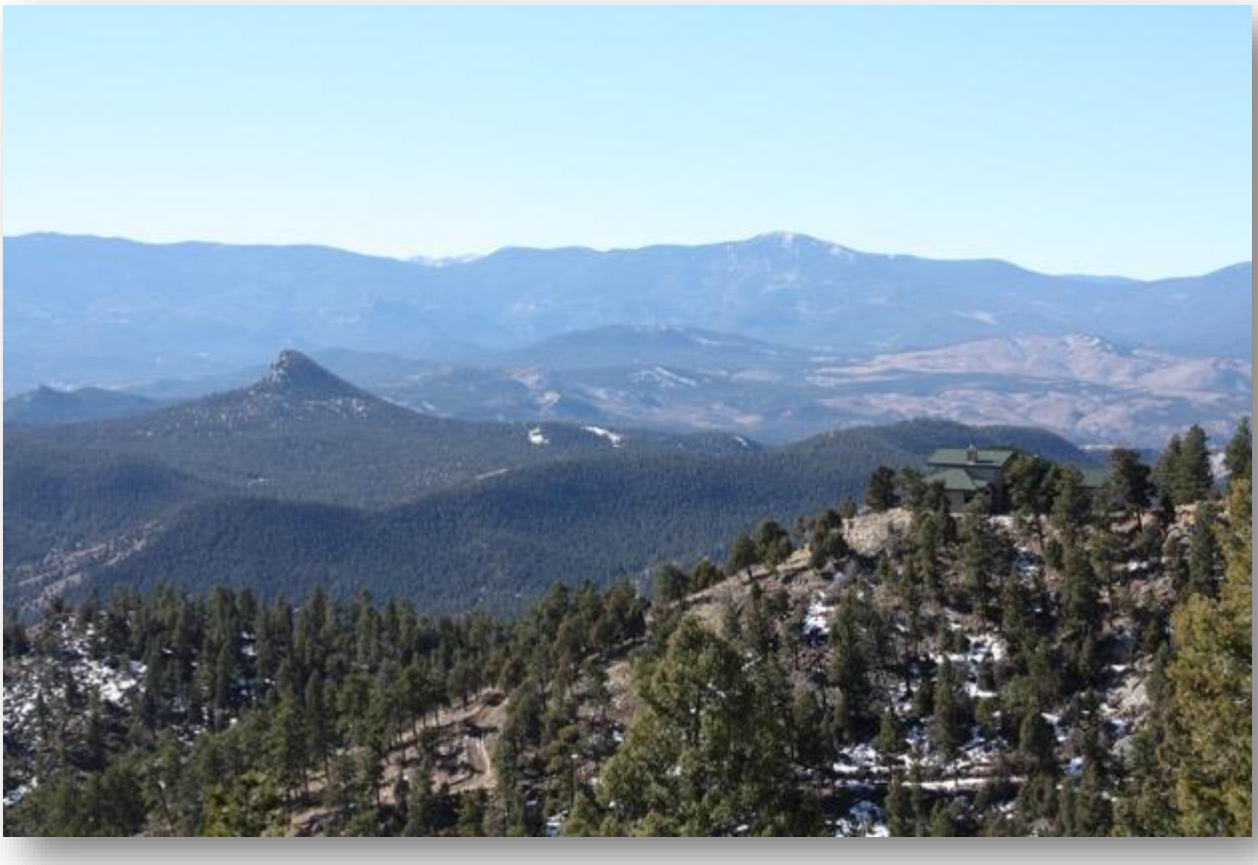

COLLABORATIVE WATERSHED ASSESSMENT

A PROFILE OF THE UPPER SOUTH PLATTE PARTNERSHIP

AUGUST 2016

PREPARED FOR THE COLORADO FOREST RESTORATION INSTITUTE

COLORADO FOREST RESTORATION INSTITUTE

Colorado State University

Contents

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About the Author: Ch'aska Huayhuaca is a Ph.D. candidate in the Graduate Degree Program in Ecology and Program Coordinator at the Center for Collaborative Conservation. Contact: *chaska@gmail.com*

Figures

Acronyms and Abbreviations

AFF	American Forest Foundation
CFRI	Colorado Forest Restoration Institute
CO-WRAP	Colorado Wildfire Risk Assessment Portal
CSFS	Colorado State Forest Service
CUSP	Coalition for the Upper South Platte
GeoWEPP	Water Erosion Prediction Project
GIS	Geographic Information Systems
HUC	Hydrological Unit Code
JCD	Jefferson Conservation District
NRCS	Natural Resources Conservation Service
PC	Partnership Council
RAWS	Remote Automated Weather Stations
RUSLE	Revised Universal Soil Loss Equation
TNC	The Nature Conservancy
USPP	Upper South Platte Partnership
USFS	United States Forest Service
WUI	Wildland Urban Interface
ZoC	Zones of Concern

Collaborative Watershed Assessment

A Profile of the Upper South Platte Partnership

Water supplies critical to a variety of users originate in forested watersheds. These forests are prone to increasingly large and severe wildfires that can result in costly damage to water supplies and delivery systems. Reducing these risks has become a high priority for water providers in Colorado and across the interior West. The Upper South Platte Partnership (USPP) in Colorado is an instructive example of how to prioritize and coordinate wildfire mitigation actions at a watershed scale across jurisdictions.

Introduction

The Upper South Platte Watershed is regionally important for several reasons. It provides Colorado's largest metropolitan area (Denver) with almost 80% of its water. It contains two wilderness areas and a high quality fishery which, combined with its proximity to the metro area, makes the watershed a popular destination for outdoor recreation. It is home to many residents living in or around the wildland urban interface (WUI), a population that is predicted to grow substantially in the coming years. The watershed also contains millions of dollars of transportation, utility, communications, and other types of infrastructure. Due to its importance, this ~1.2 million acre watershed (fig. 1) has been described as the "bull's eye" of risk on the Front Range related to wildfire, post-fire flooding and erosion, and debris flows (Upper South Platte Partnership, 2015c).

"The USPP is a partnership of government agencies, water providers, nonprofit organizations, and academic institutions with a common vision of sustainable and resilient landscapes, healthy forests, proactive and engaged fire-adapted communities, with safe, effective, and efficient fire response and management in the Upper South Platte watershed"

(uppersouthplattepartnership.org)

Large, severe wildfires in the past 20 years provide the impetus for mitigating the effects of wildfire through forest fuel reduction activities in the Upper South Platte Watershed. The Buffalo Creek (1996), Hi Meadow (2000), and the Hayman (2002) fires highlighted the need for coordinated, watershed scale planning and treatment initiatives. Examples include The Coalition for the Upper South Platte (1998), the Upper South Platte Restoration Project (2001), The Front Range Fuels Treatment Partnership (2002), the Front Range Roundtable (2004), the Colorado Bark Beetle Cooperative (2005), the Colorado Front Range Forest Landscape Restoration Project (2010), and the Watershed Wildfire Protection Group (2012). Building off these collaborative efforts, the Upper South Platte Partnership emerged towards the end of 2014 as the latest iteration of watershed wildfire mitigation with a mission to "develop, maintain, and enhance the quality and sustainability of the landscape and watershed" (Upper South Platte Partnership, 2015b).

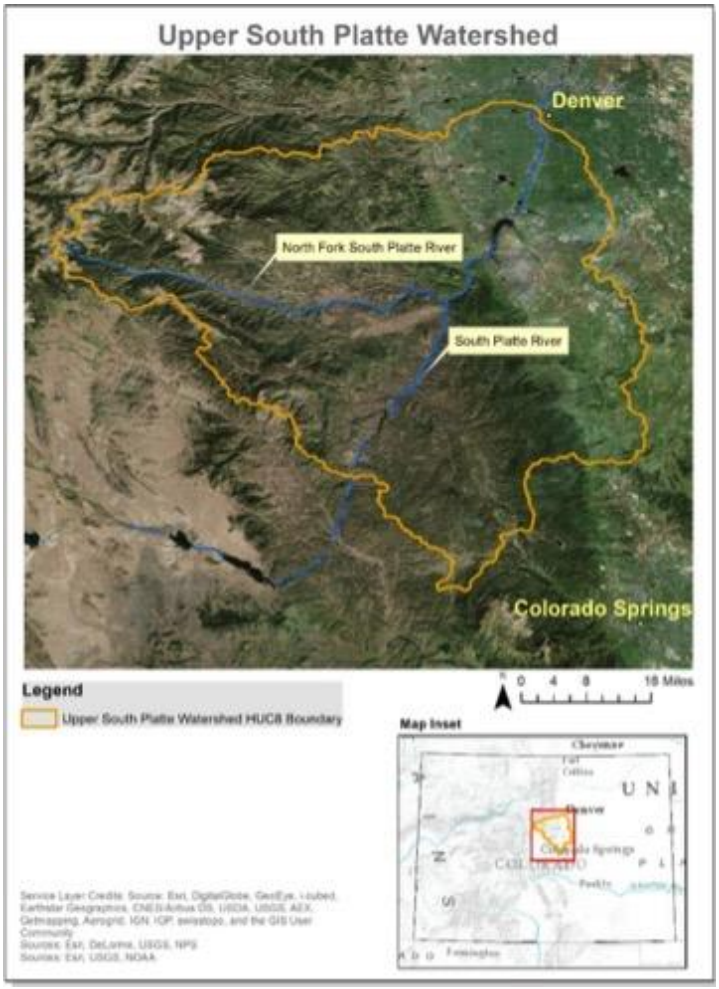

Figure 1. Level 8 Hydrological Unit Code Boundary of Upper South Platte Watershed (Source: Addington et al., N.d.)

Background and Origins

The Upper South Platte Partnership is a multi-stakeholder collaboration representing water providers, non-profit organizations, government agencies, and academic institutions who are voluntarily working together to prioritize, coordinate, implement, monitor, and adaptively manage forest treatment projects and wildfire-related community outreach efforts. Of particular emphasis within the group is the strategic prioritization of forest-fuel reduction treatment sites for maximizing the impact of reducing watershed vulnerability to wildfire. To this end, the USPP is interested in implementing fuel reduction-based forest restoration treatments (using thinning and managed fire) in locations at high risk of wildfire that would adversely impact water supplies, which overlap with private land, homes, infrastructure, and other values at risk. The planned duration of the initiative is five years. (Upper South Platte Partnership, 2015b).

