Rio Grande Basin

Watershed Health

&

Forest Biomass Opportunities Evaluation

Prepared for Rio Grande Watershed Emergency Action Coordination Team (RWEACT) by Forest Stewardship Concepts, Ltd. James Webb and Molly Pitts, December, 2014

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INTRODUCTION

RWEACT (Rio Grande Watershed Emergency Action Coordination Team) was established in July 2013 in response to the West Fork Fire Complex. RWEACT brings together local, state and federal agencies, organizations, and individuals to develop an effective, coordinated approach to address fire-caused hazards resulting in the protection of human life, property, and the natural health of the Rio Grande watershed and its environment.

While the immediate mission of RWEACT has focused on emergency actions in the interest of public safety, a partnership has been developed between RWEACT and the US Forest Service, Rio Grande National Forest (RGNF), with the shared vision to improve forest health and protect the Rio Grande watershed through management activities. This cutting-edge partnership is focused on utilizing active forest management in a way that may reduce the threat of future landscape scale wildfires and at the same time improve community economic resilience in the face of such events. This public/private collaborative recognizes that the 88,000 acre West Fork Fire Complex burn scar combined with nearly 485,000 acres of spruce beetle infested forests creates a forest/watershed health challenge of significant magnitude and urgency. For example, watershed health and protection can be achieved through the reduction of wildfire size and intensity by removing dead woody material from the forest as directed by the RGNF Forest Plan. The partnership/collaborative will enable this work to be contracted through USFS Stewardship Agreements, which can be implemented by RWEACT and engage contractors at both the local and regional scale.

This on-going discussion has led to the question of how much biomass would need to be removed from the forest to reduce wildfire hazard and improve watershed/forest health, and whether it could be done economically without significant external financial subsidies. RWEACT requested Forest Stewardship Concepts, Ltd. complete an evaluation of the opportunities to improve watershed health and community, economic viability through the utilization of biomass. As the evaluation progressed, it became evident that removal of the material was going to cost more than the anticipated value of the biomass delivered to processors. RWEACT then asked for a "white paper" describing findings to date and refocused FSC's efforts on collaborative avenues toward active forest management and watershed protection.

This paper describes FSC's findings relative to the question of forest biomass markets as a means to accomplish watershed protection activities. This draft contains some points to consider that go beyond mere forest metrics and economic analysis. Additionally, these points highlight philosophical and policy stumbling hazards that have confounded previous attempts to sustain a forest biomass industry that is realistic and transparent for the USFS and economically feasible for the private forest industries. They are included here to ensure the field of play is understood.

EXECUTIVE SUMMARY

An evaluation of the opportunities to improve watershed health and community viability in the Rio Grande Basin through the utilization of public land forest biomass has been completed. Eighty five percent of the spruce fir forests on the RGNF have been infested with spruce beetles since 2005 (RGNF 2013 Forest Health Aerial Survey Fact Sheet). These dead trees create safety hazards and change wildfire behavior across a wide swath of the landscape. Removing some of these trees and thinning non-spruce stands will improve forest health and watershed condition.

As one travels the back roads of the Rio Grande National Forest and sees dead spruce trees everywhere, it is easy to assume that there is considerable opportunity to improve watershed health and salvage the dead trees. In a "waste not ~ want not" world, it is logical to want to make use of such an abundant resource. When the harsh reality of economically viable physical accessibility is considered, opportunities to make use of bark beetle carnage become much more problematic. Much of the available biomass is currently well suited to saw log or house log purposes. As the dead trees continue to deteriorate they will eventually lose much of their commercial value. At that point they will still have utility as "biomass" for an undetermined period.

The vast majority of available biomass is located on National Forest system lands. Of the 1,856,757 acres of the Rio Grande National Forest, only 175,167 acres (roughly 9% of the total forest) are eligible for management to improve watershed health based on the present Forest Management plan and economic considerations. Consequently, approximately 2,998,395 tons of wood are potentially available. Currently, 2,698,556 tons are scheduled to be removed via timber sales. The remaining 299,839 tons is made up of small diameter material that, to date has not been commercially viable.

Saw timber salvage sales presently make up the lion's share of wood harvest activities to remove dead trees from the forest to improve watershed and forest health. Smaller dead trees are not being removed during present logging operations, due to cost and the lack of businesses that can efficiently utilize the material. Most cellulosic biomass utilization is related to sawmill waste or firewood. Future opportunities to conduct watershed health improvement projects are dependent upon how long the larger dead trees retain their utility as saw or house logs. A significant volume of low value material is likely to be available within the next ten years.

Once the trees are no longer suitable for those end purposes, it may be difficult to find a market for lower quality woody biomass. The primary impediment to financially viable biomass utilization in the Rio Grande Basin is the $75/ton cost to get the material out of the woods and delivered to processors. Financial subsidies support current biomass removal programs in other parts of Colorado. It is unlikely subsidies will be available for the Rio Grande Basin any time soon.

Recommendations:

1. Continue to make every effort to expediently remove as much of the dead spruce through timber sales as possible while its commercial value will pay for its removal.
2. Explore options to develop markets for firewood and chips for heating large complexes.
3. Develop a plan to utilize dead woody material that has lost its value as saw or house logs.
4. Utilize the Colorado State University Agricultural Experimentation Station located in the San Luis Valley to research the use of biochar as a soil amendment.

Definition of Biomass:

The Dictionary of Forestry (Helms 1998) defines biomass as the living or dead weight of organic matter in a tree, stand, or forest in units such as living or dead weight, wet or dry weight. For the purposes of this discussion we will use tons (2,000 pounds) and cubic feet as quantifying metrics.

For the purposes of this assessment, biomass is defined as cellulosic materials >3"diameter, dead or alive, that will be removed from the forest or agricultural byproducts that are used in some process that converts them into boards, house logs, firewood, biofuels, bio char, electrical energy, pellets, animal bedding, erosion waddles, and compost or yet to be developed end products. Materials ≤ 3"diameter will remain on site for soil enhancement.

GOAL

Assess opportunities to improve forest/watershed/community health and resilience through expanded utilization of forest biomass in the Rio Grande Basin.

OBJECTIVES

- Identify likely long term reliable forest biomass supply within the San Luis Valley region of the Rio Grande Basin.
- Identify reasonable harvest and haul costs for delivery of forest biomass to a processing site within a fifty- mile haul distance.
- List current facilities utilizing forest biomass in the San Luis Valley
- Identify likely new markets for forest biomass in the region.
- Explore the pros and cons of USFS Stewardship Contracts vs Agreements for getting forest management done on the ground.
- Identify synergistic opportunities to use biomass in cost effective ways.
- Establish a public outreach strategy to identify and assess the potentially affected interest groups, public opinion and acceptance of an expanded focus on biomass harvest to improve watershed and community health and resilience.

- Identify locations well suited to expanded biomass operations.
- Explore potential funding sources to facilitate biomass harvest and utilization.
- Describe county, state and federal permitting requirements associated with biomass harvest activities and facilities.

