Four Corners. They can be called upon to carry out fire prevention and mitigation projects both on private and public lands. The organization's mission statement is:

> *"Southwest Youth Corps provides young men and women of the Four Corners Region with structured, safe and challenging work and education opportunities through employment projects that promote personal growth, the development of social skills, and an ethic of natural resource stewardship."*

The Southwest Youth Corps, a non-profit organization, is a conservation-based program modeled after the Civilian Conservation Corps of the 1930s. Developed in 1997, SYC was modeled after the other 120+ Corps around the nation. SYC has developed into a sustainable organization based in Durango, Colorado and is governed by a Board of Directors. SYC is an accredited youth corps in the State of Colorado as defined by the Colorado Youth Corps Association (CYCA), and is also a member of the National Association of Service and Conservation Corps (NASCC).

Southwest Youth Corps hires young adults between the ages of 16-23 and organizes them into crews of eight corps members with two adult mentor crew leaders. These crews then complete conservation projects for a variety of land management agencies in the Four Corners, including: the USFS, BLM, National Park Service, Bureau of Reclamation, Colorado State Parks, local governments and non-profit organizations. SYC primarily offers eight-week residential conservation programs during the spring, summer and fall.

Their fuels reduction program is described in their brochure as follows:

> SYC is pleased to offer a new opportunity for 18- to 25-year-olds. This 22-week non-residential program is ideal for anyone interested in a career in preventing and fighting forest fires. Corps members are paid an hourly wage, are eligible to earn a $2,400 AmeriCorps Education Award, and work 40-hours/week.

The Federal Authorizations that specifically lists "Youth Conservation Corps" as a resource are available upon request.

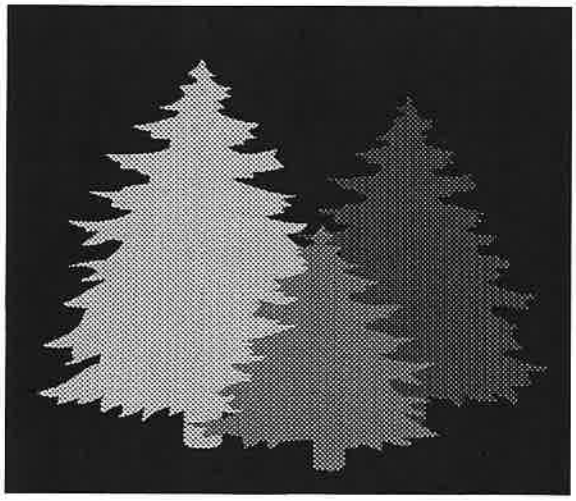
American Red Cross

In other parts of Western Colorado, the American Red Cross has been approached to take on a role in fire education. The local Red Cross chapter has expressed an interest. This could be a potential resource for the BLM, CSFS, and USFS, and/or BIA to utilize as this CFP moves forward.

Recommendation #9

Encourage the development of private, small diameter wood products processing businesses.

Once a homeowner, private contractor or developer removes fuels from a home site, the question is: *What to do with the refuse pile?* The continued development of market for these materials will create win/win partnerships with the local small-diameter timber industries in the region, and homeowners who need the fuel piles removed. Several efforts are underway to expand and increase these markets, and they should be supported. □



La Plata County -- Community Fire Plan: Appendices

A) Sample Community Survey on fire risk
B) *"A Wildfire Hazard Assessment Map for La Plata County, Colorado."* November 2001. Romme, Barry, Hanna, Floyd and White.
C) List of contractors doing fire mitigation and prevention on private lands.
D) "Areas of High Risk and Concern" map

La Plata County – Community Fire Plan: Bibliography & Sources

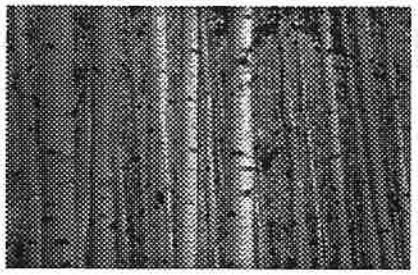
La Plata County Comprehensive Plan. Adopted December 2001. Pages 8.1 – 8.6.

"Living with WILDFIRE in Southwest Colorado." Summer 2001. A publication of the United States Forest Service, Bureau of Land Management and the Colorado State Forest Service.

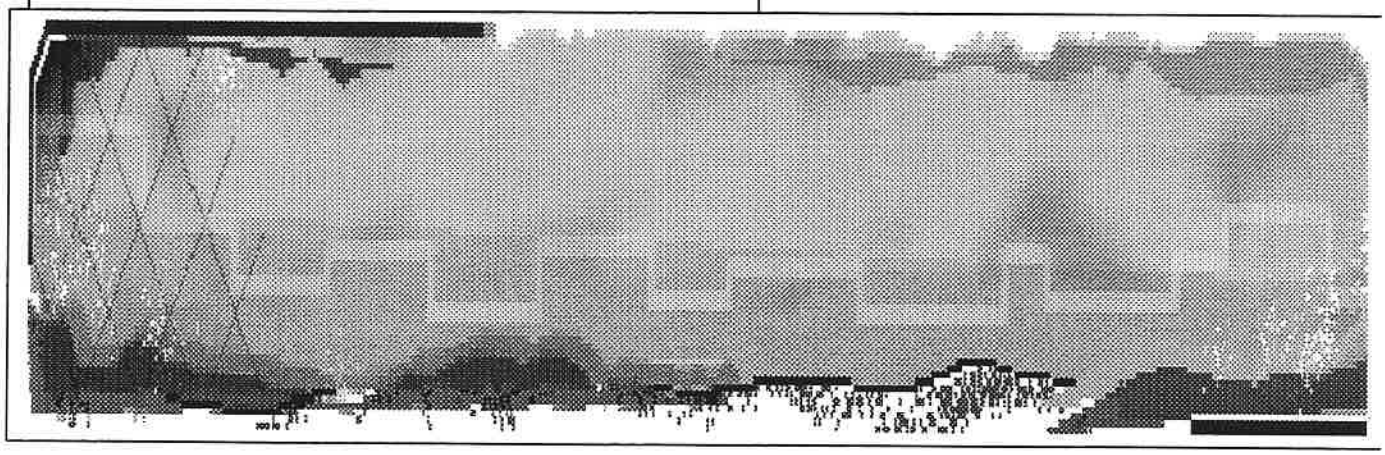
Pathways to Healthier Communities. 2001-2002. Operation Healthy Communities.

Romme, Barry, Hanna, Floyd and White. 2001. *"A Wildfire Hazard Assessment Map for La Plata County, Colorado"*.

www.firewise.org -- a web site of the Fire Wise movement.



Appendix A



LA PLATA COUNTY – WILDFIRE RISK ASSESSMENT
Community Survey – March 2001

1. How concerned are you about the risk of wildfire in Southwest Colorado?

   Not at all concerned_____ Somewhat concerned_____ Very concerned_____

2. In the residential area where you live, how concerned are you about potential damage to private property from wildfires?

   Not at all concerned_____ Moderately concerned _____ Very concerned_____

3. How well informed do you consider yourself to be about strategies and techniques you could use to protect your home or business from natural wildfires?

   Very well informed_____ Moderately well informed_____ Poorly informed_____

4. How well prepared do you think the federal land agencies, local government and fire protection organizations are to address the wildfire risks you believe exist in your neighborhood or the wider community?