USPP participants include the Nature Conservancy (TNC), Denver Water, Colorado State Forest Service (CSFS), the Coalition for the Upper South Platte (CUSP), the Jefferson Conservation District (JCD), the Natural Resources Conservation Service (NRCS), the United States Forest Service (USFS), the American Forest Foundation (AFF) and the Colorado Forest Restoration Institute (CFRI) at Colorado State University. Many participants of the USPP are also involved in other related collaborations and partnerships around the region, such as the Front Range

Roundtable, the Watershed Wildfire Protection Group, the Colorado Conservation Exchange, and others. In its short tenure, the initiative has brought a high degree of capacity, expertise, and resources to a collaborative decision making process that undertakes a notably broad set of functions. The USPP emerged as interactions between stakeholders revealed opportunities to pool significant funding sources with overlapping (but not identical) objectives together under one umbrella. The following section describes how each of these opportunities developed and contributed to shaping the USPP.

A Convergence of Opportunities

As the state's oldest and largest water provider (serving approximately a quarter of Colorado's residents), Denver Water has a history of investing substantial resources in preventative measures to mitigate wildfire, protect its source water quality, decrease erosion and debris flows, and prevent costly damage to its reservoirs and infrastructure from sediment accumulation. In order to achieve preventative watershed protection measures at an effective scale, Denver Water participates in public/private partnerships, contracting, collaboration, and cooperative agreements. Following the extensive (and expensive) devastation wrought by the Buffalo Creek and Hayman fires, Denver Water and the U.S. Forest Service entered into such a partnership. The $33 million, five year partnership became formally known as the 'From Forests to Faucets' program in 2010. Much of the work undertaken through this program can be characterized as wildfire mitigation on public land funded by Denver Water and executed by the USFS. Much of the work undertaken through this program can be characterized as wildfire mitigation on public land funded by Denver Water and executed by the USFS. However, Denver Water also has interests in the northern part of the watershed, which is largely private land. Denver Water began working with the Colorado State Forest Service for treatment of its own lands as early as 1985, formalizing the partnership following the 2002 Hayman Fire with the Forest and Land Management Service Agreement (FLMSA), which expired at the end of 2014.

Prior to renewing FLMSA in 2015, several factors led Denver Water to reassess its approach to preventative investments in forest treatments, particularly with regard to defining successful treatments and improving accountability through monitoring. Any new agreement would need to incorporate a plan to identify quantifiable measures of the effectiveness (beyond acres treated) of the funded wildfire mitigation treatments. In 2015, FLMSA was simultaneously renewed for an additional five years along with a new agreement, the *Denver Water Non-Federal Lands Forest Treatment Partnership* (NFLFTP), which represented the first formalized agreement through CSFS that included treatment on private lands. The new five year contract entailed a $1.65 million contribution from Denver Water to support JCD, the CUSP, and CSFS (the latter acting as fiscal agent) to conduct thinning, clearing, and removal of vegetation in *Zones of Concern* (ZoCs) to reduce potential for wildfire (Colorado State Forest Service, 2015). Ten ZoCs (fig. 2) had been identified a few years prior in the watershed analysis test case of the Upper South Platte Watershed, presented in a 2009 report titled *Protecting Critical Watersheds in Colorado from Wildfire: A Technical Approach to Watershed Assessment and Prioritization* (Front Range Watershed Protection Data Refinement Work Group, 2009).

In addition to supporting implementation, the contribution included funding for CFRI, based at Colorado State University, to conduct inventorying and monitoring for all treatment sites funded through the initiative. There was no funding match requirement for CFRI, but JCD, CUSP, and CSFS were each required to provide at least a one-to-one funding match in order to receive payment. In the Strontia Springs ZoC, Jefferson Conservation District would treat 750 acres and CUSP would treat 700 acres; the CSFS would treat an additional 700 acres in other ZOCs, totaling 2,150 acres. Additional funding was expected to come from federal grants provide by agencies such as the NRCS, state programs, and contributions from local conservation districts, governments, and organizations, as well as cost-share arrangements with private landowners.

The Nature Conservancy, an active participant in many conservation partnerships in Colorado and beyond, brought an additional $800,000 in corporate donor funding. The strategic goal of the investments was to maximize benefits to water security and watershed resilience by establishing a network of treatments in high priority areas that would function at a landscape scale to reduce the potential for highly destructive wildfires. TNC's funding requirements included pre-treatment analysis and prioritization as well as pre- and post-treatment monitoring, both of which aligned well with the desire for strategic investment and increased accountability expressed in the Denver Water Non-Federal Lands Forest Treatment Partnership. Volunteer and public engagement was another priority associated with TNC's funding. For their part in the USPP, TNC wanted an opportunity to showcase a model collaborative watershed process aimed at risk reduction across boundaries. The inclusion of TNC in the partnership allowed the nascent USPP to leverage additional funding support, namely, funding for the *National Cohesive Wildland Fire Strategy Pilot Project*.

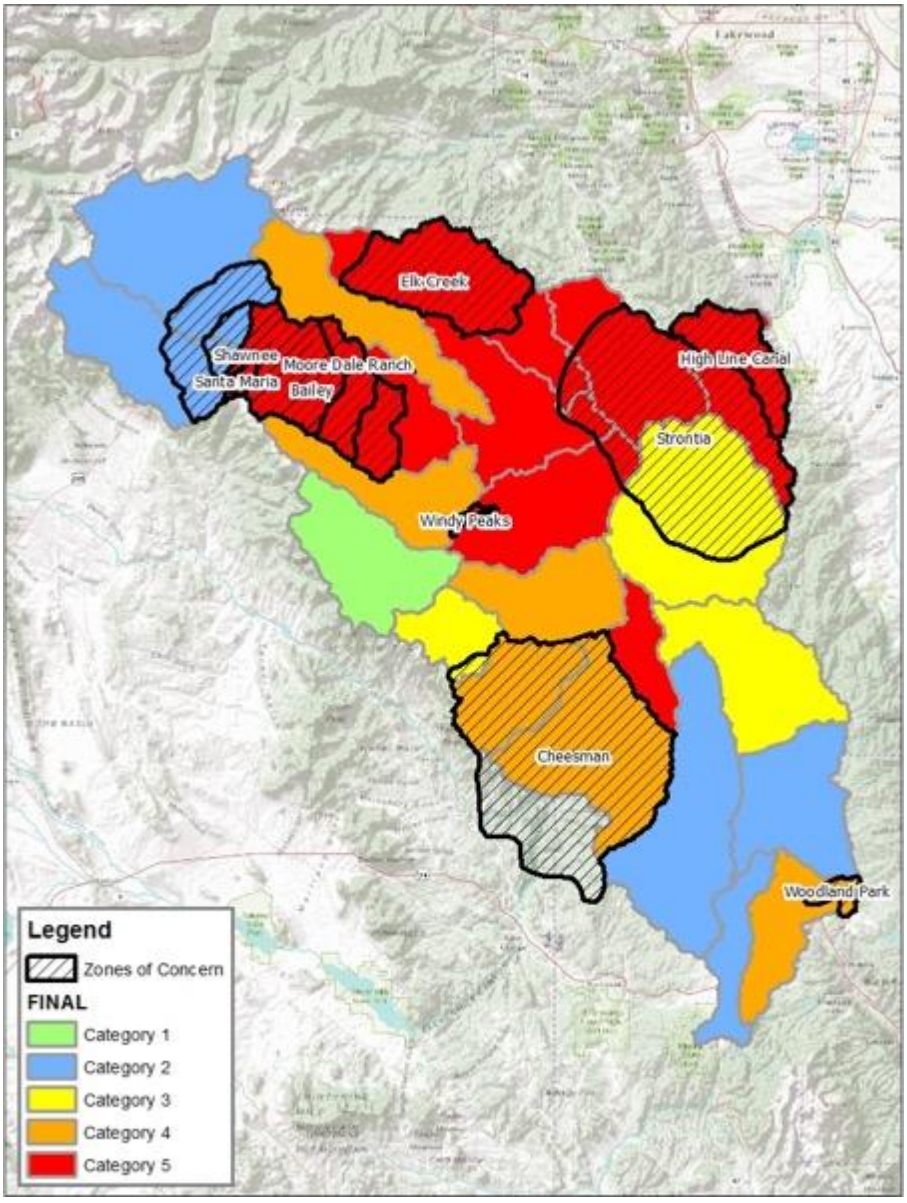

Figure 2. Zones of concern in the Upper South Platte watershed as identified in Upper South Platte Watershed Assessment (Source: JW Associates, Inc., N.d.)

Early on in its development, several USPP members began discussing the National Cohesive Wildland Fire Strategy as a potential source of funds with objectives that fit well with their own. Informally known as 'the Cohesive Strategy', this was the result of the 2009 Federal Land Assistance, Management, and Enhancement (FLAME) Act, and it outlines a framework for coordinating and integrating wildfire efforts associated with three main goals: restore and maintain landscapes, create fire adapted communities, and improve wildfire response. Cohesive Strategy funds are made available for pilot projects through the U.S. Forest Service's State and Private Forestry branch. Because they felt that a strong foundation of partnerships had already been in the Upper South Platte Watershed, these members approached the larger group with a proposal to make the efforts of the USPP a pilot project for the Cohesive Strategy.

At that point, the USPP was primarily focused on activities associated with conducting landscape-scale treatments, which would fall within the Cohesive Strategy's goal of restoring and maintaining landscapes. Proponents felt that

with this additional federal investment the USPP could expand its approach to incorporate community engagement for wildfire preparedness and risk-based wildfire response. They submitted a successful pilot project proposal in May of 2015 and received close to $2M to be divided between TNC and CSFS.