ASSUMPTIONS

- ✓ All operations will have to pay their way. No subsidies will be available from federal, state or NGOs for long term stewardship activities.
- ✓ The vast majority of biomass will originate on Rio Grande National Forest lands. Large private ranches on the east side of the Valley have not been included in this assessment for various reasons specific to each property.
- ✓ All forest stewardship activities will comply with the standards and guidelines found in the Forest Management Plan for the Rio Grande National Forest.
- ✓ Current saw log and firewood programs will be maintained or enhanced.
- ✓ By-products from forest stewardship activities will be used for their highest and best purposes.
- ✓ Costs will be based on current, market driven wages for all biomass workers.
- ✓ Integrated operations will likely be the most cost effective.

APPROACH

Conclusions in this paper are based upon several independent studies conducted in the area, and fresh information gleaned from numerous interviews of subject matter specialists in the San Luis Valley and across the nation. An in-depth analysis of biomass supply and harvest/haul costs was conducted based upon local forest and labor conditions.

Existing studies include: Biomass Resource Supply Study, prepared for S.E.E.D. Park International, by Craig Jones & Joe Hamilton, April 2013 and the Chama Healthy Forest and Wood Utilization Study, prepared for Western Environmental Law Center by Ecosphere Environmental Services, June 2013

CURRENT DEMAND & RESIDUES

Current demand for sawlog material (sound material to a 6” top) exceeds 30,000 CCF currently offered. A CCF is 100 cubic feet of wood. All Rio Grande National Forest commercial sawtimber sells for more than the $5/CCF for material >8” dbh (diameter at 4.5 feet) base advertised rate. Demand for personal and commercial firewood sales is high. Demand for house log quality material dropped during the recent recession, which started in 2007 and has not completely rebounded. It is reasonable to assume that house log material will be sought after as the economy improves.

Sawmill residue is one important source of woody biomass that is yet to be utilized to the fullest. Most sawmills have markets for animal bedding, compost, or incidental chips for landscaping but demand does not match accumulated supply. In terms of economic development, this residue could be an opportunity for the start of a new business, or expansion of an existing business. Refer to the "Existing Capacity/Current Utilization" section of this paper for an in depth discussion on the topic.

ESTIMATING SUSTAINABLE SUPPLY

Quantifying a reasonably sustainable supply of biomass material is a multi-faceted exercise with wide ranging variables. Unknowns include: annual Forest Service budgeting, litigation of proposed projects, natural processes such as wildfire, and the anticipated long-term viability of insect and fire damaged trees.

In an ideal world, Forest Service budgets will allow the Rio Grande National Forest to offer 30,000 to 35,000 CCF of commercial quality sawlogs and firewood annually. All of the proposed watershed restoration and forest health projects would have wide ranging support so litigation would be a thing of the past. Natural processes would stabilize and the current dead trees would maintain their utility as sawlogs and house logs for a very long time. If only these things were certain.

A more reasonable scenario finds annual Forest Service budgets fluctuating for various reasons that are not in the control of the RGNF. Likewise, Mother Nature will continue to provide environmental stochastic events. Broad based consensus on ethical land management will continue to be a challenge and diseased trees will optimistically retain high grade commercial value for perhaps eight to ten years.

Private lands:

Forest biomass originating on private lands is not included in this assessment. Much of the private forest land is not actively managed for watershed health and resilience. The one major exception to this norm is the Trinchera Ranch. It is actively managed and they currently have outlets for all the material they produce during forest restoration projects. As their forest stewardship program evolves they may have surplus woody biomass to add to the Valley supply. At this time, however, the Trinchera Ranch does not want to speculate on future program levels.

Approximately 45,500 ft^3 of wildfire hazard mitigation slash is produced by individuals enhancing defensible space around their structures in forested environments (Colorado State Forest Service personnel 2014).

Barley straw is another agricultural biomass by- product in the Valley. Markets exist for all the barley straw produced today.

Public Lands:

Rio Grande National Forest will provide the majority of forest related biomass. Bureau of Land Management lands may be a source of minor amounts of Piñon pine, Ponderosa pine, and Douglas-fir at some point in the future. A quick review of the Rio Grande Forest Plan land allocations shows the following:

Rio Grande National Forest Acreage as Allocated in Forest Plan

Land Category	*Acres*	*Percent of total*
Total Forest Area	1,856,757	100
Non-Forested	689,334	37
Forested	1,167,423	63
Wilderness (forested)	227,046	12
Nonindustrial (species/soil concerns)	195,127	11
Tentatively Suitable for Harvest	745,252	40
Suitable in Forest Plan*	298,100	16

*In this context "Suitable" means ground determined to be appropriate for silvicultural management which includes forested areas where the terrain, soils, tree species, and accessibility lend themselves to management of forests and woodlands to meet the diverse needs and values of society on a sustainable basis.

Methodology

Biomass quantity estimates for the RGNF are based on GIS data layers and Forest Management Plan (FMP) Management Unit prescriptions. To get a realistic impression of material that may be available, FSC and Integrated Land Services conducted the following analysis:

1. For the purposes of this section of the assessment, biomass is defined as cellulosic materials, dead or alive, that will be removed from the forest or agricultural byproducts that are used in some process that converts them into boards, house logs, firewood, biofuels, bio char, electrical energy, pellets, animal bedding, erosion waddles, and compost or yet to be developed end products.

2. We started by showing all FMP units that allowed silvicultural activities in their management prescriptions. These units include: 4.21 – Scenic Byways or Railroads, 4.3 – Dispersed Recreation, 5.11 – General Forest & Rangelands, Forest Vegetation Emphasis, 5.13 – Forest Productions, and 5.41 – Deer & Elk Winter Range.

3. Assuming that significant new road construction was unlikely , due to economic and environmental concerns, we removed all areas that were more than 0.25 miles from an existing road.

4. We then removed a 100 foot buffer from each side of riparian areas.

5. Then we excluded all terrain >30% slope.

6. The final screen consisted of removing all areas that had previous silvicultural activities that created young, small diameter seedling/sapling stands. These regeneration cut activities included clear cuts, patch clear cuts and over-story removal cuts.

7. We then sorted the remaining forested areas by dominant tree species and wildlife habitat structure stage (HSS). Since the vast majority of habitat structure stages and tree size classes are closely correlated, we did not further refine the sorts with size class categories. See the table below to interpret habitat structure stage and tree size classes. Tree species codes are found in item 9 below.

8. Wildlife Structural Stage and Tree Size Class*

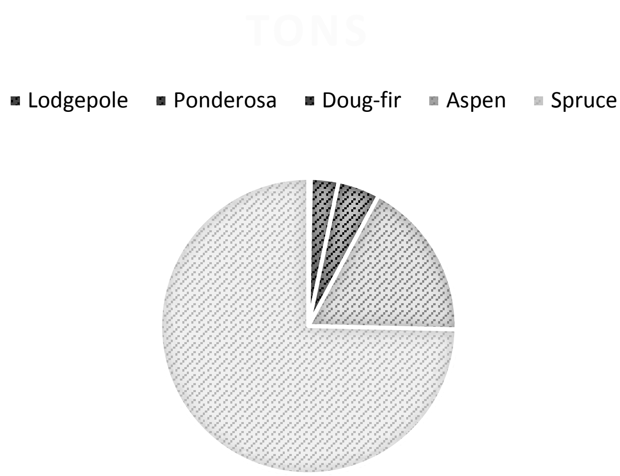
Habitat Structural Stage	% Canopy Cover	Tree Size Class
2T	na	E = Established seedlings (0.0-0.9" dbh/drc)
3A	<40	Medium = (5-8.9" dbh)
3B	40-70	Medium = (5-8.9" dbh)
3C	>70	Medium = (5-8.9" dbh)
4A	<40	Large = (9-15.9" dbh) to Very Large (16"+)
4B	40-70	Large = (9-15.9" dbh) to Very Large (16"+)
4C	>70	Large = (9-15.9" dbh) to Very Large (16"+)

*NOTE: This information allows us to approximate stand stocking levels which in turn allows us to predict amount of biomass in any given stand.

