9-17-2010

Selective tree thinning in the Santa Fe Municipal Watershed for water yield augmentation

Uday V. Joshi

Committee Approval

The Master of Water Resources Professional Project Report of **Uday V. Joshi** is approved by the committee:

Dr. William Fleming, Chair — Date: Apr. 15 '04

Dr. Michele Minnis — Date: April 15, 2004

Professor Denise Fort — Date: April 15, 2004

Table of Contents

Introduction

Water scarcity in southwestern United States is nothing new. It has been an issue since the southwest's earliest settlements. However, this problem has gained increased notoriety due to greater demands on the finite resource[1]. Increasing population and competing demands on water resources require new solutions to water scarcity. The threat of surface and underground water depletion has even catalyzed another round of experimentation in cloud seeding, one method, no matter how far-fetched, for augmenting supplies.[2] Conservation programs have reduced domestic water usage by minimizing inefficient water usage,[3] but few address the realistic possibilities of increasing water supplies. Tree thinning will increase water supplies and will concurrently return the forest to their natural densities and ensure watershed productivity.

National Forest lands represent 8 percent of the contiguous U.S. land area and contribute 14 percent of the runoff.[4] In the eleven western states, an even greater percentage (20%) of the land area lies within the National Forests.[5] Waters originating from Forest Service lands are of the highest quality, unaffected by many anthropogenic elements. In addition, these lands constitute the largest single source of fresh water in the United States.[6] Furthermore, in the west, federal lands contribute more than sixty percent of the West's water supplies, and nearly eighty percent of that originates from National Forests.[7] Locally, National Forest Service lands in New

---

[1] *See* generally...demographic studies in the Southwest in comparison to the decreasing water supplies in the same region.

[2] *Colorado Panel Studies Cloud-Seeding Plan.* Albuquerque Journal, 9-18-02 (*Also available at* http://www.abqjournal.com/north/770179north09-18-02.htm)

[3] The application of new technologies such as Low-Flush toilets, and the push to xeriscape landscapes has provided a channel to decrease inefficient water use.

[4] Water and the Forest Service, U.S. Dep't of Agric. Forest Service, FS-660, p. 2 January 2000.

[5] *See* Bureau of Land Management, Dep't of Interior, Public Land Statistics (1991); Forest Service, U.S. Dep't of Agric., Land Areas of the National Forest System 2-3 & tbl.2 (1998)

[6] Water and the Forest Service, U.S. Dep't of Agric. Forest Service, FS-660, p. 2 January 2000

[7] Charles F. Wheatley, Jr. et al., Study of the Development, Management, and Use of Water Resources on Public Lands 402-06 & tbl. 4 (1969)

Mexico yield 29% of the total runoff flows in the state.[8] However, overly dense stands are common on National Forest lands and impact those flows.

Similar to other national forests, the environment of the SF National forest is a product of fire-suppression, decreased timber-removal and over 200 years of grazing. These practices substantially altered the present condition of Forest Service lands. These lands now suffer from unnaturally high vegetation densities and decreased watershed productivity. Increased vegetation densities have placed "unnaturally" high demands on the finite water supply. Presently, tree thinning in the Santa Fe Municipal Watershed is an attempt at returning the forest to some semblance of health. Reducing the risk of catastrophic fire is the objective of thinning in the watershed. However, water yield augmentation could be an objective of thinning as well. Tree thinning may allow the Forest Service lands to increase water flows, or at least return them to their historical levels, and reduce the risk of catastrophic fire.

Tree-thinning, promoting a reduction in the number of trees per acre, may increase water supplies to lands beyond Forest Service boundaries. A reduction in the number of trees per acre invariably decreases the existing demands on the waters. A decrease in the number of trees per acre decreases the vegetative use of water by decreasing evapotranspiration (ET) and winter sublimation losses through decreased snowfall interception by the overstory canopy. The ET component of the water budget accounts for more than 70 % of the annual precipitation of the entire United States.[9] Therefore, a decrease in ET through tree thinning may increase stream flow and /or groundwater recharge. To put it into perspective, water supplies would increase by

[8] Water and the Forest Service, U.S. Dep't of Agric. Forest Service, FS-660, p. 3 January 2000

[9] Gay, L.W. 1993. Evaporation Measurements for Catchment Scale Water Balances. In *Proceedings of the First International Seminar of Watershed Management,* ed. J. Castillo Gurrola, M. Tiscareno Lopez, and I. Sanchez Cohen, 68-86. Hermosia, Sonora, Mexico: Universidad de Sonora.