The USPP was already committed to engaging landowners whose holdings fell within priority areas, and the volunteer and community engagement component of TNC's corporate funding requirement overlapped with this goal. Thus it was a matter of growing this engagement piece to more broadly promote proactive and durable commitment to planning for resilience within communities in their high priority, wildfire prone areas of interest. To address wildfire response, USPP committed to expanding the management and decision-making capacity of wildfire responders to work together across jurisdictional boundaries to prepare for and respond to wildfires. Thus, the three main goals of the Cohesive Strategy are reflected in the three main priorities of the USPP: landscape resilience, fire-adapted communities, and safe and effective wildfire response.

Priorities of the Upper South Platte Partnership

The intersection of these opportunities gave rise to the Upper South Platte Partnership in the spring of 2015. Ultimately, the purpose of the USPP is to strategically select, support, and coordinate implementation, monitoring, outreach, and information sharing for projects that fall within their geographic priority areas *and* contribute to one or more of the goals of the Cohesive Strategy. This is a uniquely broad and deliberation-intensive set of activities for a network of volunteers. There are many moving parts undertaken collaboratively, including raising and pooling funds, developing models and decision-support tools, developing project selection criteria to conducting pre-and post-treatment monitoring to conducting surveys and outreach campaigns. At this point, specific, measurable objectives and outcomes within each goal that can be used to collaboratively design and monitor projects in the future are still evolving. However, the USPP has made substantial progress in developing a set of criteria acceptable to all members for selecting projects to support (see fig. 3). This set of criteria are intended to reflect their strategic priorities, and will relate to a) the measurements outlined in their proposed objectives and b) the metrics for evaluating the success of project outcomes in the future.

Expected actions of the USPP with regard to each of the Cohesive Strategy's goals

Restore and maintain landscapes: *"The project will result in the strategic, science-based analysis, prioritization and treatment of forested landscapes within the watershed, on both federal and non-federal lands. The goal of these treatments will be to establish a connected network of treated areas that function together at a meaningful scale to reduce the potential for unnaturally large and damaging wildfires in the watershed and improve the health, safety and resilience of people, watersheds and wildlife. The emphasis of this effort will be on treating the highest priority acres not the greatest number."*

Fire-adapted communities: *"The project will engage and incentivize landowners and communities in the Upper South Platte watershed to plan and act collaboratively to proactively improve their ability to be resilient in a wildfire prone environment. Through this engagement, the Partnership hopes to build lasting community commitment to an ongoing proactive approach to fire."*

Wildfire Response: *"The project will engage wildfire responders in identifying and implementing concrete actions that improve cross-jurisdictional wildfire preparedness, increase local fire management capacity and enhance the ability of local authorities to work together in making safe and efficient risk-based wildfire management decisions."*

(The Upper South Platte Partnership, 2015a, p. 2)

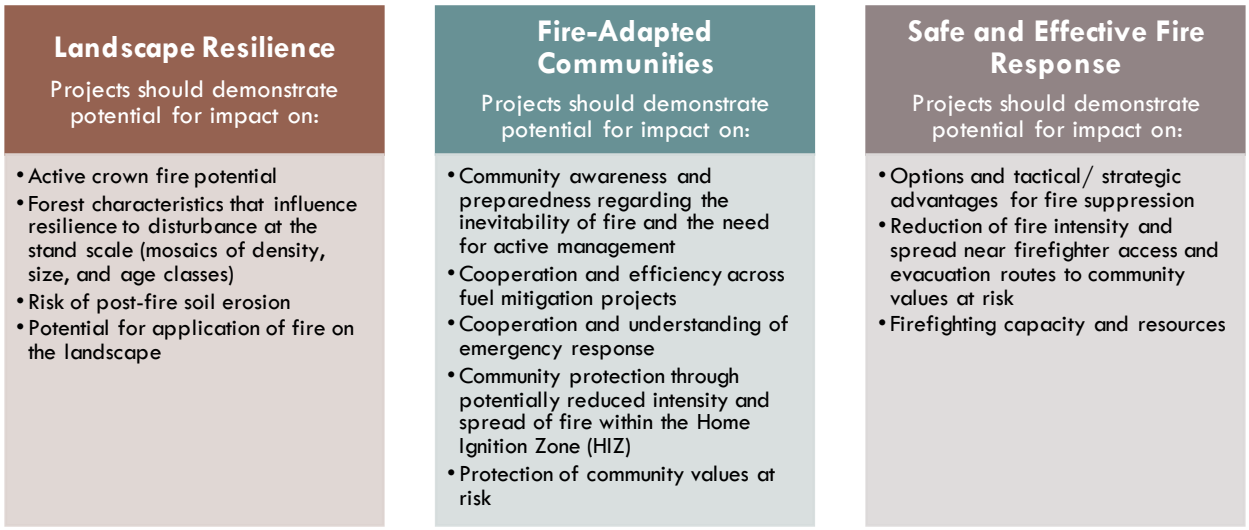

Figure 3. Summary of project criteria related to priority areas

The USPP developed five additional criteria to evaluate the strategic quality of project proposals. A proposal's **overall strategic value** is a key criterion considered as important as the three goal-related criteria, indicated by the number of points assigned. It reflects the USPP's priority of building on past projects to leverage their impacts in an attempt to influence fire behavior at a landscape scale and reduce the negative impacts on watersheds and communities. Strategic value is increased if proposed project sites cross ownership or jurisdictional boundaries. Projects that are adjacent to areas that have already been treated, or that can serve as anchors for future treatments, are preferred overall isolated treatment areas. They also value projects that will have *measurable* impacts within their priority areas.

Project proposals that present **specific and realistically achievable timelines** and **budgets** are preferred, though these criteria constitute fewer points for scoring projects than overall strategic value. Well defined timelines with anticipated milestones rate highly, as are proposals that bring matching funding to the table and provide estimates of the cost of treatment per acre.

The final two criteria constitute the fewest points for rating projects and are thus lower priority, though still valuable for selecting among competitive applications. One of these assesses the extent to which a project **facilitates active adaptive management** (that is, applies a more or less systematic approach to advancing knowledge about the relative effectiveness of management strategies). Projects that can demonstrate willingness for and feasibility of long-term monitoring may rate more highly, as do projects that indicate increased community support for experimentation and communication of lessons learned. Finally, projects are rated based on their **potential for outreach and recruitment**, in terms of effective relationships built with new landowners and promotion/ visibility of the work undertaken by the USPP and its member entities.

Arriving at consensus for this set of criteria was no small feat. As with any collaborative initiative, a great deal of commitment and effort must be invested in an iterative process of trust-building, joint fact finding, and deliberating in order to reach agreement on a shared vision for change, as well as on the specific priorities and strategies that will lead to goal attainment. As indicated by the timeline presented in the Appendices, such processes take time.

The model of collaboration that has evolved from the work of the USPP is unique; an account of the processes that have shaped this young initiative, and a few lessons learned along the way, may offer helpful insights for those interested in undertaking multi-stakeholder collaboration in the future.

Collaborative Model of the Upper South Platte Partnership

Group Coordination, Structure, and Protocols

As the partnership expanded in scope and activities, coordination became cumbersome for members who were simultaneously facilitating, participating in, and recording the process. Beyond logistical support, some members of the USPP recognized early in the process that there was a substantive divide within the group regarding the relative value of different forest treatment approaches. A professional facilitator was approached in May of 2015 to conduct a situation analysis and make recommendations for next steps. Initially, just four facilitated meetings were proposed, but the USPP decided that the service was important enough to contract with the facilitator longer-term. In addition to general meeting facilitation, the facilitator has provided guidance in establishing decision rules and process protocols for the initiative, facilitates sub-committee meetings, compiles and distributes meeting agendas and minutes, and generally holds the initiative to task for making progress towards its goals.

Building on a draft charter developed in August of 2015, the decision-making process and procedural structures of the initiative were formalized in October of 2015 with the help of the facilitator. This formalizing document lays out their vision of desired impacts and key players in achieving those impacts; a mission that presents the broad strategy for accomplishing those desired impacts and establishes three priority areas with desired outcomes for each; and a set of core principles at the center of their vision for change.

The USPP established its decision rules and process protocols with the guidance of their facilitator, who presented them with the pros and cons of several models, including an open structure and a steering committee model. The members recognized that the former would be too unstructured to accomplish their goals, but the latter would privilege certain members over others. They preferred a "one voice, one vote" model, and so established a Partnership Council (PC) to guide their decision-making process. Meetings often involve more than one representative of each organization, but only one representative from each may serve on the PC. A PC member may appoint an alternate from their organization if they are unable to attend a meeting, and it is their responsibility to ensure that the alternate is

Vision

"We envision sustainable and resilient landscapes, healthy forests, proactive and engaged fire-adapted communities, and safe, effective, and efficient fire response and management in the Upper South Platte watershed. We envision a collaborative partnership of stakeholders including individual landowners; local communities; local, state, federal, and national agencies; and other organizations working together in concert."

Mission

"The Upper South Platte Partnership will align resources and capacities of stakeholders through a collaborative structure and develop, maintain, and enhance the quality and sustainability of the landscape and watershed. The Partnership will focus on three priorities: Forest and Watershed Resilience, Fire-Adapted Communities, and Coordinated Fire Response. We will employ science-based forest management; outreach and engagement of landowners and communities; and effective and efficient fire response and management."

(Upper South Platte Partnership, 2015b, pp. 1-2)

able to make informed decisions. As new members are added to the group, they would gain a seat on the Council. Representation on the Council is limited to 15, beyond which the group would need to reassess its use of the Partnership Council model. There are two forms of membership, full or affiliate, and new organizations can become members only if all current members approve the addition. The USPP does not have legal status.

In order to achieve its objectives, the USPP has partitioned itself into smaller, ad hoc working groups that develop products agreed upon by the larger group (see fig. 4). Its original working groups included a Landscape Resilience Team (LRT), a Fire Adapted Community Team (FACT), an Outreach Team, a Wildfire Response Team (WRT), a Research and Monitoring Team (RMT), and a Funding Alignment Team (FAT). Due to overlapping membership and related objectives, four of the teams were merged into two: RMT was absorbed by LRT, and Outreach merged with FACT. The LRT, WRT, and FACT mirror the three major goals of the Cohesive Strategy, and each has developed an action plan that describes: long-term, 20-year, and 5-year goals for the watershed; benchmarks for assessing progress out to year five; desired conditions and associated metrics; and action items for the next year, assigned to team members. The full group meets once a month, while working groups meet more frequently, with variation between groups.