9. Tree species codes: ABCO = Abies concolor (White fir), ABLA = Abies lasiocarpa (Subalpine fir), PIAR = Pinus aristada (Bristlecone pine), PICO = Pinus contorta, (Lodgepole pine), PIED = Pinus edulis (Piñon pine), PIEN = Picea engelmannii (Engelemann spruce), PIFL = Pinus flexilis (Limber

pine), PIPO = Pinus ponderosa (Ponderosa pine), POAN = Populous angustifolia (Narrowleaf cottonwood), POTR = Populace tremuloides (Aspen), PSME = Pseudotsuga menziesii (Douglas fir). These codes allow us to predict the amount of biomass based upon tree species.

Tree Species Distribution



10. Tree species and habitat structural stage were sorted and displayed by individual ranger district to provide an initial spatial distribution of biomass originating on the RGNF.

11. Biomass yields were determined based on stand exam information and likely silvicultural prescriptions focused on improving stand and watershed health. This provides a close approximation of anticipated biomass removal by tree species and habitat structural stages.

Acres Available for Watershed Health Management Activities Following GIS Sort:

Conejos Peak RD	Divide RD	Saguache RD	Total
21,734	76,756	76,677	175,167

Only 9% of the Rio Grande National Forest is eligible for watershed health improvement activities that involve silvicultural treatments based on the current Forest Plan.

Estimated Available Biomass by Ranger District

Ranger District	100 Cubic Feet (CCF)	Tons (15% mc)
Conejos Peak	506,210	627,700
Divide	1,275,333	1,581,413
Saguache	636,518	789,282
Forest Total	2,418,061	2,998,395

2,998,395 tons of commercial sawlogs and firewood are likely to meet sawlog criteria **IF** bug killed trees retain their commercial integrity for a long period of time.

Only 299,839 tons are non-sawlog material that is likely to be used for biomass purposes. Approximately 573 tons of timber sale slash is piled and burned each year and 1,148 tons of thinning slash is hand piled and burned.

IF bug killed trees deteriorate within the next 10 years there may be as much as **2.6 million** tons of cellulosic material available for biomass type uses.

Supply Caveat: Estimates of available biomass are based on forest inventory plots designed to determine commercial timber quantities. These plots normally do not provide an accurate indication of smaller, non-commercial, cellulosic material. As the RGNF prepares to revise its Forest Plan, field crews are conducting current forest inventories that will provide more accurate information on overall forest metrics. Refined knowledge of smaller (<8" diameter) tree size class distribution will provide a clearer understanding of the material available, it's possible uses and the challenges related to getting it to processing facilities.

Haul Distance and Supply to Various Logical Processing Sites:

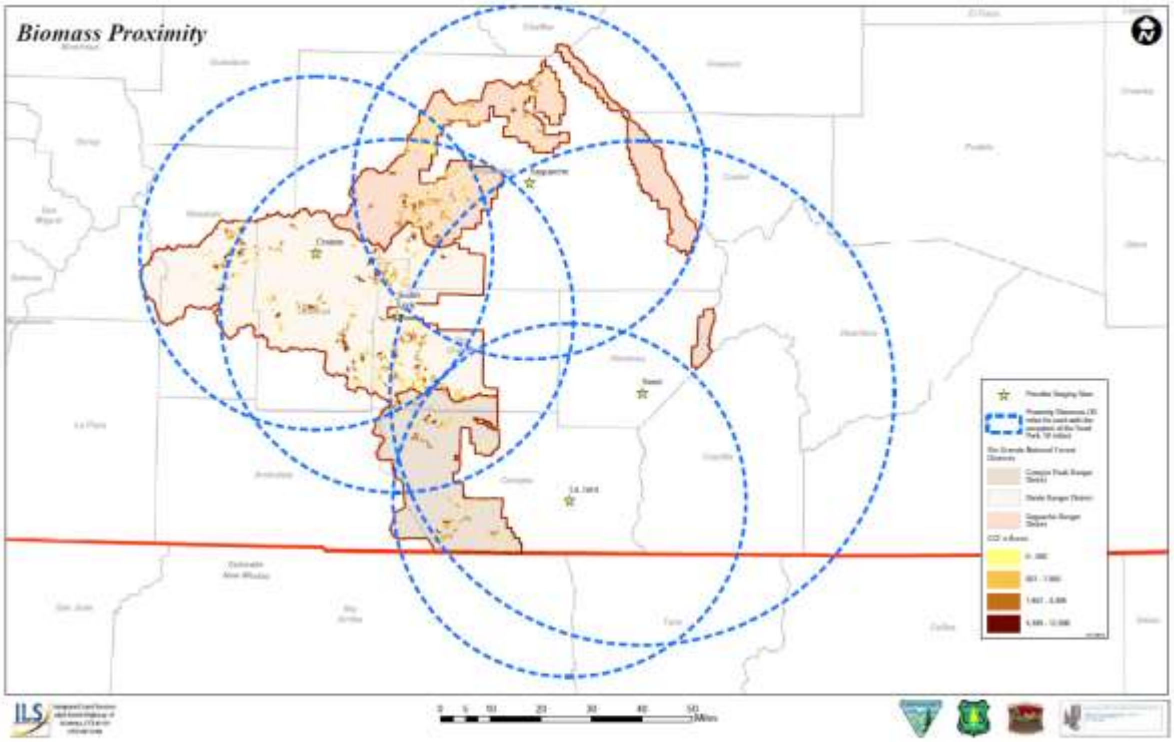
Determining how much biomass is available to logical processing sites is one component in identifying the optimum locations for such infrastructure. Five locations were selected as likely sites for biomass processing in the Rio Grande Basin. Several sites are associated with existing sawmill operations while others were selected based on inquiries by various interested parties.

The central haul locations include: Creede, La Jara, Saguache, South Fork and the SEED Park east of Alamosa.

Generally, a fifty-mile radius is referenced as the economic working circle for biomass raw material. This works well for relatively flat country but becomes problematic in highly dissected terrain. Rio Grande Basin topography and road systems do not lend themselves to an arbitrary fifty-mile radius. The Continental Divide and many deep drainages that route roads around large land masses often dramatically increase the miles driven to get to a facility within a fifty-mile circle. We used a flexible haul distance that ranged from twenty two to fifty miles that responded to terrain and haul difficulty.