   Very well prepared____ Moderately well prepared_____ Poorly prepared_____ Don't know_____

5. How would you balance the responsibility of citizens to reduce wildfire risks on their own property, in relation to government's responsibility to protect their home and neighborhood? (*Check one*)

   Private property owner 0%--Government 100%____
   Private property owner 20%--Government 80%____
   Private property owner 40%--Government 60%____
   Private property owner 60%–Government 40%____
   Private property owner 80%–Government 20%____
   Other: Private property owner _____% Government_____%

6. What specific areas do you believe are at highest risk from natural wildfires? Describe the area or its location. For example, near what roads or parts of the community. *(Please use back of form for your response.)*

7. What steps have you taken to reduce wildfire risk on your property or in your neighborhood? (*Check all that apply)*

   _____Clearing property of combustible underbrush and debris.
   _____Trimming branches on lower parts of trees.
   _____Setting your home back from the top of a ridge.
   _____Constructing a non-combustible roof.
   _____Removing wood piles from near your home.
   Other (specify)_____

8. Which of the following efforts on the part of public land agencies and/or local government would you support in order to decrease the risk of wildfires to property? Please rank the following (1 = most preferred alternative).

   _____An increased awareness campaign regarding property protection measures.
   _____An increase in prescribed fire on public lands from 6-7000 acres per year to 14-15,000 acres.
   _____Removing underbrush and thinning dense stands of small trees.
   _____Reducing the number of trees, including some up to 12-14 inches in diameter
   _____Discouraging people from building homes in or near the forest through education about fire risks
   _____Using land use regulations to prohibit or restrict people from building in or near forest lands.

9. How strongly do you encourage private property owners to become active in reducing wildfire risk on their property?

   Not at all____ Somewhat_____ Strongly_____ Very strongly_____

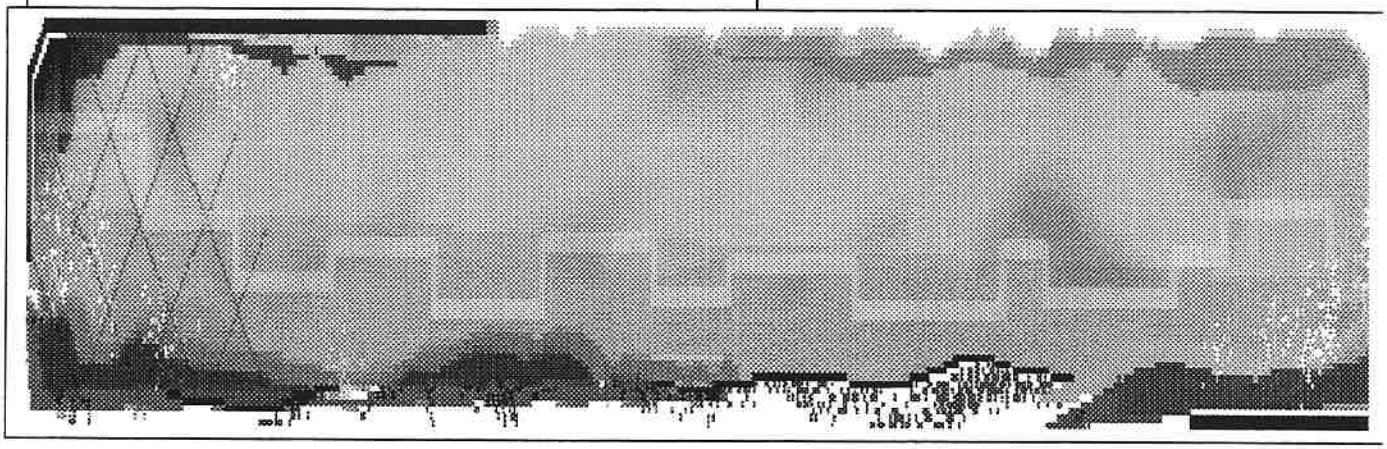
10. How willing are you to work with neighbors to reduce wildfire dangers to life and property in La Plata County?

    Not at all____ Somewhat_____ Strongly_____ Very strongly_____

Optional: If you would like to be placed on a mailing list for additional information about wildfire risk and community fire protection planning in La Plata County, please provide contact information below. Please use reverse for additional comments.

Name_____ Phone_____ E-mail_____
Mailing address_____

Appendix B



Note:

This is only the narrative portion of Dr. Romme's work. For the appendices, tables and maps, please contact:

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These documents can be emailed or faxed to you.

A WILDFIRE HAZARD ASSESSMENT AND MAP FOR LA PLATA COUNTY, COLORADO

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Final Report on Phase I of the Study

October 31, 2001

Introduction

A spate of large, destructive wildfires during the last decade has raised public awareness of the threat of uncontrollable fires in forest ecosystems throughout the western United States. Federal fire statistics show that annual acreage burned in western states was substantially greater during the last two decades than in previous decades (Sampson et al. 2000). The National Interagency Fire Center web site (http://www.nifc.gov) indicates that the 2000 fire year was one of the worst in the last century in terms of acreage burned and economic damage sustained. The increased fire activity of recent decades is due in part to severe fire weather conditions that have occurred in several years, e.g., in 1987, 1988, 1994, 1996, and 2000. However, it also is a result of nearly a century of fire exclusion and fuel accumulation in forest ecosystems that burned every 10-20 years prior to the twentieth century (Dahms and Geils 1997, Moir et al. 1997). The growing economic losses and social concerns related to wildfire are a consequence not only of changes in the fires themselves, but also of recent social changes in the United States -- notably the dramatic increase in the building of homes and other structures within fire-prone forest ecosystems (Babbitt 1996, Romme 1997, Riebesame et al. 1997).

In response to the increasing threat of wildfire damage to human life, property, and natural resources, especially in the western U.S., the federal government released the National Fire Plan in 2000, and authorized wildfire-related expenditures of nearly $ 3 billion for fiscal year 2001 (USDA Forest Service and USDI 2000, Hill 2001). The state of Colorado also passed legislation (H.B. 1283), which enables counties to actively plan and participate in wildland fire management (Hodgson 2001), and numerous counties are enacting "firewise" zoning laws (Firewise 2000) to help reduce wildfire losses.

The objective of this study was to assess the hazard of wildfire within a representative portion of southwestern Colorado, and to depict the results of this assessment in the form of a spatially explicit fire hazard map. The concept of fire hazard, as we use it in this report, has two different components. First is the probability of

extreme and damaging fire behavior under severe fire weather conditions. We dealt with three key parameters of fire behavior in our analyses: total potential heat release, rate of fire spread, and flame length. The second component of fire hazard is the human values that may be lost or damaged if fire occurs. For this study, we treated only built residential parcels of land as areas of high value, but at the end of the report we identify additional components of value that should be addressed in future work.

Similar wildfire hazard assessments have been conducted in this and other areas, and others are in progress in response to the federal government's National Fire Plan of 2000. However, most previous wildfire hazard assessments either have been restricted to a single ecological and land-ownership type, e.g., a portion of a national forest, or have had very low spatial resolution. Burgan et al. (1998) mapped fuel model types and a fire potential index at 1-km^2 resolution across the entire continental United States. Broad-scale fire hazard maps also have been developed for portions of Spain (Chuvieco and Congalton 1989), Greece (Gouma and Chronopoulou-Sereli 1998), and the European Mediterranean Basin (Chuvieco et al. 1999). A group of fire, resource, and GIS experts met in Pingree Park, Colorado, in 1996 to develop a coarse-scale assessment of wildfire hazard throughout western Colorado (Sampson et al. 2000). The Colorado State Forest Service also has produced a more detailed assessment for the Front Range "red zone" – a 1.2 million acre wildland-urban interface zone near Denver, Colorado (Colorado State Forest Service, *undated*). A similar effort is underway in Florida (Brenner et al. *undated*). Broad-scale, wildfire hazard maps have been developed for parts of the northern Rockies (Burgan and Shasby 1984, Idaho Panhandle National Forests 1999, Landres et al. 1999), southwestern U.S. (Swantek et al. 1997, Keane et al. 2000), and Sierra Nevada Range (Caprio et al. 1997). Finer-scale analyses also have been conducted in the immediate vicinity of communities known to be at risk, e.g., the East Bay Hills near Oakland, California (Radke 1995), and Colorado Springs, Colorado (Mills 2000).