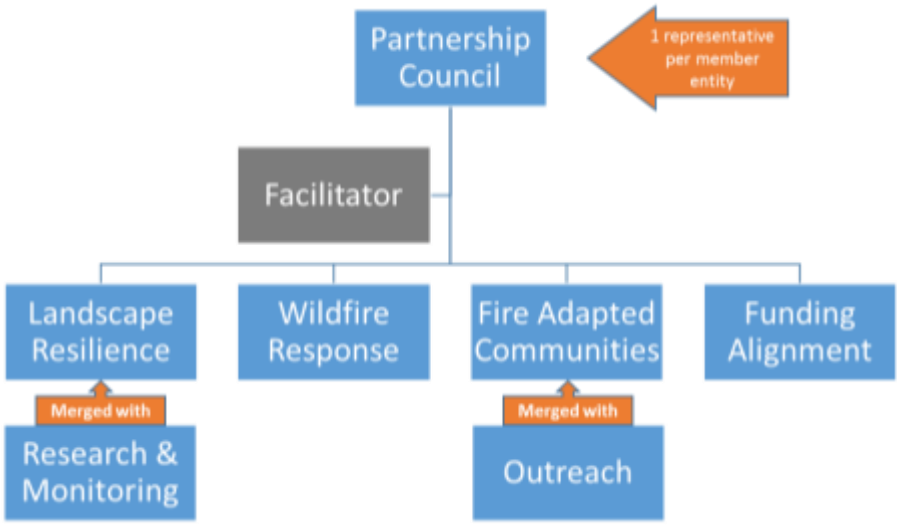

Figure 4. Organizational structure of the USPP

Individuals and entities that do not sit on the Partnership Council are still able to participate in the USPP, since meetings include time for open discussion beyond the Council. It is understood that views expressed by all participants in open discussion do not necessarily reflect the views of that individual's home organization unless otherwise stated.

Official decisions are made by the Partnership Council only, and views expressed in these decisions are expected to reflect the views of their respective entities. Decision making strives to be consensus-based, but may employ majoritarian voting if resolution cannot be reached otherwise. In either case, each PC member has a single and equal vote. Proposals for all major decisions must be passed by a super-majority (two thirds) of attending members. Decisions may be delayed in the event of insufficient representation for decision making.

The USPP employs a 'no surprises rule,' which means that if members are unable or unwilling to abide by the Partnership Council's decisions, they must clearly state and justify the reasons for this. All members are committed to upholding the reputation of the USPP.

Values & Principles for Agreement

The work will be based in science; the approach will be large-scale and boundary-spanning.

The USPP will apply available resources to high priority efforts; they strive to integrate landscapes, communities, and wildfire response and management in their approach.

Members believe it's possible to achieve both resilient forest and resilient communities.

Members are committed to the idea that they can achieve higher leverage and greater benefits through collaboration than would otherwise be possible.

Members have committed to continuous learning and adaptation throughout the process.

(*Upper South Platte Partnership, 2015b*)

Process of Watershed Assessment and Treatment Prioritization

Avoiding 'random acts of conservation' by strategically choosing and designing management interventions is a key strategy of the Upper South Platte Partnership. Well before undertaking a facilitated process to develop a charter, the USPP began with a joint analytical process using both local knowledge and a suite of modeling and Geographic Information Systems (GIS) decision support tools to identify high priority areas for treatment activities within the watershed (see fig. 5).

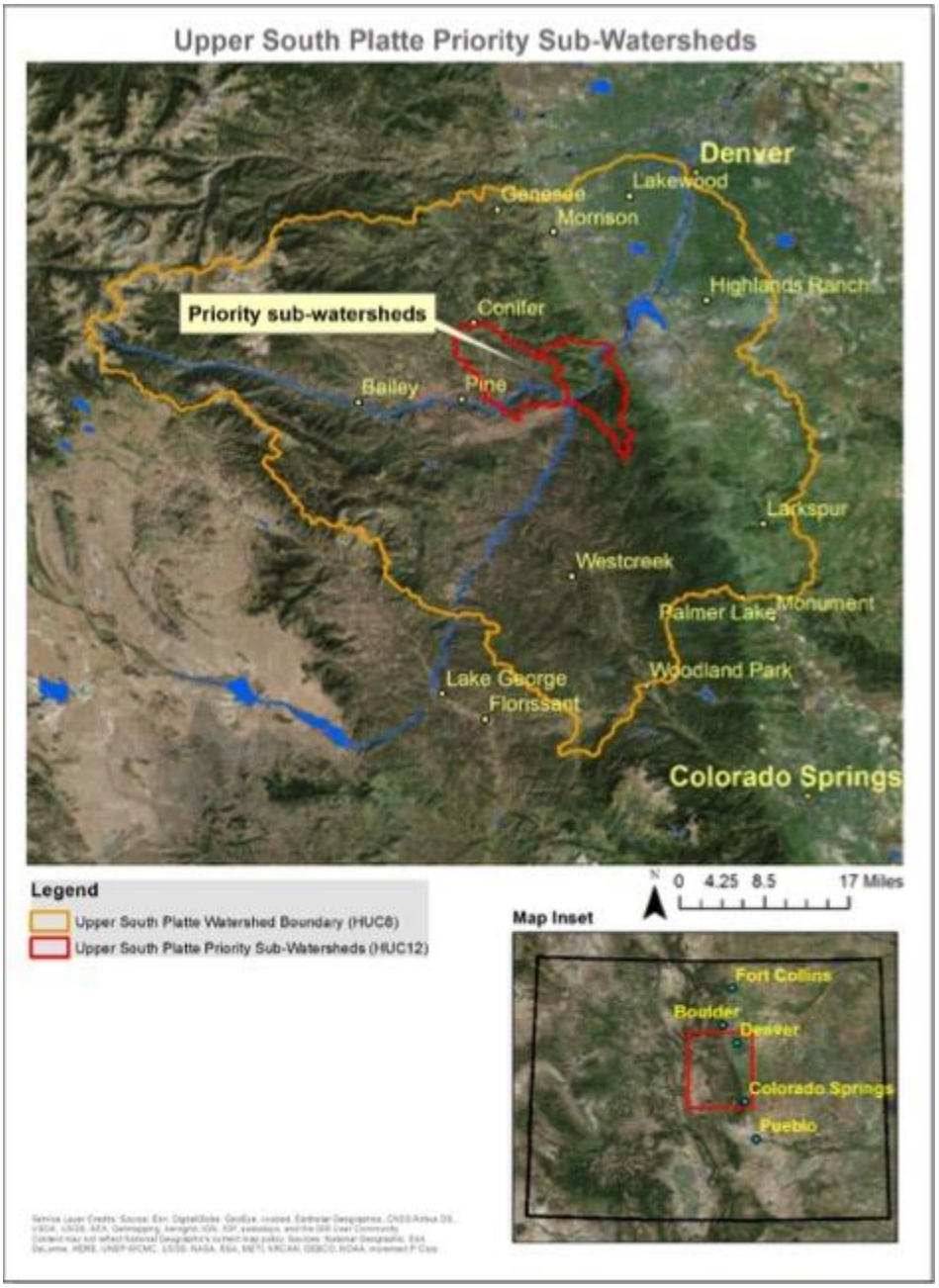

Figure 5. Priority sub-watersheds identified through USPP prioritization process (Source: Addington et al., N.d.)

Prioritizing within the Upper South Platte Watershed

Soon after the formation of USPP, members began building modeling tools to support strategic assessment and decision-making. The Nature Conservancy, which was already in the process of developing these tools for use in this and other collaborative endeavors they are engaged in, led the effort with input and support from other USPP members. The process follows a basic risk assessment framework within the South Platte Watershed, beginning by gauging the probability of event happening (in this case, wildfire); assessing the event's potential intensity or magnitude; considering the values at risk (water resource and community protection); and evaluating

the degree of exposure for these values (Miller and Ager, 2013). Their models build upon existing watershed assessment tools developed and applied in the region.

Tools for Watershed Assessment

In 2007, The Front Range Fuels Treatment Partnership had commissioned a report from the Pinchot Institute for Conservation, Protecting Front Range Forest Watersheds from High-Severity Wildfires, which identified risk factors for water supplies and infrastructure stemming from increasing wildfire potential and associated post-fire hazards. In 2009, J.W. Associates developed the report referenced earlier, Protecting Critical Watersheds in Colorado from Wildfire: A Technical Approach to Watershed Assessment and Prioritization, as a watershed assessment framework for the Front Range Watershed Protection Data Refinement Work Group, specifically for the Upper South Platte watershed. Using the national network of delineated watersheds, this assessment method targets sixth-level watersheds as their unit of analysis, and is designed to consistently analyze and prioritize all sixth-level watersheds within a fourth-level watershed. This watershed assessment approach focuses on four components for evaluating hazardous watershed conditions: wildfire hazard, flooding or debris flow risk, soil erodibility, and a ranking of water uses. Among its outputs, the watershed assessment report identified ten ZoCs in the Upper South Platte. ZoCs are areas particularly vulnerable to damage from debris and sedimentation due to their location above or close to key intakes, diversion points, and reservoirs classified for supplying drinking water. Another important tool USPP built upon was the Colorado State Forest Service's Colorado Wildfire Risk Assessment Portal (CO-WRAP), which provides a suite of applications for information sharing and planning for wildfire risk, prevention, and mitigation.

Both of these tools informed the design of the applications developed for the USPP, and were particularly valuable for calibration and validation of models. Rather than relying solely on existing platforms, however, the USPP directed resources towards building their own customized set of models in order to accommodate the specific needs of their partnership. Specifically, their units of analysis were much smaller than a sixth-level watershed, and they required finer resolution data layers appropriate for project-level (~1,000 acres) and individual treatment unit level (~100 acres) assessment. Additionally, they were interested in building models that could be used not only for prioritization, but also for post-treatment monitoring and evaluation of treatment effectiveness (and eventually pre-treatment design, discussed below).