Biomass Proximity to Potential Processing Sites:

Site	Haul Distance Miles	Total Acres	Total CCF	Total Tons
Creede	35	17,203	1,263,220	1,566,392
La Jara	35	11,950	437,856	542,941
Saguache	35	43,446	803,227	996,002
South Fork	25	39,972	1,838,156	2,279,313
SEED Park	50	31,665	855,366	1,060,653



Supply Summary:

As one travels the back roads of the Rio Grande National Forest and sees dead spruce trees everywhere, it is easy to assume that there is considerable opportunity to improve watershed health and salvage the dead trees. In a “waste not ~ want not” world it is logical to want to make use of such an abundant resource. When the harsh reality of economic accessibility is considered, opportunities to make use of bark beetle carnage become much more problematic. Much of the available biomass is currently well suited to sawlog or house log purposes. As the dead trees continue to deteriorate they will eventually lose much of their commercial value. At that point they will still have utility as “biomass” for an undetermined period.

TREATMENT COSTS

Harvest and Haul: Evaluating what it may cost to remove small diameter trees from stands is an elusive endeavor primarily because it has not been done in this area on an operational level. We interviewed several logging contractors in the San Luis Valley and compared their best estimates to other operations across the central Rockies. We also referred to recent biomass studies to develop an informed harvest and haul cost for this report.

$75/ton appears to be the point at which a prudent logger can deliver biomass material 3-8" in diameter within a fifty-mile haul. This figure assumes a livable wage and reasonable profit and loss.

Present logging operations use mechanical feller bunchers, skidders, log processors, and log trucks to remove designated trees from the woods and deliver them to a sawmill. The equipment is sized to handle trees normally harvested. It is expensive to purchase and maintain, and requires skilled operators to maximize efficiency. Present equipment is not designed to economically remove significantly smaller sized trees from the woods or haul it to a processing plant off site. Considerable ingenuity will be required to reconfigure equipment and operations to maximize efficient removal of small diameter biomass material.

Biomass Harvest & Haul Daily Costs

Equipment	Daily Cost ($s)
Tracked Feller/Buncher	2,200✓
Tracked FB w/ Processor Head	2,200✓
Rubber Tire Skidder	1,300✓
Forwarder	1,200
Short Self Loading Log Truck	800
5710 Horizontal Grinder	5,500✓
2710 Horizontal Grinder	3,500
Total Daily Cost one Operation✓	11,200
+ Haul costs	

Items marked with a ✓ are included in total daily cost calculation.

To *break even* on daily costs, an operation will have to produce 149 tons a day, at $75/ton. This requires treating at least nine acres per day and will produce six log trucks of material. To make a profit, more area will have to be treated. In most instances the initial equipment purchase will be financed requiring monthly payments whether the equipment works or not. Heavy snow, wet summers, and spring breakup are periods when equipment is idle and unable to generate income.

Stewardship Contracting Costs:

Rocky Mtn. Region of the USFS has entered into several stewardship contracts that provide for thinning and salvage of biomass materials to improve forest health and reduce wildfire hazard. These contracts have a variety of conditions and stipulations that must be met and cost from $400 to $1,700 per acre. Treatments on private lands within the Black Forest fire burn scar near Colorado Springs, are running from $1,800 to $2,500 per acre depending upon salvage rights. According to CSU Professor Kurt Mackes, most forest restoration work in Colorado costs between $900 to $1,500 per acre. Contract specifics can vary dramatically depending upon expected work and contractor salvage rights.

DELIVERED COST VS EXPECTED VALUE

We have reached the crux of the biomass utilization question. Is there a market for $75/ ton biomass when most biomass processors can make a profit with raw material cost around $30-$40/ ton? Probably not.

Discussions between the electrical generation plant in Gypsum and biomass interests in Chama have revealed that it may be feasible to build a plant in the Chama area if they can get raw materials for $30/ ton and sell their electricity for $0.12/kwh. The San Luis Valley Rural Electric cannot afford to pay more than $0.08/kwh.

The company, BioChar Now, is interested in establishing a plant in the Creede area if they can get 75,000 tons/year at around $38/ton.

The reality is that current biomass operations in Colorado rely on significant subsidies to break even or make a marginal profit.

ECOLOGICAL IMPLICATIONS

Forest Health & Resilience:

Helms (1998) defines forest health as the perceived condition of a forest derived from concerns about such factors as forest age, structure, composition, function, vigor, and presence of unusual levels of insects or disease and resilience to disturbance. Perception and interpretation of forest health are influenced by individual and cultural viewpoints, land management objectives, spatial and temporal scales, the relative health of stands that compromise the forest, and the appearance of the forest at a point in time. Helms further defines ecological resilience as the capacity of a plant community or ecosystem to regain normal function and development following disturbance.

US Forest Service Manual defines Resilience and restorations as follows:

> Resilience. The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.
>
> Restoration. The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on establishing the composition, structure, pattern, and ecological processes necessary to facilitate

terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions.

The forests surrounding the San Luis Valley have experienced significant insect mortality. They appear to be well beyond their normal range of "natural" variability. The concept of range of natural variability is used to describe the fluctuation of natural processes in terms of timing, intensity, and scope of an event. While periods of increased insect activity are normal, the scale of the present activity may be beyond historic epidemics. Spruce forests normally have long (300 – 400 year) periods between disturbances such as fire or insect mortality. Most old growth stands have been killed. Fortunately, spruce seedlings and saplings are present in the understory of many stands. Their presence assures continuing spruce forests following the recent insect activity.

Watershed Condition:

The following discussion is extracted from *Factors that influence watershed condition are described in the Watershed Condition Classification Technical Guide, USDA Forest Service FS-978, July 2011.*

Watershed condition is the state of the physical and biological characteristics and processes within a watershed that affect the hydrologic and soil functions supporting aquatic ecosystems.

Watershed condition reflects a range of variability from natural pristine (functioning properly) to degraded (severely altered state or impaired). Watersheds that are functioning properly have terrestrial, riparian, and aquatic ecosystems that capture, store, and release water, sediment, wood, and nutrients within their range of natural variability for these processes. In general, the greater the departure from the natural pristine state, the more impaired the watershed condition is likely to be. Watersheds that are functioning properly are commonly referred to as healthy watersheds. Watersheds that are functioning properly have five important characteristics (Williams et al. 1997):

1. They provide for high biotic integrity, which includes habitats that support adaptive animal and plant communities that reflect natural processes.
2. They are resilient and recover rapidly from natural and human disturbances.
3. They exhibit a high degree of connectivity longitudinally along the stream, laterally across the floodplain and valley bottom, and vertically between surface and subsurface flows.
4. They provide important ecosystem services, such as high quality water, the recharge of streams and aquifers, the maintenance of riparian communities, and the moderation of climate variability and change.

5. They maintain long-term soil productivity.

Wildfire Impacts on Watershed Condition:

As the bug killed trees fall to the ground, tons of material will accumulate. When a wildfire does occur, fire residence time will increase dramatically with more heat produced in close proximity to the ground. Litter and duff are likely to be burned with very little organic material left on site. At the same time the unusual density of downed logs will seriously constrain fireline building efforts. With dead woody fuel loading substantially beyond normal accumulations, one can anticipate more impacts on soils and larger fires due to resistance to control.