Our assessment of La Plata County is distinctive in that (1) it treats a wide range of land ownership types, including public lands, private lands, and American Indian reservations; (2) it encompasses substantial variability in vegetation/fuel types, from low-elevation semi-arid grasslands and woodlands, to alpine forests and meadows, to cultivated and residential lands; (3) it develops quantitative indices of potential fire behavior based on output of mechanistic fire behavior models; and (4) it maps wildfire hazard at relatively fine resolution (1 ha) for a large area (ca 4,500 km^2).

We envision two applications of the wildfire hazard evaluation and mapping that we present in this report. First, resource managers and fire control officers can use these results to identify the areas of highest priority for mitigation treatments designed to reduce local fire hazard. Appropriate mitigation techniques might include mechanical thinning, prescribed burning, or other actions (e.g., Kalabokidis and Omi 1998, Fule et al. 2001, Hollenstein et al. 2001). The second application will be for educational purposes, to better inform the public and land use planners about the hazards of wildfire in general and also to highlight specific geographic locations where fire hazard is most acute.

In its coarse-scale assessment of wildfire hazard throughout western Colorado, the Colorado State Forest Service (*undated*) identified southwestern Colorado as one of three regions in the state that may be at greatest risk of wildfire damage (the others being northwestern Colorado and the Front Range). Therefore, planners and managers in southwestern Colorado hope within the near future to conduct detailed wildfire hazard

assessments for the entire five-county region that includes Montezuma, Dolores, La Plata, San Juan, and Archuleta Counties. La Plata County is representative of this region in terms of vegetation, topography, land ownership patterns, land development patterns, and existence of pertinent data. Therefore, in addition to providing necessary data for La Plata County, the results and the methodology reported here can serve as a template for fire hazard assessment and mapping throughout the region.

Study Area and Methods

Study Area: La Plata County encompasses 4,500 km^2 in southwestern Colorado (Figure 1). It is a region of striking physical and socio-economic-political contrasts. The northern portion of the county lies within the rugged terrain of the San Juan Mountains, with alpine peaks exceeding 3,900 meters in elevation, whereas the southern part of the county is mostly foothills, plateaus, and river valleys, at lower elevations of 1,500 – 2,100 m. Most of the northern county is public land, part of the San Juan National Forest, with a sprinkling of private inholdings, especially along the highway corridor north of Durango. In contrast, the southern county is a mosaic of public land (Bureau of Land Management, state school sections, and Colorado Division of Wildlife), tribal land (Southern Ute Reservation), and private land. Agriculture is still a major land use in the southern part of the county, although much of the former agricultural land is rapidly being converted into low-density exurban housing (Romme 1997). Private residential development is concentrated in and near the incorporated urban areas of Durango, Bayfield and Ignacio, with extensive development along valley floors and mesa tops. Over half the residential population resides in the rural, unincorporated areas of the county.

Overview of the Mapping Process: Our overall approach for creating a wildfire hazard assessment and map is depicted in Figure 2, and details of each step are provided in the sections below (also see Appendix 1). All mapping was done in a GIS environment, primarily using ESRI ArcView 3.2a software with Spatial Analyst extension. All datasets were co-registered to the Universal Transverse Mercator Projection, NAD27, zone 13. This is the common format for federal resource management agencies. In the interest of enabling adjacent counties to repeat the process for their areas of concern, we emphasized the use of data that are easy to obtain, are available at no cost, and require minimal pre-processing. We obtained a vegetation map for the entire county from the Colorado GAP Analysis Project (Colorado GAP 1998), which is the basic vegetation layer for most of the wildfire hazard mapping work being done in Colorado (Skip Edel, Colorado State Forest Service, telephone conversation June 7, 2001). We supplemented the GAP data layer with the vegetation map of the San Juan National Forest, which is more accurate than the GAP map but covers only the northern part of the county. We developed a topographic map using 30-meter digital elevation model (DEM) data from the U. S. Geological Survey. The vegetation and topography data layers were combined to produce a raster base map of vegetation/slope units for the entire county. Each vegetation type was assigned a fuel model type, and then fire behavior under severe weather conditions was simulated for each fuel model using Behave. Output from Behave was adjusted to reflect the effects of aspect, and the

resulting values from the Behave simulations were assigned to each pixel in the vegetation/slope data layer to produce a map of expected fire behavior under severe weather conditions. Finally, we obtained a GIS layer of built parcels from the La Plata County Planning Department, and superimposed this map on the simulated fire behavior map to produce a final map of wildfire hazard.

Vegetation: Two sources of vegetation data were available in digital form: the Colorado GAP Analysis Project and San Juan National Forest. Disparities between resolutions and classifications of vegetation from the two sources required an initial investigation to determine suitability of each source for this project. The GAP vegetation map was created through photointerpretation of Landsat TM imagery with a minimum map unit of 100 hectares (40 hectares for riparian zones). The reason for the coarse resolution was the intent to use this map for vegetation assessments at the scale of a state to an eco-region– i.e., study areas of several thousand to millions of hectares and > 1:100000 scale (Colorado GAP 1998). The San Juan National Forest also photointerpreted Landsat imagery, but the minimum map unit was 30m, allowing finer resolution for the more localized applications of this vegetation map.

Testing the Accuracy of the GAP map: We knew from our previous work in the San Juan National Forest (Romme et al. 2001) that the Forest Service vegetation map had a high degree of accuracy, but we were unsure whether the coarse-scale GAP map was adequate for the high-resolution analyses involved in this fire hazard assessment. Therefore, to test the GAP vegetation map, we extracted from the San Juan National Forest vegetation map the area of the Columbine Ranger District, which covers most of northern La Plata County, and clipped this map to the GAP map using the ArcView Geoprocessing extension. We reclassified the Forest Service clipped layer according to GAP derived primary vegetation classes, based on our familiarity with the Forest Service vegetation types. The re-classified Forest Service polygons then were dissolved according to the GAP classification, using the Geoprocessing extension, and intersected with the GAP coverage to produce a layer reflecting the degree of coincidence of vegetation polygons.

This test produced a match of 45% -- not really good enough to give us great confidence in the accuracy of the GAP vegetation map. Therefore, we partially compensated for the coarse nature of the GAP data by comparing the Forest Service data not only to the primary vegetation on the GAP map, but also to the secondary vegetation types listed for each GAP polygon (i.e., vegetation types present in each GAP polygon but comprising less of the polygon area than the primary vegetation type). Other studies have used similar "fuzzy tolerances" to improve the usefulness of coarse vegetation data (Keane et al. 2000). Our second test of intersection of the two maps, incorporating both primary and secondary GAP classes, increased the match to 63%. By also including the "other" vegetation class in GAP, we increased correspondence between the Forest Service and GAP maps to 73%. No such comprehensive test model was available for the southern portion of La Plata County.