The USPP assessment process is built on assumptions about the goals of treatments as understood by participants early in the collaborative process, and models were built to assist prioritization in accordance with each of these goals:

- **Wildfire hazard and risk reduction** – Treatments should reduce the risk of high-severity crown fire by reducing hazardous fuels and decreasing canopy continuity.
    - The models should help the USPP identify those areas within the watershed that are most likely to burn, and those that are most at risk of high-severity wildfire in the event of ignition due to high forest density, patch size and continuity.
- **Soil erosion and sedimentation potential** – Treatments should target areas at high risk of post-fire soil loss were a wildfire to occur.
    - Models should identify the areas at highest risk of soil loss due to slope steepness and length, soil type, and precipitation patterns. Analysis of overland flow patterns and accumulation potential within the watershed's network of streams and reservoirs should predict where soil loss from hillslopes will be deposited.
- **WUI values at risk** – Treatments should protect communities and critical infrastructures.
    - Using data on the locations of buildings and structures in the WUI, models will help determine whether there is an optimal treatment buffer around them that could ensure their protection.

- **Opportunity assessment** – The spatial distribution of treatments within the watershed will likely be shaped by land ownership patterns.
    - An important piece of the assessment will be the identification of landowners willing to have their properties treated and interested in becoming part of a network of treated areas.
- **Treatment leverage and feasibility** – Treatments should build upon existing work to expand treatment benefits to larger scales.
    - Assessment should reveal previously treated areas that may be used to anchor new treatments. It will also reveal the extent to potential treatments may be constrained by access, terrain and slope breaks, and will help the USPP distinguish between areas within the watershed that are operable for mechanized treatments versus hand thinning or other types of treatments, such prescribed fire.

The Modeling Process Step by Step

The following description draws on The Nature Conservancy's *Prioritizing Forest Restoration Treatments in the Upper South Platte Watershed of the Colorado Front Range* (Addington et al., N.d). Figure 13 presents a schematic of the model components.

Step 1: Fire Behavior Models

Models for both burn probability and active crown fire potential (figs. 6 and 7) are derived from FlamMap, a commonly used landscape fire behavior analysis program that can be used to predict flame length, rate of spread, fireline intensity, and crown fire potential based on canopy cover, crown bulk density, crown height, fuel model, slope, aspect, and weather. The team used data from the LANDFIRE database for three critical determinants for wildfire behavior: topography, fuels, and weather. As with any modeling activity, it's important to note that assumptions are built into the choice of inputs and outputs, and there may be a gap between these assumptions and the way a fire actually plays out on the land.

Step 1a: Assessing Burn Probability

Burn probability modeling integrates variables of topographic conditions (e.g. slope, elevation) with vegetation fuel models (see for example Miller and Ager, 2013). Using a function within FlamMap, the USPP team simulated a series of 10,000 randomized ignitions with the South Platte watershed under constant weather conditions for six hours. Burn probability for a given pixel within the model is calculated by dividing the number of times the pixel ignites by the number of potential ignitions (10,000, in this case).

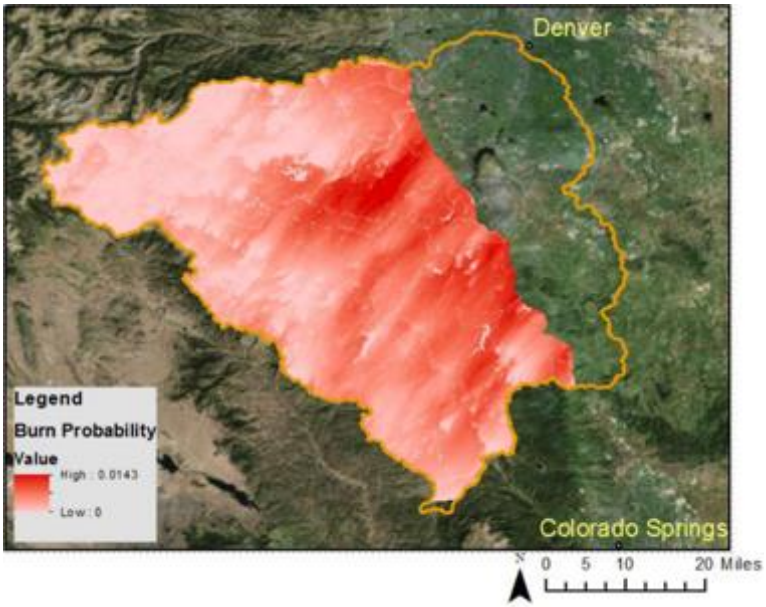

Figure 6. Burn probability (Source: Addington et al., N.d.)

Step 1b: Active Crown Fire Potential

Using data from local Remote Automated Weather Stations (RAWS) compiled within FireFamily Plus software, the team developed twelve weather scenarios ranging in fuel moisture (80th, 90th, and 97th percentile) and wind speed (at 10, 20, and 40 mph). Active crown fire was then modeled in FlamMap using these 12 scenarios, based on the equations of Scott and Reinhardt (2001). The resulting 12 active crown fire layers were then merged using the raster calculator in GIS to depict the percent of simulations a given pixel burns with active crown fire. Those pixels with high percent incidence of active crown fire are most likely to burn with active crown fire under a range of weather conditions.

In addition to assessing magnitude and intensity with active crown fire potential, the team plans to incorporate model outputs for flame length and fire intensity. At this point they have chosen not to incorporate an output for rate of spread, since it is difficult to interpret for some types of treatments. CO-WRAP could also be used to model wildfire risk, fire intensity, and difficulty of suppression.

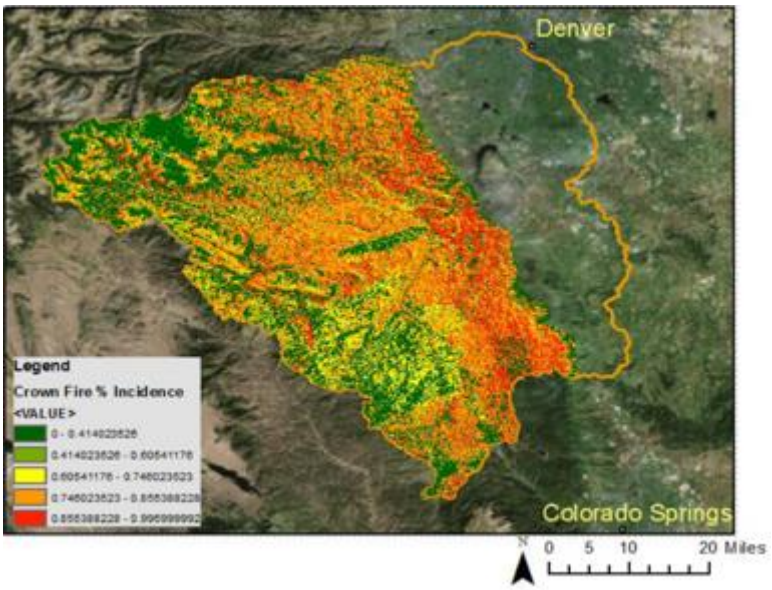

Figure 7. Active crown fire potential (Source: Addington et al., N.d.)

Step 2: Post-Fire Soil Erosion and Deposition

The team is modeling current and potential post-fire soil erosion and deposition (fig. 8), deriving soil loss estimates from both GeoWEPP (the Water Erosion Prediction Project, which uses soils, topography, climate, and vegetation inputs to predict erosion and sediment deposition) and RUSLE (Revised Universal Soil Loss Equation). Besides serving as an indicator of impact severity, this model output provides a spatially explicit projected post-fire soil loss in tons per year, revealing areas of high risk for soil loss, patterns of soil deposition resulting from overland flow paths, and estimates of percent increases of sedimentation in the event of active crown fire. The team plans to eventually extend the analysis to provide estimates of avoided costs associated with post-fire recovery, given strategic treatments at high priority sites.

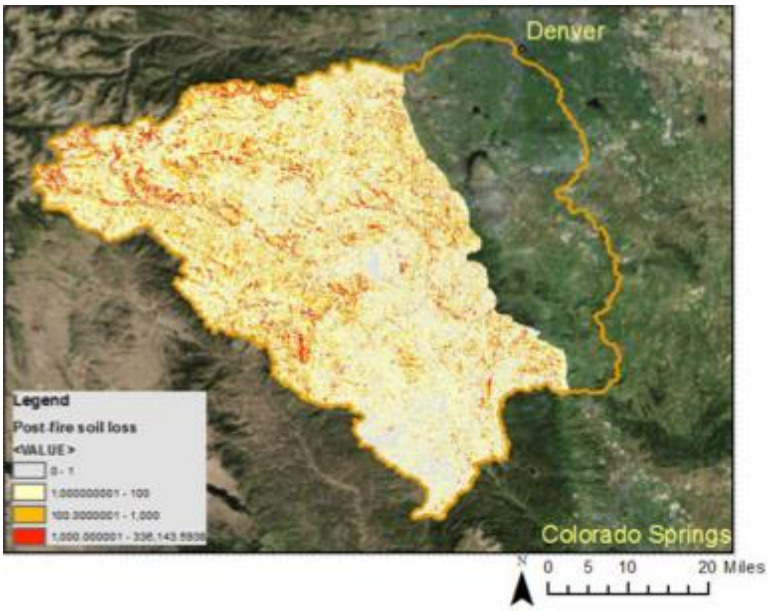

Figure 8. Post fire soil loss (Source: Addington et al., N.d.)

Step 3: Wildland Urban Interface (WUI)

Next, the team obtained data on infrastructure and housing in order to identify structures that fall within areas of high burn probability and active crown fire potential (fig. 9). They obtained data layers from CO-WRAP (housing density polygons) and the WUI Center at Colorado State University (the Buildings Location Database, which contains point files for every structure exceeding 1,000 sq ft).