Fire Regime & Condition Class:

A natural fire regime is a general classification of the role fire would play across a landscape in the absence of modern human intervention, but includes the influence of aboriginal burning. The five natural fire frequency regimes are classified based on average number years between fires combined with the severity of the fire on the dominant overstory vegetation. These five regimes include:

Fire Regime Group	frequency (fire return interval)	severity
I	0 – 35 years	Low severity
II	0 – 35 years	Stand replacement severity
III	35 – 100 + years	Mixed severity
IV	35 – 100 + years	Stand replacement severity
V	>200 years	Stand replacement severity

A fire regime condition class (FRCC) is a classification of the amount of departure from the natural regime. The classification is based on a relative measure describing the degree of departure from the historical natural fire regime. This departure results in changes to one (or more) of the following ecological components: vegetation characteristics (species composition, structural stages, stand age, canopy closure, and mosaic pattern); fuel composition; fire frequency, severity, and pattern; and other associated disturbances (e.g. insect and disease mortality, grazing and drought). There are no wildland vegetation and fuel conditions or wildland fire situations that do not fit within one of the three classes.

The three condition classes are based on low (FRCC 1), moderate (FRCC 2), and high (FRCC 3) departure from the central tendency of the natural (historical) regime. Low departure is considered to be within the natural range of variability, while moderate and high departures are outside. Features of each condition class are defined through a qualitative description of the current state of five key ecosystem attributes: (1) disturbance regime; (2) effects of disturbance regime; (3) potential production of smoke emissions; (4) hydrologic function; and (5) vegetative composition, structure and resilience.

Condition Class 1

The historic disturbance regime is largely intact and functioning as defined by the historic natural fire regime. The effects of insects and disease as well as the potential intensity and severity of the fire are within historic ranges, but are increasing with the length of current fire return interval. Smoke production is relatively frequent, but is low in volume and short in duration. The hydrologic functions are within normal historic range. Vegetative composition and structures are resilient to disturbances from wind, insects, disease, or fire and do not predispose the stand or its key components to a high risk of loss.

Condition Class 2

Moderate alterations to the historic disturbance are clearly evident, such as one or more missed fire return intervals. The effects of insects and disease as well as the potential intensity and severity of fire pose an increased threat to key components that define the ecosystem. Smoke production has increased both in volume and in duration and has increased potential to affect health and visibility values. Riparian areas and their associated hydrologic functions show measurable signs of adverse departure from historic conditions. Both the composition and structure of vegetation has shifted towards conditions that are less resilient and are therefore more at risk to loss from wind, insects, disease, or fire.

Condition Class 3

The disturbance regime has been significantly altered and historic disturbance processes and effects may be precluded. The effects of insects, disease, or fire may cause significant or complete loss of one or more defining ecosystem components. Episodic smoke production is unpredictable and of high volume and long duration, posing significant impacts to human health, safety and societal values. Hydrologic functions may be adversely altered, with significant increases in sedimentation potential and measurable reductions in stream flows.

The highly altered composition and structure of the vegetation predispose the stand or ecosystem to disturbance events well outside the range of historic variability, potentially producing changed environments never before measured.

As described above, fire frequency or intervals between fires on a landscape play an important role in determining what vegetation will be in place and what condition it will be in. The Rio Grande Basin exhibits a significant range in elevation, aspect and hence a wide variety of fire regimes and condition classes. Ponderosa pine forests have experienced the most alteration of fire regime and condition class, and are most prone to burn intensely. Many mixed conifer stands are similarly out of ecological balance. Spruce stands have been less impacted due primarily to the less frequent fire occurrence at higher elevations.

Wildfires were less prevalent during the 1900s due in part to a wetter climate and to rapid initial attack of small fires. The recent increase in wildfire numbers and intensity is attributable to a prolonged drought, wide spread insect mortality, and forest stands that are much denser and hence; more prone to hot crown fires.

Examples include:

The Million Fire of 2002 burned over 11,000 acres in Rio Grande County and destroyed 33% of the structures in Willow Park subdivision. The Missionary Ridge fire burned 70,480 acres and destroyed 83 structures. The Sand Dunes Fire of 2000 burned over 8,500 acres in one burning period and destroyed one structure in Great Sand Dunes National Park & Preserve. The Medano wildfire in the Great Sand Dunes National Park & Preserve burned over 6,000 acres. Last but certainly not least, the West Fork Fire Complex burned over 107,000 acres, much of it in high elevation spruce forests that seldom experience wildfires of any kind.

The vast majority of the forests covered by this biomass assessment would normally fall in Fire Regime V (>200 year fire return interval) and Condition Class 1 (Very little impacts from fires). It could be argued that the widespread insect mortality causes hot enough fires to exceed the range of natural variability and therefore raise condition class to a 2 or 3 level.

Wildfire Fire Suppression Considerations:

Fire behavior during the West Fork Fire Complex of 2013 demonstrated the new norm for wildfires in bug killed spruce forests. Individual dead trees torched and threw burning embers into the convection column to ignite new fires as much as a half mile ahead of the flaming front. With the probability of ignition as high as ninety percent, most embers that landed on receptive fuel beds became new fires. Containment of fires of this nature requires robust, pre-existing, fire control features on the ground with many safety zones scattered along the control features for firefighters to migrate to when it is no longer safe to make a stand along firelines.

One reason the West Fork Fire Complex got so large was the scarcity of safe places to make a stand against it. One way to provide opportunities to catch future wildfires in the spruce type is to create fuelbreaks by removing dead standing trees and cleaning up dead woody debris on the ground. When this cleaned up area coincides with roads that provide access for fire apparatus and escape routes for firefighters, there is a much more likely chance fire suppression activities will prevail. These fuelbreaks will provide a much safer place to engage future fires (Jenkins et. al. 2012)

Travel Corridor Safety:

Fuelbreaks along existing roads also significantly reduce the probability that hazardous trees will blow down on people in these corridors be they forest workers or visitors. It is currently almost impossible to find a place to camp in the spruce type on the Rio Grande forest without being at least a tree length away from the forest edge and well into an open meadow. Many historical, dispersed recreation sites are extremely hazardous at the present time.

Natural Processes:

Fully functioning ecosystems are dependent upon natural processes. One could develop a philosophy that watershed and or forest health is just fine when "natural processes" prevail. In fact, no human intervention is warranted when natural events occur. So was watershed health intact following the Mount Saint Helens eruption? Is it possible that some natural events are of such scale and impact on human activities that restoration or mitigation activities are warranted? In fact it can be argued that humans are natural. At birth we are as natural as a grizzly cub or a hummingbird.

Has the current bark beetle epidemic created an unusually large scale impact on the landscape? We know it has killed the vast majority of old growth spruce forests on the San Juan and Rio Grande forests and is working its way north with impunity. Are 100,000 acre wildfires really within the past range of natural variability? Fire scar and vegetative evidence does not support such a conclusion. Has watershed condition been enhanced by the natural insect epidemic? These are points to ponder as we attempt to improve watershed and forest health in the Rio Grande Basin. Additionally, while large-scale insect outbreaks by themselves are not necessarily unnatural, the situation does get complicated when these outbreaks occur in areas that are routinely used by forest visitors or are the foundations for community economic vitality.

EXISTING CAPACITY/ CURRENT UTILIZATION

Currently, most wood removed from the Rio Grande National Forest is typically processed within the San Luis Valley by the following businesses:

- Mountain Valley Lumber – located in Saguache. This mill can utilize all species and produces tongue and groove (T&G) round house logs, dimensional lumber, T&G flooring and paneling, log siding, rustic slab siding, beams, rough sawn material, planed lumber and grade stamped material.
- Allpine Lumber Company – located in La Jara and has a milling capacity of 1 to 1.5 million board feet (MMBF) /year. This mill can utilize all species and produces log homes, logs, log

siding, wood paneling, beams, furniture, decking, wood flooring, rough dimensional lumber and molding. Waste from the sawmill is utilized as compost, animal bedding and landscape material.