It was not possible to test the accuracy of the GAP map in southern La Plata County, because no independent vegetation data exist for that area (although

work is in progress on the Southern Ute Reservation – Friedley and Burger 1997). However, based on the reasonable accuracy of the GAP map for the northern part of the county (i.e., the 73% correspondence between the GAP map and the accurate Forest Service map described above), we felt it was acceptable to use the GAP data as the base vegetation map for all of La Plata County. Rather than relying entirely on the GAP map, however, we modified the GAP map to correct two errors that were conspicuous when we visually compared the Forest Service and GAP maps. These two errors were related to the distribution of aspen forests and riparian vegetation.

Improving the Aspen Coverage: The GAP vegetation classification includes aspen forests within a coarse category called "aspen/mixed conifer." Because aspen and mixed conifer exhibit very different fire behavior, and because nearly all of the aspen in La Plata County occurs in the northern part of the county which is covered by the Forest Service vegetation map, we improved GAP's aspen coverage as follows. First, we intersected Forest Service aspen polygons with the GAP aspen/mixed conifer polygons. All intersecting polygons then were re-classified as Aspen in our final vegetation map. Portions of the GAP polygons that did not intersect Forest Service aspen polygons were re-classified as mixed conifer.

Adding Riparian Coverage: The GAP map contains only a coarse-scale (40 ha resolution) riparian vegetation class, which was not adequate for our purposes since even small riparian and wetland areas can strongly influence fire behavior. Creating a high-resolution riparian layer was not straightforward. After trying several different approaches that gave unsatisfactory results (based on visual inspection of the resulting maps), we obtained an extension from ESRI's ArcScripts web site (http://gis.esri.com/arcscripts/scripts.cfm). The Buffer by Elevation Change extension ("buffbyrise1.avx" file, authored by Damon Holzer, Texas A&M University) creates a buffer zone around a line feature based an elevation change away from that feature. This script, applied to our DEM layer (described below) and a line shapefile of the stream network produced reasonable riparian polygons -- polygons that were accurate enough for this first phase of mapping, but that could be improved in future work (see Discussion below for directions of future model refinement). Riparian areas delineated with this procedure were added to the GAP coverage.

Topography: We created a base map of elevation through the acquisition and manipulation of 30- meter resolution USGS 7.5 minute DEMs . The process to create the base topographic map involved downloading 40 individual DEMs covering all of La Plata county plus an adjacent area beyond its borders. The individual DEMs were mosaicked in five to six piece portions using the Grid Analyst extension from ESRI. All DEMs west of 108d longitude required re-projection from UTM Zone 12 to Zone 13 in order to achieve correct spatial orientation with the remaining DEMs. This was achieved by using the Reproject Grids extension downloaded from ESRI's ArcScripts web site ("reproject.avx" file, authored by William Huber, Quantitative Decisions). The re-projected DEMs were then mosaicked, and merged as a group to the UTM Zone 13 mosaic to create a complete a countywide DEM. This layer was then clipped to the county

boundary shapefile using the Clip Grid(s) script (clipgrid.ave file, authored by Tom Van Niel, CSIRO) available from the ESRI ArcScripts web site. The clipped countywide DEM was then manipulated using Spatial Analyst to derive slope and aspect layers. Slope was classified into three classes: low (0-20%), moderate (20-40%), and steep (>40%) to coincide with classes used in public information documents (USDA 2000). The slope coverage was cross-classified with the vegetation. coverage. This allowed us to identify areas with unique combinations of slope and vegetation.

Behave does not directly simulate the effects of aspect, but aspect is an important modifier of fire behavior because of its effects on fuel moisture, fuel pre-heating, vegetation mix, and exposure to prevailing wind. The National Fire Danger Rating System incorporates a southwestern aspect in its calculations to represent worst-case conditions (Bradshaw et al. 1978), and other studies have incorporated aspect by assigning various subjective or weighted values to the various azimuth directions (Caprio et al. 1997, Colorado State Forest Service 1997).

For our analysis, we divided aspect into three weighted classes (Table 1). By assigning a multiplier value to each of the three aspect classes, Behave output could be adjusted for aspect to give a final value for the three fire behavior parameters used in our hazard assessment. Note that the weighting coefficients for the three aspect classes were derived subjectively, based on our prior experience with fire and vegetation in this area. These coefficients could be adjusted to reflect local experience in other areas.

Fuel Models: Two systems of fuel classification are frequently used in fire management: the 13 FBFM (Albini 1976) models and the 20 NFDRS models (Burgan and Rothermel 1984, Burgan 1988). The FBFM fuel models were used in this project to allow incorporation into Behave modeling, and to coincide with fire line fire behavior handbooks (NWCG 1993). We assigned a fuel model to each GAP vegetation type, based on descriptions provided by fuel models documentation (Anderson 1982) as well as our knowledge of local vegetation characteristics and fire behavior. The assigned fuel models were then added to the vegetation grid attribute table to enable querying by fuel model (Table 2).

Fire Behavior Modeling with Behave: Behave is a mechanistic fire behavior model that is widely used in fire management (e.g., Andrews 1986, Rothermel et al. 1986, Andrews and Chase 1989, Radke 1995, Gardner et al. 1999, Mills 2000), and is available free on-line at www.fire.org. Our combined vegetation/slope grid, with fuel models assigned to each vegetation type (Table 2), provided the necessary matrix to spatially display our Behave results.

From the six fire behavior outputs available in Behave, we selected heat release (btu/ft2), spread rate (ch/hr), and flame length (ft) as the parameters most pertinent to our analysis. *Heat release* (btu/ft2), an indicator of the total potential damage from a fire, varies with fuel model type and fuel moisture, but is independent of slope and wind. *Rate of spread* (chains/hour, a chain is 66 feet) is affected by fuel model, fuel moisture, slope, and wind. *Flame length* (ft) is

influenced by fuel model, fuel moisture, slope, and wind. Flame length is often used as a general descriptor of fire intensity and difficulty of suppression: a flame length of four feet is considered the upper limit for hand crews (NWCG 1993). Flame length also is one determinant (along with crown base height and sub-canopy ladder fuels) of whether a fire will spread from surface fuels into the canopy. Heat release, rate of spread, and flame length are all inter-related in Behave (Andrews 1986), but each gives a somewhat different perspective on overall fire behavior and potential for causing damage.

Fuel moisture, atmospheric humidity, temperature, and wind all have powerful influences on fire behavior, and one could simulate an almost endless array of potential fire behaviors under all combinations of vegetation type, slope, and ambient weather conditions. However, our focus in this study was on fire behavior and fire damage that could occur under severe fire weather conditions. In much of western North America, most of the fires are small, while a few fires burning under severe conditions account for most of the area burned during any given time period (e.g., Renkin and Despain 1992, Johnson 1992, Moritz 1997). Therefore, to identify areas of fire hazard in La Plata County based on a worst-case scenario, we used realistic but extreme weather conditions rather than average conditions in our Behave simulations (Table 3). Live woody fuel and live herbaceous fuel were both assigned 50% fuel moisture, which is at or near the threshold to be considered as potentially dead fuel. We did not incorporate wind in the Behave simulations, however, because nearly all output parameters are simply increased by wind, and our objective was to compare potential fire behavior among different geographic areas within the county under a given severe fire weather scenario.

We began our fire behavior analysis by simply running Behave for each fuel model in the study area (Table 2) under extreme weather conditions (Table 3). Inspection of the output revealed one serious problem: both the ponderosa pine and the pinyon-juniper types produced relatively low values for heat release, rate of spread, and flame length (data not shown). We knew from our own previous experience, and from consultation with local agency fire managers, that these two vegetation types actually are capable of exhibiting extreme fire behavior. The reason for the discrepancy was that the fuel models we had assigned to these two vegetation types assumed light surface fuels composed mainly of litter. In La Plata County, however, both ponderosa pine and pinyon-juniper forests almost always have a well-developed understory of Gambel oak or big sagebrush – both of which can produce extreme fire behavior.