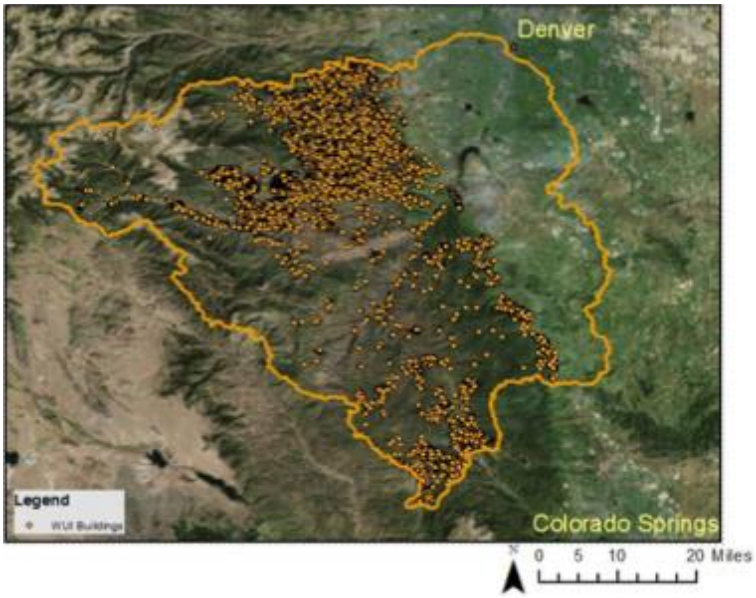

Figure 9. Buildings in the wildland urban interface (Source: Addington et al., N.d.)

Step 4: Landscape Treatment Designer

Landscape Treatment Designer (Ager et al., 2012), a program for analyzing treatment scenarios available through the Western Wildland Environmental Threat Assessment Center of the US Forest Service, provides a decision support framework for project prioritization. It combines each of the previous components to identify areas of overlap between high risk areas, and allows weights to be assigned in accordance with relative importance, as negotiated through the collaborative process. Building on insights about ZOCs identified in the report noted earlier, the team used the Landscape Treatment designer to identify priority watersheds at the HUC12 level near the Strontia Springs ZOC (figs. 10 and 11); it will also help the USPP identify project sites at finer scales.

The eventual goal for decision support framework is to offer an optimization tool, which is under development. Optimization will allow the USPP to assess and compare tradeoffs and synergies among treatment options given multiple objectives (e.g. source water protection, community protection, or both). The optimization tool would also generate spatially optimized scenarios for targeting treatments to achieve landscape-level impacts.

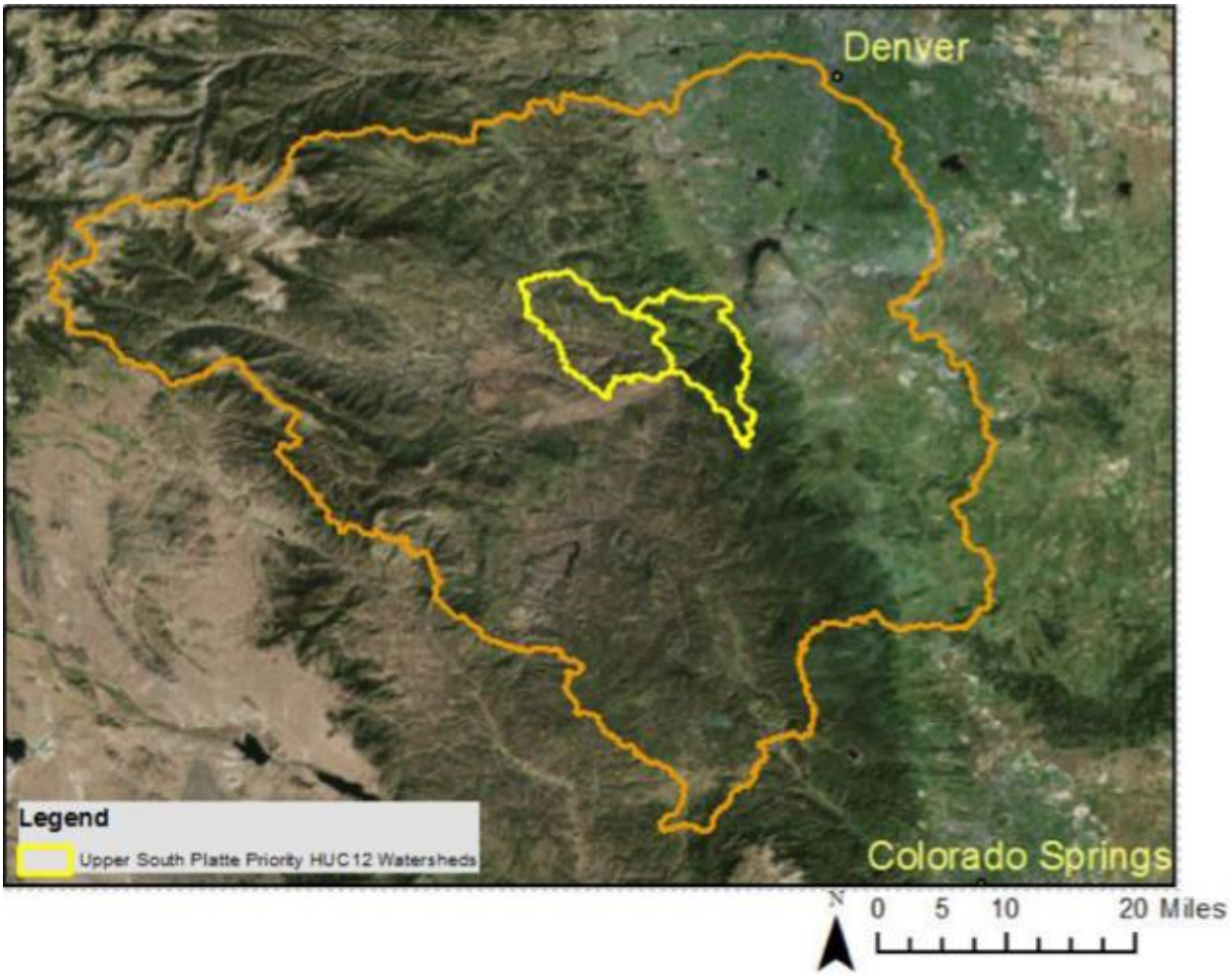

Figure 10. Priority HUC 12 sub-watersheds (Source: Addington et al., N.d.)

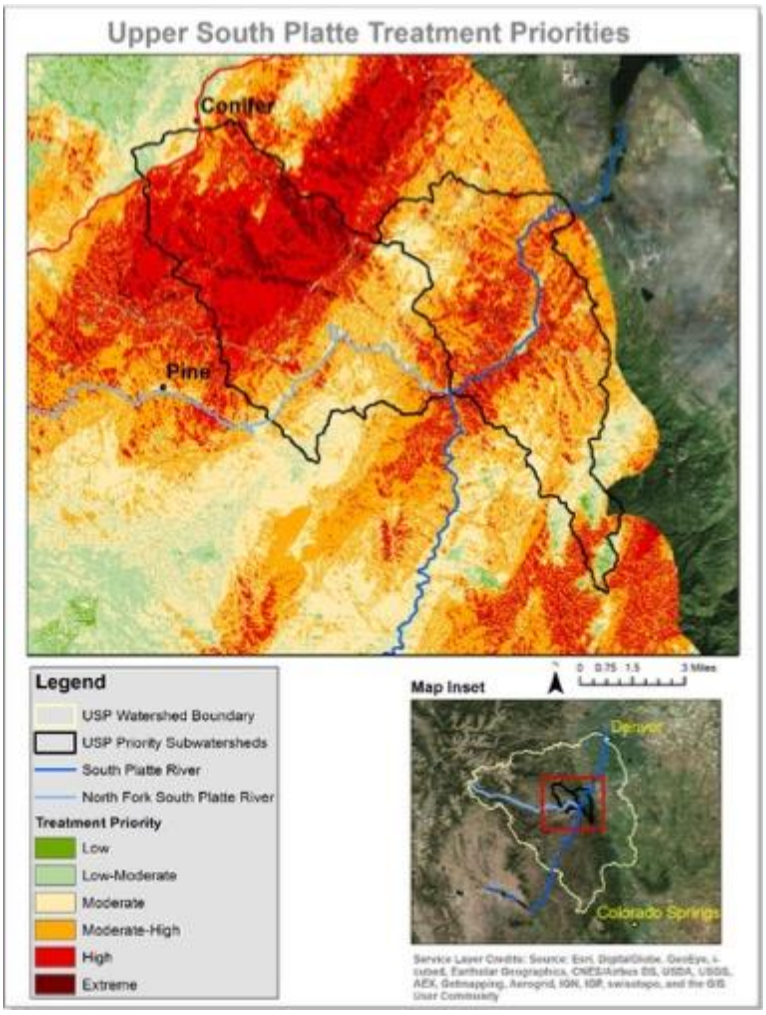

Figure 11. Landscape Treatment Designer output example based on wildfire risk, soil loss, and WUI values (Source: Addington et al., N.d.)

Step 5: Opportunity Assessment

With their priority treatment areas identified in the last step, the team then overlays a layer of land ownership boundaries (fig. 12). The team developed a rating system of risk for individual parcels based on percent overlap with high risk areas. USPP members from the Colorado State Forest Service can then look at high risk parcels and identify which overlap with 'willing' landowners, that is, landowners who have historically worked with CSFS or have expressed an interest in conducting forest treatments on their land. Combining risk assessment with land ownership has also helped shape another objective of the USPP that falls within its Cohesive Strategy goals, developing a landowner outreach strategy (the USPP members from the American Forest Foundation have taken a lead on this objective, but other members will also contribute as landowner engagement grows).

In addition to working with willing landowners in high priority areas, other aspects of the assessment will assist in site prioritization based on feasibility and leveraging opportunities. First, they will identify existing treatment areas from which to anchor new treatments. The benefit of anchoring treatments is that a strategic network of treatments is likely to have a greater impact on fire behavior at the landscape level. The feasibility of different

kinds of treatments (such as mechanized extraction, hand thinning, and opportunities for use of prescribed fire) can also be assessed through topographic conditions, road access, and remoteness.