- Rocky Mountain Timber Products – located in Del Norte. This mill has an annual milling capacity of 3-4 MMBF/year and can utilize all species. Primary products include surfaced and rough cut timber, logs, paneling, siding, beams, mulch and firewood. Sawmill waste is utilized as mulch, animal bedding and landscape material.
- Pleasant Western Lumber, Inc. – located in Monte Vista. Following a recent sawmill fire they have converted to a firewood operation that is on track to cut about 3,000 cords of firewood a year. Trinchera Ranch presently supplies their raw material. Pleasant Western Lumber may be interested in purchasing firewood from the Rio Grande National Forest dependent upon species available and price.

Outside of the San Luis Valley, the primary business that is removing wood from the Rio Grande National Forest is Montrose Forest Products, which is owned by Neiman Enterprises, LLC. and located in Montrose, Colorado. It has a milling capacity of 110 MMBF/year. The Montrose mill is primarily a stud mill and can utilize all species.

PROVEN TECHNOLOGY

Although there is a lot of on-going research on new and exciting ways to utilize woody biomass, most wood is still being utilized through traditional methods such as sawmills and firewood as highlighted above. Other products include: House logs – Since the recession, the house log market has been very slow and has not yet recovered to pre-recession level. There has been some preliminary discussion that a large log home manufacturer may be setting up a plant in the Chama, New Mexico area. Overall, volume utilized will still be low.

- Wood pellets – Currently, there are two primary wood pellet manufacturers in Colorado. Overall production of pellets is relatively low compared to operations in other states. Wood pellets could be a great way to utilize the dead material that is planned to be removed. The most economical and efficient set-up for a pellet plant is to co-locate it with another wood processing facility such as a sawmill, especially one that is utilizing dry material or operates a kiln. The most significant barrier to another pellet plant being built is long-term, reliable supply of raw material. Existing businesses are very hesitant to expand their current operations to include pellet manufacturing due to the uncertainty of supply.
- Wood chips – Wood chips can be used for many different products including landscape material and playground cover. Chips can also be used to produce heat and electric power through the use of direct combustion. Several projects throughout Colorado showcase the opportunities of using wood chips to heat buildings. This type of utilization could be very beneficial in those areas throughout the San Luis Valley that currently utilize propane or electricity for heat. Similar to the situation with wood pellets, uncertainty regarding long-

term supply makes it difficult for institutions such as counties, schools, and hospitals to switch from their current heating method to wood heat, even though the savings could be tremendous. In the same regard, local logging companies are hesitant to purchase the necessary equipment to produce quality chips since the market does not currently exist.

- Biochar – Biochar, which is similar to charcoal, is produced using slow pyrolysis (heating biomass in an oxygen-deprived environment). Biochar can be produced at various scales depending on the type of production, and through the process, can produce by-products such as syngas and bio-oil. Biochar can be used as a soil amendment, for reclamation, oil and gas, odor control, and bio-filler. "Biochar Now", a company located in Loveland, Colorado, has given a presentation in Creede and is interested in potentially building a plant within the San Luis Valley. Initial discussion call for 75,000 tons of raw material per year delivered in the Creede area.
- Posts and poles
- Shavings/ animal bedding
- Mulch/ topsoil

Cutting Edge Technology

There isn't any shortage of innovative ideas on how to turn biomass into valuable products. There is a gap however, between ideas and commercial viability. It bodes well for future uses of what is currently considered a waste product. As prototypes evolve, we can expect some valuable break-throughs. Until then, it is not prudent to base biomass operations in the Rio Grande Basin on processes and technology that are unproven, unreliable, and that may be many years in development.

Procurement Options

Since most of the wood that needs to be removed to improve watershed condition and forest health within the upper Rio Grande Basin is located on the Rio Grande National Forest, procurement of wood will be through Federal contracting. Procurement options include the following:

- ✓ Timber Sales – Historically and even currently, most wood is removed through the use of a timber sale. Timber sales can vary in size and are usually awarded based on highest bid. Timber sales do not typically include service work, with the exception of road work, and a portion of receipts generated must be returned to the US Treasury. The remaining funds can be used to support salvage and thinning projects. Timber sales can be limiting to industry in that they are usually not long term and the amount of wood available from year to year can vary.

- ✓ Thinning Contracts – Thinning contracts are typically used to complete projects in which the value of goods removed is less than the value of service being provided and therefore the contractor is typically paid to complete a specific project.

- ✓ Stewardship Contracts – Stewardship contracts are used when a project will include both forest product removal and service work items. Stewardship contracts can be awarded for multiple years (up to 10) and can be awarded on a "best-value" basis. Currently, there are several Stewardship Contracts within Rocky Mountain Region of the Forest Service, and at this time the Region is not very interested in another long-term contract.

- ✓ Stewardship Agreements – New stewardship agreements are typically tied to an existing Master Agreement within the Region and historically have been through large non-profit organizations such as the Wild Turkey Federation and the Rocky Mountain Elk Foundation. Stewardship agreements require that partners provide at minimum, a 20% project match in the form of cash, non-cash, or in-kind contributions. The 20% is based on the total project less the value of timber. An agreement does not have to be with a non-profit, but those involved are not allowed to make a profit and if a profit is realized, the funds are either used for additional service work or paid back to the Forest Service as excess receipts. In reality, for a new stewardship agreement to work, the partner organization will need to bring 100% of the funding to the table since funding for a new project within the Region is not feasible at this time.

FINANCING OPTIONS

Colorado, and specifically the San Luis Valley, there are several

- Tax Incentives
    - There is currently a sales tax exemption on beetle wood products, including lumber, furniture, wood chips, and wood pellets generated from salvaged trees. This is especially important since most of the wood that will be removed in the future is related to spruce beetle mortality.
    - The San Luis Valley, including six counties and 18 communities, is within an established Enterprise Zone. Businesses that operate with this Zone may qualify for up to nine different tax credits. Mike Wisdom, Executive Director for the San Luis Valley Development Resources Group, is an excellent resource that can work with new and/or existing businesses to determine their eligibility.
    - The Biomass Crop Assistance Program provides financial assistance to biomass facilities with the cost of biomass delivery. There is an application process and only $25 million per year is authorized nationally and competition is very stiff.

Currently, the only facility in Colorado to be receiving payments is Evergreen Clean Energy in Gypsum.