Behave allows the use of two fuel models in combination, as long as one model is a majority. Behave results provide parameter values for each model and a combined spread rate. To determine appropriate mix percentages, we used an attribute of the GAP vegetation called primary crown, which describes the percent coverage of the primary vegetation crown in each GAP polygon. Since oak and big sagebrush were both assigned fuel model 4 (Table 2), the process became one of incorporating fuel model 4 into the mix with Ponderosa and Pinyon-Juniper, based on primary crown percentages. In the resulting combined fuel models, spread rate was calculated for fuel combinations, heat release was determined as the percentage mix of btu/ft2 values for the two fuel models, and flame length

was determined as the greater of the two values produced by the two fuel models (Andrews and Chase 1989).

Cultural Values: People may value an enormous variety of characteristics of the natural and built environment (Hodgson 2001), and it was beyond the scope of this project to identify and adequately incorporate all potential cultural values in La Plata County. Community-wide discussions are now under way to address this issue of values (Sam Burns, Office of Community Services, Fort Lewis College, personal communication), and future hazard assessments will incorporate a richer treatment of values as a result of those discussions. Nevertheless, because one important and urgent objective of fire managers is to identify specific areas where residential property is threatened by wildfire, and because pertinent spatial data were already available, we focused this analysis on residential parcel values only.

A parcel shapefile was acquired on-line from the La Plata County GIS Department (http://co.laplata.co.us/gis.html). This shapefile was queried by the property use attribute (prop_use) to identify residential parcels only. These parcels were then queried for development status (built/un-built) based on the year built attribute (yr_built) -- a method suggested by Alan Andrews (personal communication) manager of the La Plata County GIS Department. This query produced a GIS map of residential areas containing homes or other structures throughout the county. The residential parcel data did not precisely locate individual structures within a given parcel. This is a problem for large parcels that may contain only one or a few structures, since fire on the un-built portion of the parcel really does not threaten structures. Despite a number of attempts, we were unable to find a satisfactory way to deal with this problem (see Discussion section in this report). The residential parcel data also excluded agricultural parcels, although conversion from agricultural to residential use is an on-going process. The La Plata County GIS office routinely updates parcel information as it receives records of changes in land use, so the fire behavior output maps that we developed here can be overlaid on updated parcel maps at any time in the future to depict current hazards.

Results

Vegetation and Fuels Map: The final vegetation map that we produced for La Plata County (Figure 3) illustrates the striking environmental differences that exist between the northern and southern portions of the county. The northern part of the county is rugged and mountainous, and contains several vegetation types that are absent in the southern part, e.g., tundra, spruce-fir, Douglas-fir, and aspen. In contrast, the southern part of the county is comprised of gentler topography and a preponderance of grassland, shrubland, woodland ,and agricultural vegetation types. Appendix 2 contains detailed descriptions of the vegetation types. Each vegetation type was assigned a fuel model (Figure 4) for use in the Behave fire behavior modeling.

Patterns of Residential Development: The map of built residential parcels (Figure 5) reveals a concentration of homes along an east-west band in the central part of La Plata County. There are numerous patches of exurban development elsewhere in the county as well – on the mesas and along the major river valleys in the southern part of the county, and along the Highway 550 corridor and around Vallecito Reservoir in the north. However, the greatest concentration of exurban development is in the central part of the county, in the foothills of the San Juan Mountains. A wide variety of housing is represented in Figure 5, from multi-million dollar homes on large lots, to medium-scale homes in tract subdivisions, to low-rent trailer parks.

Potential Fire Behavior: What kinds of fire behavior could occur in La Plata County under severe fire weather conditions (Table 3)? Numerical results of the Behave simulations are summarized in Appendix 3, and spatial patterns are depicted in Figures 6 – 11. *Simulated heat release* (Figure 6) ranges from < 500 Btu/ft2 in tundra, riparian vegetation, and irrigated agriculture, to > 5000 Btu/ft2 in oak, ponderosa pine/oak, and pinyon-juniper/sagebrush on steep southerly slopes. Intermediate values of heat release are predicted in aspen, grasslands, and some of the other, less widespread vegetation types in the county. Notice in Figure 6 that heat release values tend to be especially high in the central portion of La Plata County where exurban development also is most concentrated. This pattern is even more striking when built parcels are overlaid on potential heat release (Figure 7).

Simulated flame length under severe fire weather conditions (Figure 8) ranges from < 3 feet in tundra and wetlands, to > 15 feet in ponderosa pine / oak and pinyon-juniper / sagebrush on steep southerly slopes. Aspen and some less common vegetation types have simulated flame lengths of 3 – 8 feet. The greatest simulated flame lengths tend to be in the southern and central portions of the county, including the central zone where exurban development is highly concentrated (Figure 9).

Simulated spread rates under severe fire weather conditions (Figure 10) are relatively low (< 14 chains/hour) in most of the county. However, moderate to high rates of spread (25 – 75 chains/hour) are seen in some grasslands and oak shrublands on steep southerly slopes. The greatest occurrence of moderate and high spread rates is in the central zone of the county where exurban development is concentrated, although most of the built parcels lie in close proximity to areas having high spread rates rather than within such areas (Figure 11).

Discussion

Validating the Model: Formal model validation is difficult in an analysis of this kind, because no rigorous independent data set is available. However, we tested our model output using a less rigorous, but nevertheless informative, approach based on expert opinion.

There were two components to this testing process. First, we developed a draft version of the model independently of input from local fire managers, using single fuel models for each vegetation type and disregarding topographic aspect because we had no quantitative data on effects of aspect on fire behavior. We then held a meeting with federal and state fire managers who have worked for many years in La Plata County, as well as fire control officers from the local fire protection districts. At the meeting we

presented our preliminary results and asked for critical feedback – which was freely given! Overall, the practicing fire managers thought our modeling approach was sound, and thought that most of the predictions of fire behavior under severe fire weather conditions were consistent with their previous experience. However, they identified two areas where our predictions were inconsistent with their experiences. The first was in ponderosa pine and pinyon-juniper forests, where our simulations – based on single fuel models -- predicted relatively benign fire behavior. The managers' experience was that these vegetation types could produce extreme fire behavior because of the highly flammable shrub component. In response, we developed the combined fuel models (described above in the Methods section). The managers' second criticism of our preliminary model was that aspect in fact makes a big difference in fire behavior in La Plata County. Specifically, in their experience, southerly aspects tend to burn more vigorously than northerly aspects. Therefore, we added the weighting factors for aspect, as described in the Methods section.

The second test of our model involved a written survey given to the same local fire managers and fire control officers. The survey asked managers to (1) identify specific locations within the county where they perceived the greatest wildfire threat to homes (Bill, this was the map that Dan Ochocki furnished), and (2) to rate each vegetation type for its potential to exhibit extreme fire behavior and for the difficulty of controlling fire under severe weather conditions. The managers and control officers identified several rural subdivisions at risk within the central and southeastern portions of the county and along the Highway 550 corridor in the north (Figure 12). All of these areas were in places where our Behave simulations predicted high values for heat release, flame length, and/or rate of spread, and where we identified a concentration of built parcels. Similarly, the experts identified oak shrublands, ponderosa pine / oak forests, and pinyon-juniper / sagebrush forests as the vegetation types with the greatest potential for extreme and uncontrollable fire behavior (Table 4). Interestingly, the local fire experts assigned relatively low values to spruce-fir forests for potentially severe fire behavior and difficulty of control. This was surprising, in light of the extreme fire behavior observed in spruce-fir forests during the 1988 Yellowstone fires. This apparent discrepancy may reflect the fact that no major fires have occurred in spruce-fir forests in southwestern Colorado during the last century. Overall, however, the survey results indicated that our predictions of fire hazard were generally congruent with the experience of local fire experts.