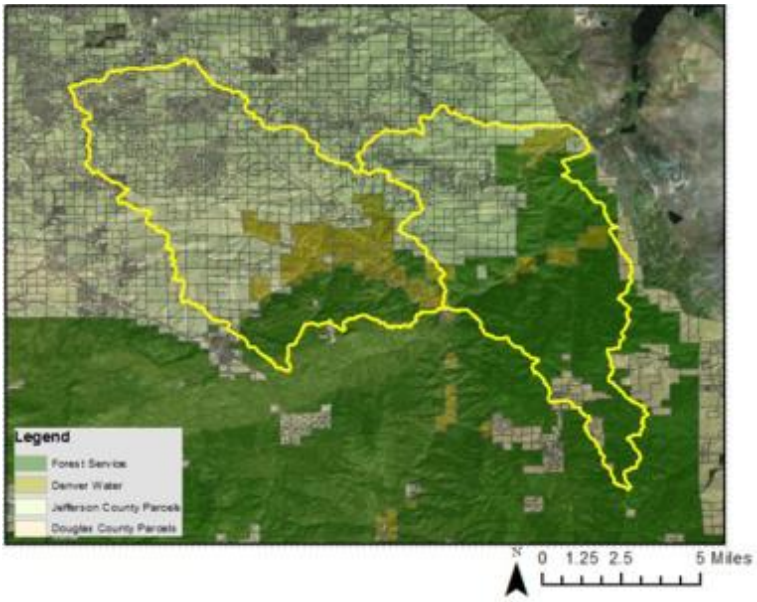

Figure 12. Land ownership patterns within priority sub-watersheds (Source: Addington et al., N.d.)

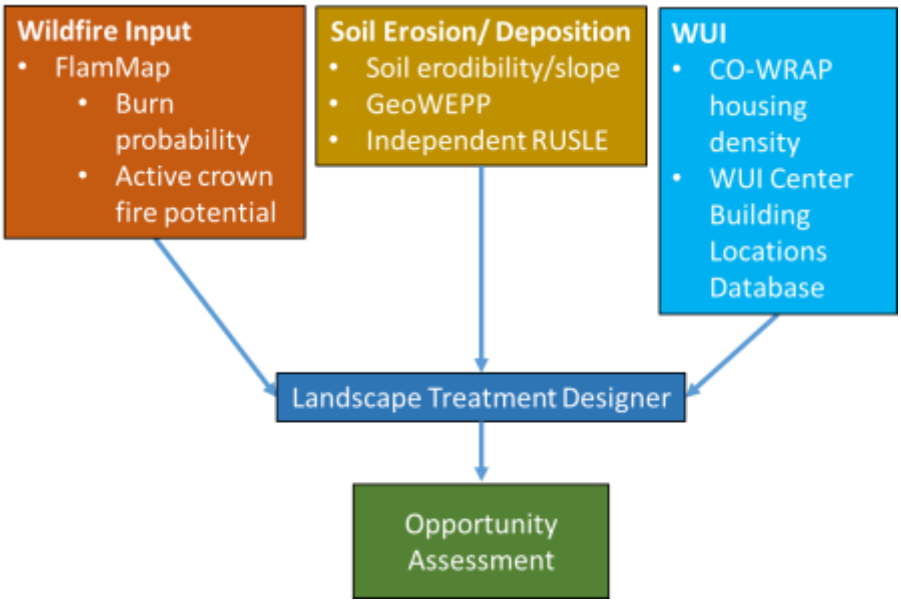

Figure 13. Components of the USPP's modeling process for assessment

Discussion of Prioritization Process

Although the suite of tools described here is still under development, the USPP sees opportunities for extending these initial analyses in several ways, some of which have been touched upon. An important advancement would be for the models to inform treatment design. For example, USPP could determine explicit desired outcomes in the form of treatment standards. Once a set of potential sites has been selected, but prior to conducting treatments, the modeling team could change the base data inputs to the model (wildfire behavior or other) in

accordance with these sites to determine whether the specified treatment actually achieves the treatment standard in a modeling environment. The hope is that this would lead to more effective, appropriately scaled treatments that will improve return on investment. Further refinements may include economic analyses of tradeoffs and formal assessment of avoided costs and ROI.

The individuals leading the development of the models used data and tools that are publically available online, such as the LANDFIRE database (www.landfire.gov/). CO-WRAP (www.coloradowildfirerisk.com/), FlamMap (www.firelab.org/project/flammap), and other programs are also available through the State and Federal Forest Services, and the optimization tool is available through the Western Wildfire Threat Assessment Center (www.fs.fed.us/wwetac/tools.html). Participants in other multi-stakeholder collaborative processes may find that CO-WRAP, for example, offers all the tools needed to support the objectives of their process. These objectives are what determine the investment and expertise required. The process developed for the USPP did require advanced modeling work and a substantial investment of time and expertise to combine model components within the decision support and optimization framework, and to link the models to treatment design, evaluation, and assessment of return on investment. Regardless of what the tools selected, some facility with data and models, as well as an understanding of their limitations, will be required to develop a prioritization process.

The modeling process emerged early in the timeline of the USPP, and was particularly active from February through May of 2015, before the initiative had developed its decision rules and charter, and before formal subcommittees had been formed. Collaboration occurred throughout the model building process: in reviewing available models; in deciding which parameters and variables should be incorporated, as well as their range of values; in calibrating and adjusting the models; in interpreting the outputs of the models; and in identifying the values at risk. Inclusive collaboration is particularly important for capturing the diverse values at stake, sources of risk, degree of exposure, and for balancing objectives. One particularly challenging aspect of the collaborative modeling process was the selection of model parameters and values, and collectively deciding how to balance robust treatment design with treatment feasibility. Deciding on these parameters is essentially deciding on the conditions under which the proposed treatments are expected to hold up: clearly they want to design treatments that are robust to wildfire, but to what extent given extreme conditions? For example, modeling the 97th fuel moisture percentile and 40 mph winds leads to all pixels blowing up into active crown fire, which nothing short of clear cutting would prevent. The incorporation of models into the broader collaborative process can provide a platform for stakeholders to consider, debate, and build consensus around acceptable tradeoffs.

Conclusion: Successes, Challenges, and Lessons Learned

The Upper South Platte Partnership has identified and approved the initial treatment areas and work has been underway since the summer of 2016. The USPP is bringing millions of dollars into the Upper South Platte watershed that will be invested in forest treatments that its participants believe will improve landscape resilience, reduce risk of forest fire, support the local economy, improve fire response, and improve wildlife habitat and recreational opportunities (Upper South Platte Partnership, 2016). They are also investing substantial resources in community engagement and outreach intended to build the capacity of local communities to proactively adapt to wildfire. While still fairly early in its development, it has demonstrated a high level of capacity in terms of resources, knowledge, and perceived legitimacy. Even with its numerous advantages the USPP has faced challenges, some of which are fairly common for such partnerships, and some that are unique to the context of this set of actors at this place and time. While each situation is different, the remainder of this report summarizes a few of the insights from the USPP's experience that may be worth considering when undertaking collaborative watershed assessment and planning elsewhere.

- **Effective facilitation**: Beyond process management and coordination, the support of a professional and experienced facilitator has been critical in addressing many of the challenges faced by the USPP and maintaining group momentum. Issues of trust and competing knowledge claims often arise in collaborative settings, and disagreements are inevitable. Consistency of representation at meetings, degree of commitment, and distribution of responsibilities across participants are also common challenges among voluntary partnerships made up of busy professionals (particularly given that many participants are members of multiple collaborative groups). Competent facilitation has helped the USPP navigate disagreements and has kept participants focused on developing and making progress towards goals and action items. With the guidance of its facilitator, the group established protocols for decision making and adopted a more formal organizational structure that clarified the roles and responsibilities of participants. Clear and detailed meeting notes are taken by an assistant and circulated to all participants shortly following each full group meeting. These, along with concise agendas and firm time-keeping, can increase the institutional memory of the group, reduce meeting time spent rehashing issues addressed previously, and generally avoid derailments.

- **Fundraising expertise**: The Partnership has been adept at pooling and leveraging financial resources, and the availability of resources has allowed it to invest not only in action on the ground, but in improving organizational capacity through the services of a professional facilitator. A key factor in their ability to continue to attract funding into the future is the designation of a funding alignment team and the appointment of well-connected team members that are experts in this arena.

- **Community connections**: Several partners associated with project implementation (such as CSFS, CUSP, and JCD) have established trusted relationships with landowners over time, and still others bring with them valuable knowledge about local conditions within the priority watersheds and the values and attitudes of the people that live there, which may serve as a form of social capital as the USPP continues its outreach efforts. This knowledge has helped the outreach team be strategic in framing the message of the USPP and in communicating about their efforts with influential decision-makers in the priority watersheds. Participation from local fire authorities shows promise for strengthening the efforts of the Wildfire Response Team and the initiative overall.

- **Knowledge**: In addition to a firm base of local knowledge, participants also bring a great deal of specialized expertise, as well as the flexibility to incorporate their work for their home organization or agency with the collaborative efforts they are leading or contributing to within the USPP. The emphasis they place on a science-based approach to decision making is evidenced by the time and effort participants have invested in the design of the decision-support tools discussed above, as well as the extensive deliberation over appropriate criteria, measurable objectives, and a consistent pre- and post-treatment monitoring plan for their projects. While knowledge and expertise certainly strengthen the USPP in many ways, competing knowledge claims regarding the relative merits of different forest treatments have contributed to a degree of conflict within the group, again pointing to the importance of facilitation to make disagreements productive. For example, these uncertainties could be framed as hypotheses to provide a basis for monitoring and adaptive management, in turn contributing to an intentional learning process.

- **Decision making**: The ability of the USPP to act on its decisions is improved by the fact that members of the partnership council operate at a high enough level that they carry the authority to make decisions regarding the activities of the USPP on behalf of their home agencies or organizations. Its adoption of the Partnership Council model has also served to streamline and formalize the decision making process.