- Loans
    - The San Luis Valley Development Resources Group administers the San Luis Valley Revolving Loan Fund. This fund has several different types of loans available, depending on specific needs and qualifications.
        - The San Luis Valley Revolving Loan Fund has a minimum loan fund of $10,000 and a maximum of $250,000. In order to qualify, the business must be located within one of the 6 counties in the valley and create at least one full-time job for every $20,000 borrowed. The loan can be used for land, buildings, equipment, working capital and inventory and has a maximum loan term of 10 years.
        - The San Luis Valley Micro Enterprise Loan Fund has a minimum loan of $2,500 and a maximum of $100,000. To qualify, the business must be located within one of the six counties in the valley, have 5 or fewer employees, including the owners, and meet the low to moderate family income criteria. This loan requires at least 10% equity and for an existing business, current sales can't be more than $1,000,000 or personal net worth more than $250,000. This loan can be used for land, buildings, equipment, working capital, inventory and/or refinancing of up to 30% of an existing debt.
    - Shade Fund, administered with help by the Colorado State Forest Service, provides loans to entrepreneurs who are involved with forest restoration and wood utilization. Loans are capped at $50,000, although most average around $25,000 or less.
- Grants
    - Colorado State University recently received $250,000 to start a Colorado Wood Energy Team. This team has been tasked with promoting the development of wood-to-energy projects within the state and will be a great resource for any potential wood energy projects within the San Luis Valley.
    - The Forest Products Lab (USDA) typically has a Wood to Energy grant cycle every year that helps to fund engineering services necessary for final design and cost analysis on wood energy projects. The maximum grant amount is $250,000, and could be a good resource for a wood energy project within the San Luis Valley. These grants are highly competitive and require good financials.

CONCLUSIONS

Sawtimber salvage sales presently make up the lion's share of activities to remove dead trees from the forest to improve watershed and forest health. Smaller dead trees are not being removed during present logging operations. Most cellulosic biomass utilization is related to sawmill waste or fire wood. Future opportunities to conduct watershed health improvement projects are dependent upon how long the larger dead trees retain their utility as saw or house logs. A significant volume of low value material is likely to be available within the next ten years.

Once the trees are no longer suitable for those end purposes it may be difficult to find a market for lower quality woody biomass. The primary impediment to financially viable biomass utilization in the Rio Grande Basin is the $75/ton cost to get the material out of the woods and delivered to processors. Financial subsidies support current biomass removal programs in other parts of Colorado. It is unlikely subsidies will be available for the Rio Grande Basin any time soon.

Recommendations

1. Continue to make every effort to remove as much of the dead spruce through timber sales as expediently as possible while its commercial value will pay for its removal.

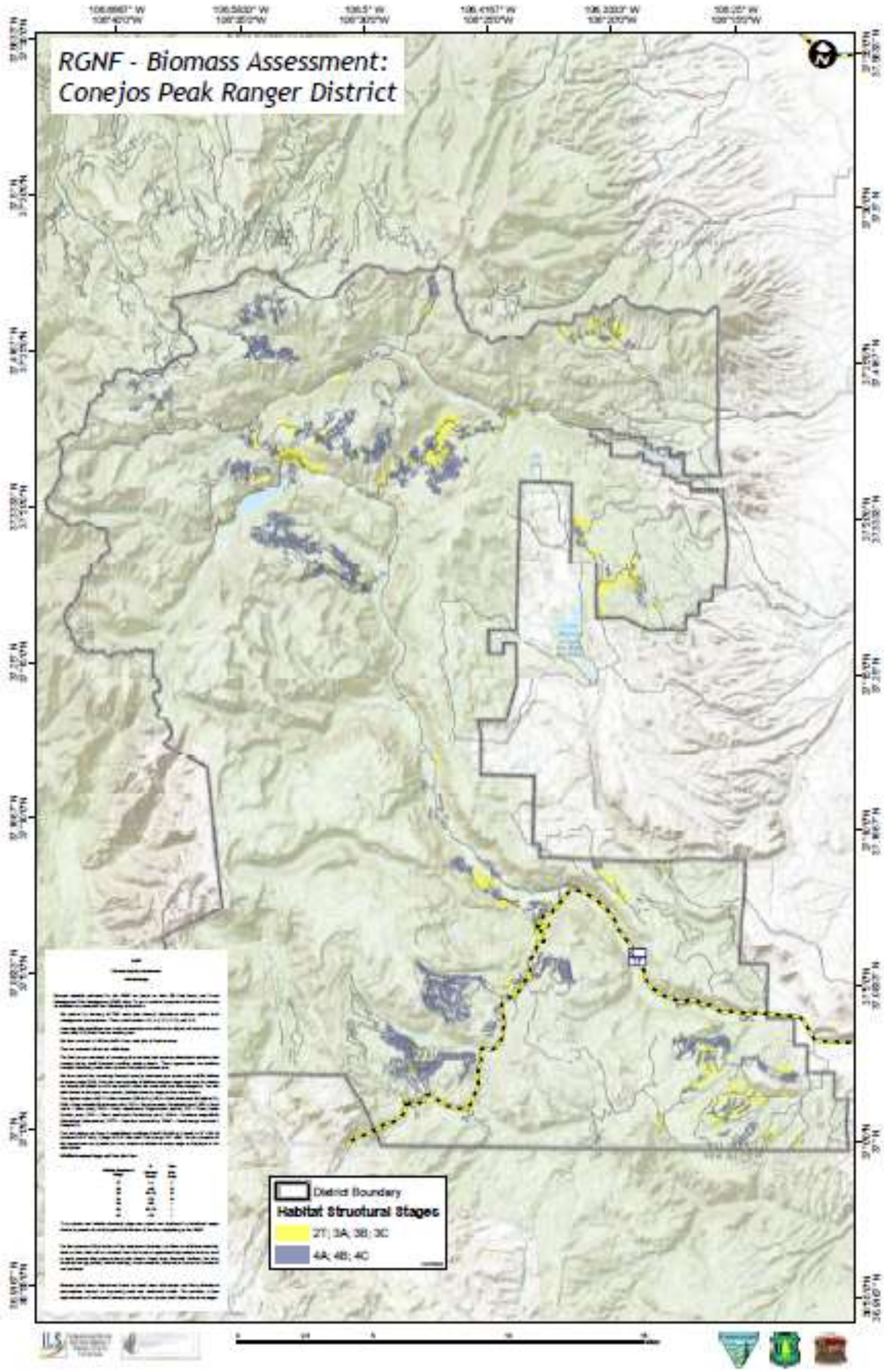
2. Explore options to develop markets for firewood and chips for heating large complexes.