Where in La Plata County is Wildfire Hazard the Greatest? Our Behave simulations indicated that the environments likely to produce the most damaging and uncontrollable fire behavior are those with (1) steep southerly slopes and (2) oak, ponderosa pine, or pinyon-juniper vegetation. Unfortunately, these also are some of the most popular locations for building homes, because of the views and greenery that they afford.

The portion of La Plata County having the greatest potential for serious losses to wildfire appears to be the central zone depicted in Figures 5 – 11. This area is characterized by generally high values for heat release, flame length, and rate of spread, because of the preponderance of highly flammable ponderosa pine, pinyon-juniper, and oak vegetation on moderate to steep slopes. A composite map of wildfire hazard –

produced by equally weighting the three individual parameters of heat release, flame length, and rate of spread, and normalizing the combined values to a scale of 0 –1, in combination with a synthetic normalized parcel density index (Figure 13) – clearly shows the potential for extreme fire behavior in the central part of the county. The central zone also contains numerous major subdivisions around Durango (e.g., Shenandoah, Durango West, Rafter J, Edgemont Ranch, and the Grandview area), north of Bayfield (e.g., Forest Lakes), as well as numerous subdivisions on the northern portion of Florida Mesa. According to local fire control officers, some of these subdivisions also have serious problems related to access of emergency vehicles in the event of a fire.

In addition to the central band of high wildfire hazard, a number of smaller areas throughout La Plata County appear in Figures 6-11 as places of concern. Areas of concern in the northern part of the county include Falls Creek Ranch and the dispersed housing on the south-facing slopes of the lower Hermosa drainage, where homes are nestled within dense ponderosa pine forests; as well as the Electra Lake area, the Highway 550 corridor near Durango Mountain Resort, and the shores of Lemon and Vallecito Reservoirs, all of which are places having numerous houses within flammable mixed conifer forests. Areas of concern in the southern portion of the county are scattered across Florida Mesa, along the lower Animas River corridor, and on the "dry side" of the county – all places where houses are situated within pinyon-juniper or sagebrush vegetation.

Further Refinements of the Wildfire Hazard Model: We believe that the analysis and maps presented above are adequate for initial strategic planning purposes in La Plata County. For more precise and accurate assessments, however, we identified three aspects of our model that will require additional work. The most serious shortcoming of our product is the coarse resolution of our basic fuels / vegetation map. In similar hazard mapping efforts around the country, inadequate spatial fuels data have been identified as one of the most serious limitations (e.g., Caprio et al. 1997, Keane et al. 2000). We plan to address this problem by producing a finer-scale map of fuels conditions – especially crown density -- in ponderosa pine and pinyon-juniper forests throughout the central zone that we identified as the general area of highest fire hazard. We also hope to develop a more accurate map of riparian areas. This refined vegetation / fuels map will be produced through aerial photo interpretation (e.g., Oswald et al. 1999). Because photo interpretation is slow and labor-intensive, it is not feasible to map the entire county in this way. However, it is feasible to map the central zone of potentially greatest hazard. By coupling a more detailed fuels map for the central portion of the county with a spatially explicit database of historic fire starts (e.g., Avalos and Alvarado 1998, Vasquez and Moreno 1998), we also hope to simulate fire behavior and spatial patterns using a model such as Farsite (e.g., Meyer 1996, Finney 1999). These planned new simulations will be presented in a future report.

A second shortcoming of our current model is the lack of precision as to locations of homes and other structures. We simply mapped all of the built parcels in the county, but were not able to specify exactly where individual structures were situated within each parcel. This is a minor problem with small parcels, but a potentially serious problem with large parcels. We made a preliminary attempt to use coordinates of electric meters (data provided by La Plata Electric Association) to pinpoint locations of homes,

but the meter locations failed to identify numerous significant structures other than homes. A related shortcoming of our current map is that it does not distinguish between parcels that have been treated to create defensible space and parcels that have not been so treated. We will address both of these problems with our aerial photo interpretation (described above), which will provide a better map of both fuels and of structures within the central zone of the county where wildfire hazard is generally the greatest.

The third major limitation of this completed phase of our wildfire hazard assessment is its restricted definition of cultural values. We have identified wildfire hazards only for homes and other structures. In future work, we hope to expand our treatment of cultural values to watersheds, viewsheds, critical habitats for sensitive species, and other aspects of the landscape that people value (e.g., Fried et al. 1999, Hodgson 2001).

Acknowledgments

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Literature Cited

Albini, Frank A. 1976. Estimating Wildfire Behavior and Effects. General Technical Report INT-30. Ogden, Utah. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 92 p.

Anderson, Hal E. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. General Technical Report INT-122. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forestry and Range Experiment Station. 22 p.

Andrews, Patricia L. 1986. BEHAVE: Fire Prediction and Fuel Modeling System-BURN Subsystem, Part 1. General Technical Report INT-194. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 130 p.

Andrews, Patricia L.; Chase, Carolyn H. 1989. BEHAVE: Fire Behavior Prediction and Fuel Modeling System- BURN Subsystem, Part 2. General Technical Report INT-260. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 93 p.

Avalos, C. D., and E. Alvarado. 1998. Space-time analysis of fire pattern in the Blue Mountains, Oregon. 13th Fire and Forest Meteorology Conference, Lorne, Australia 1996, p 413-420. Published by IAWF .

Babbitt, B. 1996. Making Peace with Wildland Fire. NYC, NY. Wildfire Magazine: 1-9.

Bradshaw, Larry S.; Deeming, John E.; Burgan, Robert E.; Cohen, Jack D. 1983. The 1978 National Fire-Danger Rating System: Technical Documentation. General Technical Report INT-169. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 44 p.

Brenner, J., K. Green, J. Coen, and S. McLellan. *undated*. Assessing fire risk in Florida using integrated GIS and remote sensing applications. http://www.esri.com/library/userconf/proc01/professional/papers/pap826/

Burgan, Robert E. 1988. 1988 Revisions to the 1978 National Fire-Danger Rating System. Research Paper SE-273. Asheville, North Carolina: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 39 p.

Burgan, R. E., and M. B. Shasby. 1984. Mapping broad-area fire potential from digital fuel, terrain, and weather data. Journal of Forestry 82:228-231.

Burgan, Robert E.; Rothermel, Richard C. 1984. BEHAVE: Fire Prediction and Fuel Modeling System- FUEL Subsystem. General Technical Report INT-167. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 126 p.

Burgan, R. E., R. W. Klaver, and J. M. Klaver. 1998. Fuel models and fire potential from satellite and surface observations. International Journal of Wildland Fire 8:159-170.

Caprio, T.; Conover, C.; Keifer, M.B.; Lineback, P. 1997. Fire Management and GIS. Three Rivers, California: U.S. Department of the Interior, National Park Service, Sequoia-Kings Canyon National Park. www.nps.gov/seki/fire. 9 p.

Carlton, Don. 2000. BehavePlus Fire Modeling System: Users' Guide. Missoula, Montana. Systems for Environmental Management. 81 p.

Chuvieco, E., and R. G. Congalton. 1989. Application of remote sensing and geographic information systems to forest fire hazard mapping. Remote Sensing of Environment 29:147-159.