- **Capacity**: Some key participants that have devoted more time to the initiative have been able to do so with a directive from their home organizations to support collaborative work. Capacity to invest time, expertise, energy, and resources is especially important within the working groups.

- **Division of labor**: The assignment of participants to working groups is an important structural feature for the overall productivity of the USPP. Much of work of collaboration happens between meetings, and each working group requires a substantial commitment of time and resources from its participants. Strategies such as structuring the work in phases and focusing on achievable, intermediate goals can help a group make incremental progress and avoid burnout. Though still in development, the USPP working groups are investing a lot of time up front to develop action plans with clear and measurable objectives, deadlines, and assigned responsibilities, which should increase accountability down the road. While the working group meetings themselves may or may not be facilitated, the USPP's facilitator again provides valuable assistance by coordinating communication among participants within and across groups, promoting consistency in outputs (e.g. by providing work plan templates), and ensuring that participants receive regular updates on each working group's progress during monthly meetings.

Some insights from the USPP's experience are unique to its circumstances and may be less applicable or more difficult to replicate elsewhere. For example, many of the participants of the USPP are well-connected actors within a larger professional network focused on forest and watershed health along Colorado's Front Range, which has contributed social capital to the Partnership and may serve to raise both its profile and its expectations for success. The fact that the focus of its efforts concerns the water supply for the state's largest city likely increases its potential to attract resources, and its locus near the urban corridor of the Front Range may bolster its visibility and participation. Moreover, the USPP has benefitted from a history of collaboration among various stakeholders in the region, allowing it to build upon prior learning, existing relationships, open channels of communication, well-integrated science, and a culture of resource sharing. This kind of foundation takes time to grow and cannot be replicated quickly or easily. However, successful multi-stakeholder collaboration can be built by recognizing and leveraging the unique assets of any region, and those of the communities it serves.

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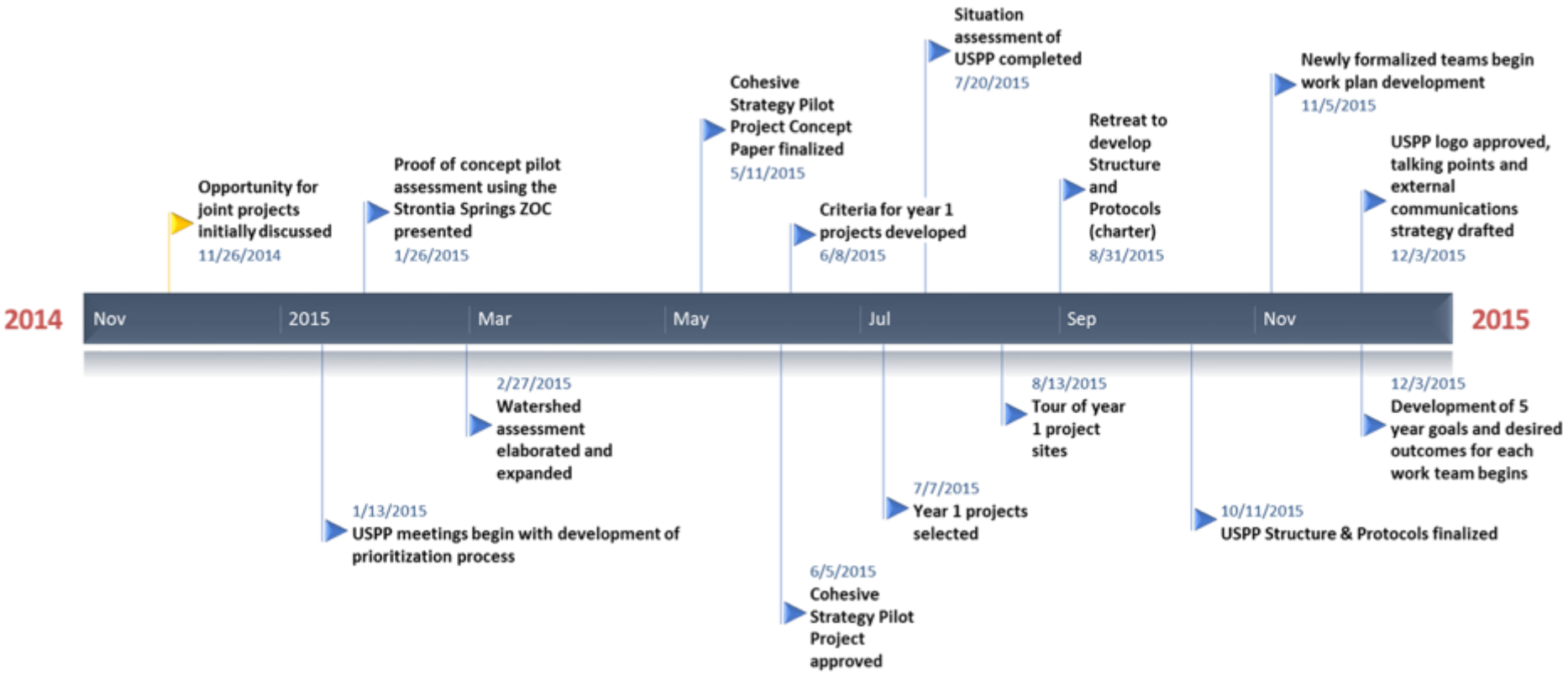
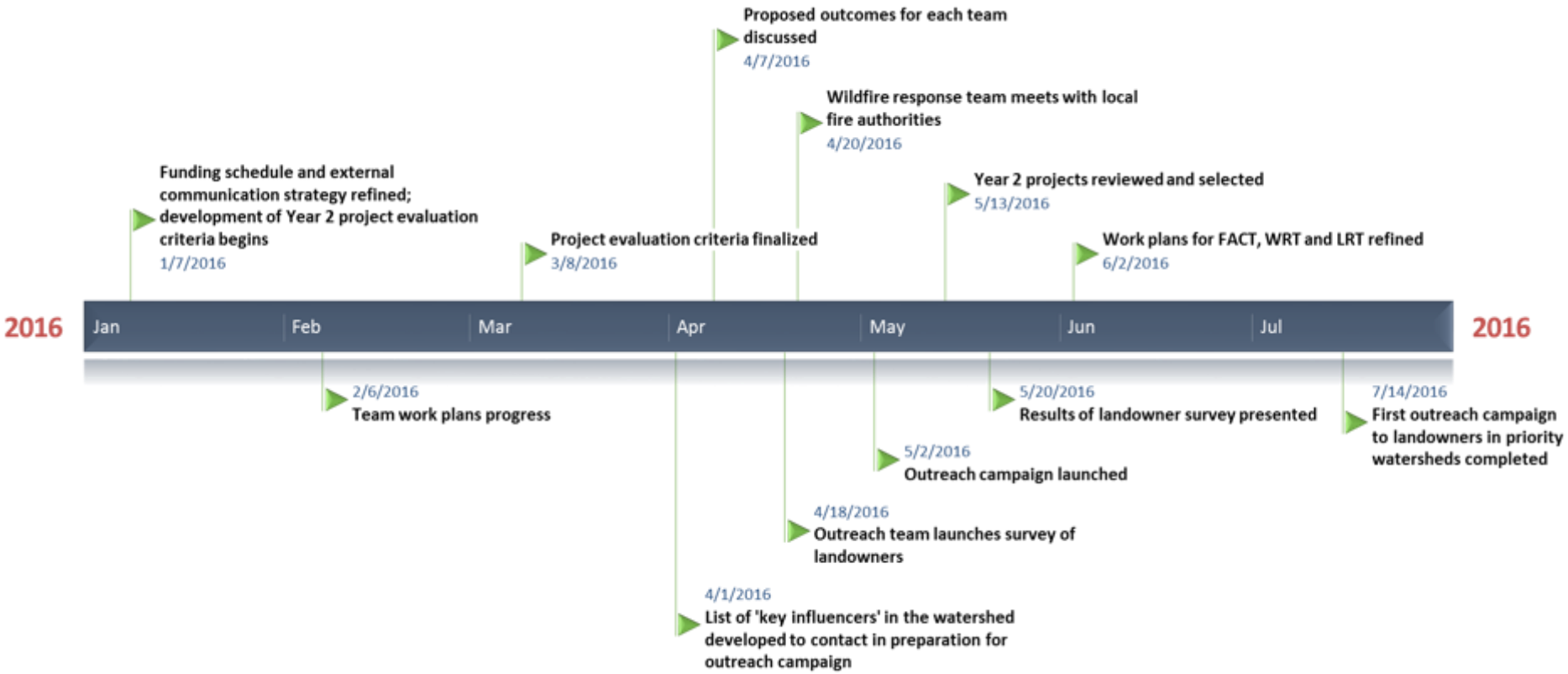
Appendix A: USPP Timeline of Activities Year 1



Appendix B: USPP Timeline of Activities Year 2



About the Colorado Forest Restoration Institute

The Colorado Forest Restoration Institute (CFRI) was established in 2005 as an application-oriented program of the Department of Forest & Rangeland Stewardship in the Warner College of Natural Resources at Colorado State University. CFRI's purpose is to develop, synthesize, and apply locally- relevant science-based knowledge to achieve forest restoration and wildfire hazard reduction goals in Colorado and the Interior West. We do this through collaborative partnerships involving researchers, forest land managers, interested and affected stakeholders, and communities. Authorized by Congress through the Southwest Forest Health and Wildfire Prevention Act of 2004, CFRI is one of three Institutes comprising the Southwest Ecological Restoration Institutes, along with centers at Northern Arizona University and New Mexico Highlands University.

The Colorado Forest Restoration Institute at Colorado State University receives financial support through the Cooperative and International Programs of the U.S. Forest Service, Department of Agriculture, under the Southwest Forest Health and Wildfire Prevention Act.

Forest and Rangeland Stewardship
1472 Campus Delivery
Colorado State University
Fort Collins, CO 80523-1472
970.491.1900
www.cfri.colostate.edu