3. Develop a plan to utilize dead woody material that has lost its value as saw or house logs.

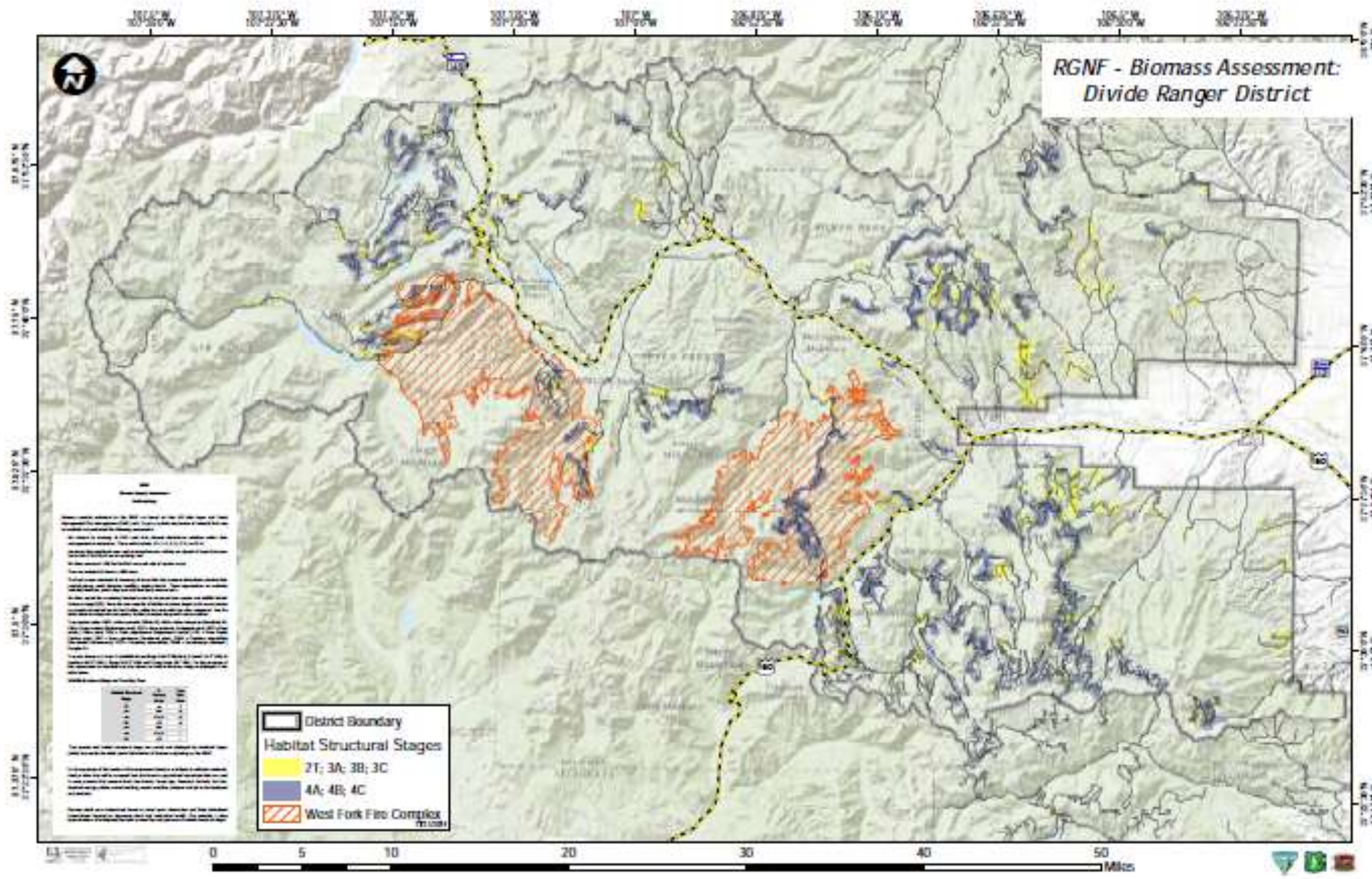
4. Utilize the Colorado State University Agricultural Experimentation Station located in the San Luis Valley to research the use of biochar as a soil amendment to improve soil water holding capacity and reduce overall agricultural water use in the San Luis Valley.

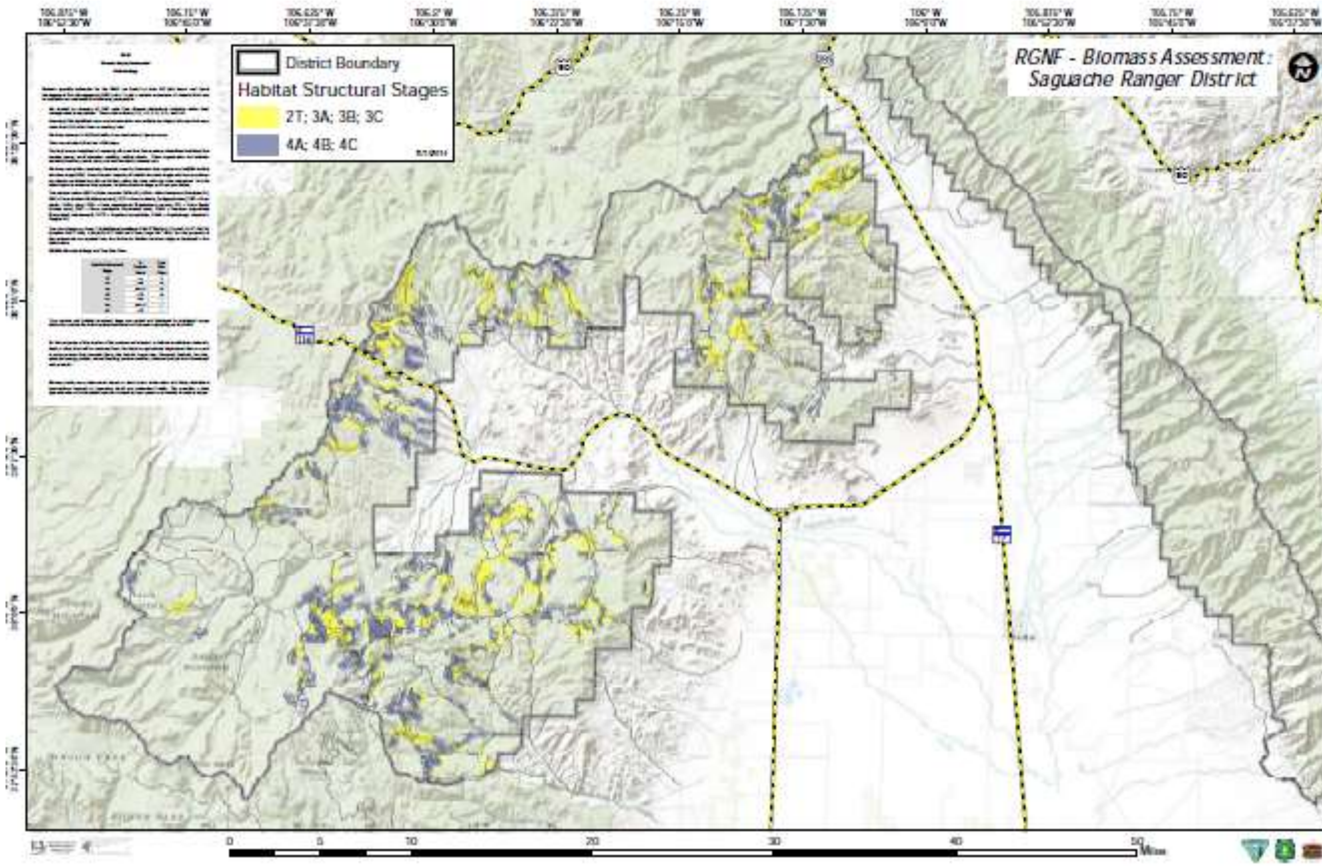
MAPS

Maps Final Maps will be 11” x 17



RGNF - Biomass Assessment:
Conejos Peak Ranger District
District Boundary
Habitat Structural Stages
2T; 3A; 3B; 3C
4A; 4B; 4C


RGNF - Biomass Assessment:
Divide Ranger District
District Boundary
Habitat Structural Stages
2T; 3A; 3B; 3C
4A; 4B; 4C
West Fork Fire Complex
0
5
10
20
30
40
50
Miles


District Boundary
Habitat Structural Stages
2T; 3A; 3B; 3C
4A; 4B; 4C
RGNF - Biomass Assessment:
Saguache Ranger District
0
5
10
20
30
40
50
Miles