Chuvieco, E., F. J. Salas, L. Carvacho, and F. Rodriguez-Silva. 1999. Integrated fire risk mapping. Chapter 5 (p 61-100) in: Chuvieco, E. (Editor), Remote sensing of large wildfires in the European Mediterranean Basin. Springer-Verlag, Berlin Heidelberg.

Colorado GAP Analysis Project. 1998. Metadata. Denver, Colorado: Colorado Division of Wildlife. 108 p.

Colorado State Forest Service. 1997. Wildfire Hazard Mitigation and Response Plan. Colorado State Forest Service, Fort Collins, Colorado. 37 p.

Colorado State Forest Service. Undated. Colorado Statewide Fire Hazard Analysis. Compilation of Reports and analyses, Colorado State Forest Service, Fort Collins, Colorado. 37 p.

Dahms, C. W., and B. Geils (editors). 1997. An assessment of forest ecosystem health in the Southwest. USDA Forest Service General Technical Report RM-GTR-295.

Finney, Mark A. 1999. FARSITE: Fire Area Simulator Version 3.0 User Guide. Missoula, Montana. Systems for Environmental Management. www.fire.org/farsite.

Firewise. 2000. A Little Background. www.firewise.org.

Fried, J. S., G. J. Winter, and J. K. Gilless. 1999. Assessing the benefits of reducing fire risk in the wildland-urban interface: a contingent valuation approach. International Journal of Wildland Fire 9:9-20.

Friedley, Jim; Burger, Bruce. 1997. Meeting Forestry Resource Data Needs with Digitally Captured Aerial Photo Imagery and GIS. Ignacio, Colorado: U.S. Department of the Interior, Bureau of Indian Affairs, Branch of Forestry. 8 p.

Fule, P. Z., A. E. M. Waltz, W. W. Covington, and T. A. Heinlein. 2001. Measuring forest restoration effectiveness in reducing hazardous fuels. Journal of Forestry 99(11):24-29.

Gardner, R. H., W. H. Romme, and M. G. Turner. 1999. Predicting forest fire effects at landscape scales. Chapter 7 (p. 163-185) in: Mladenoff, D. J., and W. L Bakers (editors), Spatial modeling of forest landscape change: approaches and applications. Cambridge University Press.

Gouma, V., and A. Chronopoulou-Sereli. 1998. Wildland fire danger zoning – a methodology. International Journal of Wildland Fire 8:37-43.

Hill. B. T. 2001. The National Fire Plan: Testimony before the Subcommittee on Forests and Forest Health, Committee on Resources, House of Representatives. United States General Accounting Office, GAO-01-1022T.

Hodgson, Ron. 2001. Quick Fire Plan: Community-Based County Fire Planning. Presentation at La Plata County Fire Hazard Assessment Map meeting. June 26, Durango, Colorado. 6 p.

Hollenstein, K., R. L. Graham, and W. D. Shepperd. 2001. Biomass flow in western forests: simulating the effects of fuel reduction and presettlement restoration treatments. Journal of Forestry 99(10):12-19.

Idaho Panhandle National Forests. 1999. Wildfire risk assessment (http://www.fs.fed.us/outernet/ipnf/eco/projects/nzfirerisk/index.html)

Johnson, E. A. 1992. Fire and vegetation dynamics: Studies from the North American boreal forest. Cambridge University Press, Cambridge, UK.

Kalabokidis, K. D., and P. N. Omi. 1998. Reduction of fire hazard through thinning / residue disposal in the urban interface. International Journal of Wildland Fire 8:29-35.

Keane, Robert E.; Mincemoyer, Scott a.; Schmidt, Kirsten M.; Long, Donald G.; Garner, Janice L. 2000. Mapping Vegetation and Fuels for Fire Management on the Gila National Forest Complex, New Mexico. General Technical Report RMRS-GTR-46-CD. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 126 p.

Landres, P. and others 1999. Wildland fuels management: evaluating and planning risks and benefits. Project description in 1999 Joint Fire Science Program (http://www.nifc.gov/joint_fire_sci/99proj.htm).

Meyer, Joseph. 1996. FARSITE GIS Modeling in the 1996 Yosemite Ackerson Fire. ESRI User Conference Proceedings. San Diego, California. http://www.esri.com/library/userconf/proc97. 2 p.

Mills, William. 2000. Colorado Springs Wildland Fire Management Officer. Personal communication. October 6, Colorado Springs, Colorado.

Moir, W. H., B. Geils, M. A. Benoit, and D. Scurlock. 1997. Ecology of southwestern ponderosa pine forests. Pages 3-27 in: Block, W. M., and D. M. Finch (editors), Songbird ecology in southwestern ponderosa pine forests, USDA Forest Service General Technical Report RM-GTR-292.

Moritz, M. A. 1997. Analyzing extreme disturbance events: fire in Los Padres National Forest. Ecological Applications 7:1252-1262.

NWCG (National Wildfire Coordinating Group). 1993. Fireline Handbook. Appendix B. Fire Behavior. NFES 2165. NIFC. Boise, Idaho. 115 p.

Oswald, B. P., J. T. Fancher, D. L. Kulhavy, and H. C. Reeves. 1999. Classifying fuels with aerial photography in east Texas. International Journal of Wildland Fire 9:109-113.

Radke, John. 1995. A Spatial Decision Support System for Urban/Wildland Interface Fire Hazards. San Diego, California. ESRI User Conference Proceedings. http://www.esri.com/library/userconf/proc95. 11 p.

Renkin, R. A., and D. G. Despain. 1992. Fuel moisture, forest type and lightning-caused fire in Yellowstone National Park. Canadian Journal of Forest Research 22:37-45.

Riebesame, W. E., H. Gosness, and D. Theobald. 1997. Atlas of the new West: portrait of a changing region. W. W. Norton & Company, New York, NY, USA.

Romme, W. H. 1997. Pseudorural landscapes in the Mountain West. Chapter 8 in: Nassauer, J. (editor), Placing Nature: Culture and Landscape Ecology. Island Press, Washington, D.C.

Romme, W. H., M. L. Floyd, and D. Hanna. 2001. Landscape condition analysis for the south central highlands section, Colorado and New Mexico. Unpublished report to San Juan National Forest, Durango, CO.

Rothermel, Richard C.; Wilson, Ralph A.; Morris, Glen A.; Sackett, Stephen S. 1986. Modeling Moisture Content of Fine Dead Wildland Fuels: Input to the Behave Fire Prediction System. Research Paper INT-359. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 61 p.

Sampson, R. N., R. D. Atkinson, and J. W. Lewis. 2000. Indexing resource data for forest health decisionmaking. Chapter 1 (p1-14) in: Sampson, R. N., R. D. Atkinson, and J. W. Lewis (editors), Mapping wildfire hazards and risks. The Haworth Press, Inc., New York [co-published as Journal of Sustainable Forestry, Volume 11, Numbers 1,2, 2000].

Sampson, R. N., R. D. Atkinson, and J. W. Lewis (editors), Mapping wildfire hazards and risks. The Haworth Press, Inc., New York [co-published as Journal of Sustainable Forestry, Volume 11, Numbers 1,2, 2000].

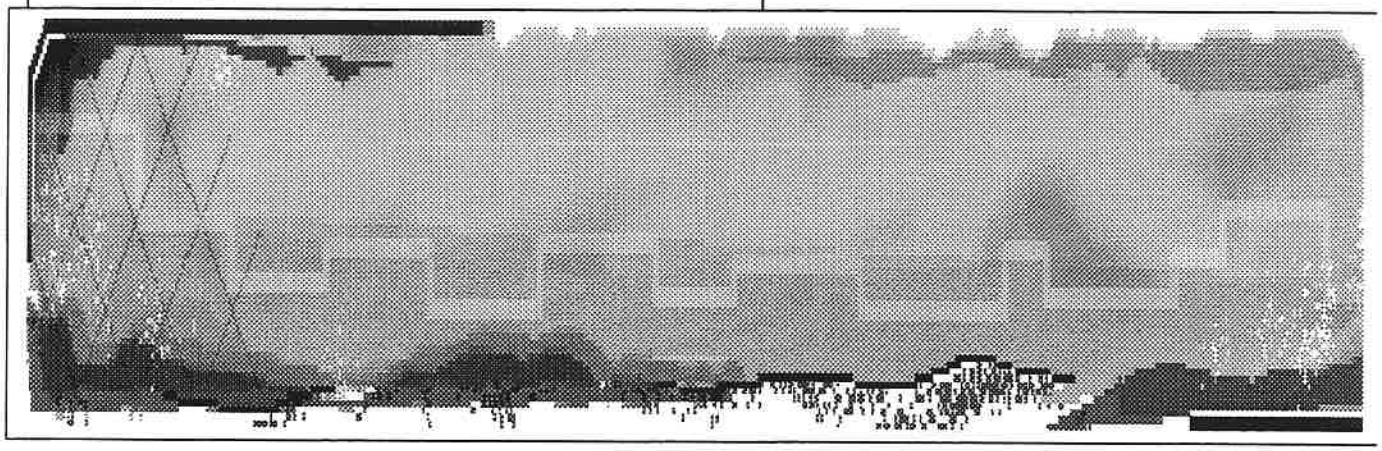
Swantek, P.J; Halvorson, W.H.; Schwalbe, C.R. 1997. The Use of GIS and the Internet for Analyzing Fire History of the Sonoran Desert: A Regional Approach in Arizona. ESRI User Conference Proceedings. San Diego, California. http://www.esri.com/library/userconf/proc97. 12 p.

U.S.D.A. Forest Service. 2000. Living With Fire. Reno, Nevada. University of Nevada Press. 10 p.

U.S.D.A. Forest Service; U.S. D.I. 2000. Report to the President: Managing the Impact of Wildfires on Communities and the Environment. http://www.fs.fed.us/fire/nfp/president. 26 p.

Vasquez, A., and J. M. Moreno. 1998. Patterns of lightning-, and people-causes fires in peninsular Spain. International Journal of Wildland Fire 8:103-115.

Appendix C



January 7, 2002

Forest Products Purchasers, Service Contractors (TSI, Defensible Space, etc.), Arborists, & Natural Resource Consultants Servicing the CSFS Durango District (Archuleta, Dolores, La Plata, Montezuma, & San Juan Counties, CO)

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FAX: (970) 564-0415
E-mail: cfpinc@fone.net

Cogburn Timber Company
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Crosscut Logging
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Horse Logging & Farming Cooperative
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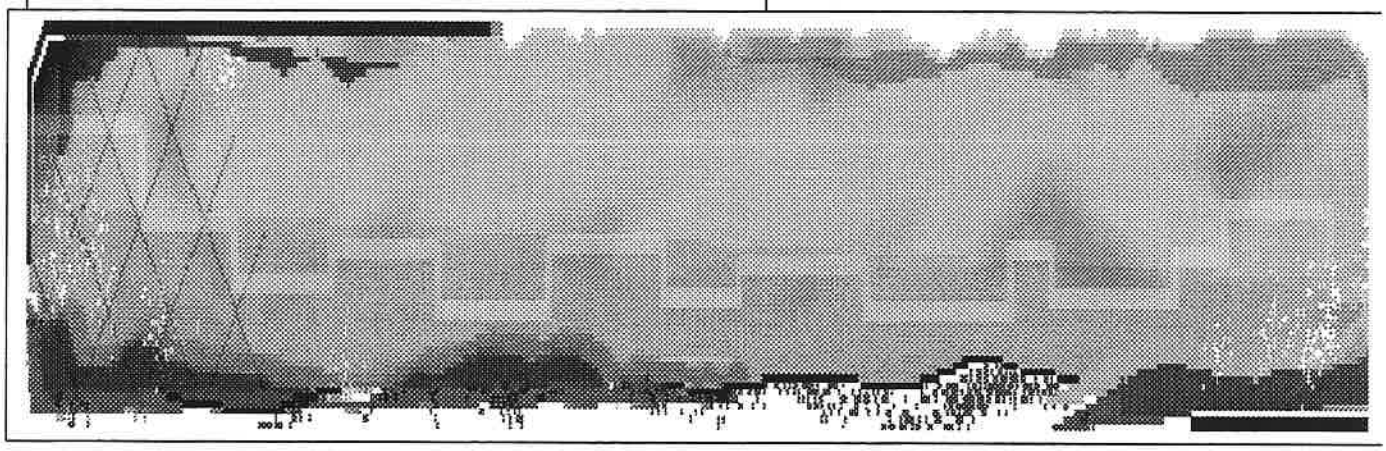
* Denotes a professional forester or organization employing a forester.

Appendix D



La Plata County Fire Chiefs 2002

CONDITIONS TO EVALUATE STRATEGY FOR FIRE ATTACK IN URBAN INTERFACE
General Guidelines

CONDITIONS	LOW (*SEE NOTE)	MODERATE (*SEE NOTE)	HIGH (*SEE NOTE)
ACCESS & EGRESS	Two ways in & out Roadways greater than 12' wide	Two ways in & out Roads are 12' wide	One way in & out Road standard not followed Less than 12' wide
TOPOGRAPHY	Flat ground No fuels Open space No tree canopy No heavy shrubs, sagebrush or oak brush	Fuel loading heavy to light North slope South-East-West facing slopes less than 20% Open space Moderate tree canopy more than 10' apart Ladder fuels are reduced Mitigation in place	South-East-West facing slopes more than 20% Types of fuel—pine, pinion, juniper, heavy oak brush or brush Tree canopy closer than 10' Ladder fuels are not reduced No mitigation in place
STRUCTURE	Total fire resistant construction Managed defensible space Water supply-Pond/ Stream/Hydrants	No wooden shake roofs Defensible space around structure Water supply within vicinity	Roofs & buildings made of combustible construction materials No defensible space around structure No water supply
RESPONSE	Emergency Response	Emergency Response	Response Limited to Situation

NOTE: Low & moderate may move to high depending on these factors: 1) Weather; 2) Location of fire; 3) Size of fire and; 4) Availability of local resources.

LA PLATA COUNTY COMMUNITY ACTION PLAN

National Fire Plan

COUNTY BOUNDARY
FOREST/DISTRICT BOUNDARY
FIRE PRETECTION AREAS OF CONCERN

FS HAZARDOUS FUEL REDUCTION ACTIVITIES
- 2001
- 2002
- 2003
- 2004

BLM HAZARDOUS FUEL REDUCTION ACTIVITIES
- 2001
- 2002
- 2003
- 2004 and Beyond

FS PREVIOUS TREATMENTS

LAND STATUS
- Private
- National Forest
- BLM
- Southern Ute
- Ute Mtn Ute
- State
- CO Div of Wildlife

LA PLATA COUNTY FIRE PROTECTION DISTRICTS
DFRA - Durango Fire/Rescue Authority
UPFD - Upper Pine Fire Protection District
LPFD - Los Pinos Fire Protection District
FLMFD - Fort Lewis Mesa Fire Protection District

No warranties, implied or otherwise, are made as to the fitness and accuracy of this data. It is intended only for general planning purposes.

Initial mapping prepared by San Juan Public Lands - 11/13/2001