1.75 million acre-feet if evapotranspiration in the Colorado River basin were reduced by just 1 percent.[10]

The Santa Fe River Watershed is an important sub-basin of the Rio Grande providing water flow constituting 40% of Santa Fe's available water supply and providing an additional 30% of drinking water supplies from wells located adjacent to the Santa Fe River.[11] Additionally, water originating from the Santa Fe National Forest supplies domestic water for three municipalities: Santa Fe, Las Vegas, and Los Alamos. However, water flows from the municipal watershed, within the Santa Fe National Forest have decreased 33% since 1914. Furthermore, other sources of water for the City of Santa Fe, including the Buckman Well-field and San Juan Chama Project, may no longer be available due to pending litigation with the San Il delfonso pueblo and lease termination, respectively. Therefore, surface water flow from the Santa Fe Municipal Watershed is even more critical to support the region's needs.

Although the goal of thinning in the Santa Fe Municipal Watershed is to reduce catastrophic fire, this paper analyzes tree thinning in relation to increasing water yields with reducing the risk of catastrophic fire and ecological restoration solely mentioned as incidental benefits of thinning for water yield augmentation. The first part of the paper examines the technical aspects of water yields and the results of past watershed studies throughout the western United States to illustrate the possibility of increasing water yields. Next, the paper examines the statutory ability of the Forest Service to manage a forest primarily to increase water yields by looking at the mandates of the Forest Service created through the Organic Act and all subsequent acts relating to the management of Forest Service lands. Finally, theses two distinct analyses are used to develop the major conclusions on tree thinning for water yields: that water yield

[10] Hibbert, A.R. 1979. *Managing vegetation to increase flow in the Colorado River basin.* General technical report RM-66. Fort Collins, CO.: USDA Forest Service.
[11] Santa Fe Municipal Draft Environmental Impact Statement p. 1

augmentation is conceivable in specific regions through methods other than clear-cutting and that it is not prohibited by federal lands legislation and more specifically, it is encouraged by the organic act of the National Forest Service.

Scientific Considerations

Background

The Santa Fe National Forest encompasses a variety of temperature and moisture zones. Temperature and moisture are the critical factors for water yield augmentation. Water yield augmentation is only realistic in a temperature-moisture zone that receives more than 18 inches[12] precipitation per year and is designated as either frigid[13] or cryic.[14] This zone is otherwise defined as the sub-alpine or alpine zone[15]. There is also some potential of increasing water yields where annual precipitation is between 15 and 20 inches.[16] Below this rate, the remaining vegetation, new growth appearing after treatment, [17] and soil moisture recharge consumes all the precipitation.

The Santa Fe Municipal Watershed is entirely within the sub-alpine zone and receives more that 18 inches of precipitation. The sub-alpine zone accounts for the majority of the land area in the Santa Fe National Forest. This zone consists of high-elevation forested watersheds primarily inhabited by tree-species such as Douglas fir, spruce, and aspen (mixed conifer). Within the sub-alpine zone of the Santa Fe Municipal watershed selective thinning of vegetation

---

[12] Hibbert, Alan R. Water Yield Improvement Potential by Vegetation Management on Western Rangelands. Water Res. Bul. 19(3): 375-381; 1983 June

[13] Frigid is a temperature regime characterized by the abundance of Ponderosa Pine or similar vegetation.

[14] Cryic is a temperature regime characterized by the abundance of Englemann Spruce or similar vegetation.

[15] Sub-Alpine region is a combination of the Ustic and Udic Moisture regimes coupled with the frigid and cryic temperature regimes.

[16] Hibbert, Alan R. Water Yield Improvement Potential by Vegetation Management on Western Rangelands. Water Res. Bul. 19(3): 375-381; 1983 June

[17] Hibbert, A.R. 1979. Managing Vegetation to increase flow in the Colorado River Basin. USDA Forest Service, General Technical Report RM-66

may contribute to higher water yields. Overly dense stands of small diameter timber have been said to decrease the water yields from the municipal watershed. The increased effect of evapotraspiration (ET)[18] and sublimation[19] explains the decrease. ET is the cumulative effect of evaporation from soils, plant surfaces and water bodies.[20]

Vegetation density and type in the Santa Fe Municipal Watershed varies according to elevation and past land-use management activities. Harvesting of timber products occurred since the earliest settlements and reached its apex in the early 1900s. Much of the watershed was extensively cut during the early 1900s. Prior to the large-scale management of forests, records indicate a vastly different forest composition than what is found today. One explorer described the Jemez Mountains, just west of Santa Fe, in New Mexico as "generally an open park like forest with well spaced trees and clean grama turf beneath. The trees are large and symmetrical, often 5 feet in diameter and 80 to 100 feet high with beautifully smooth trunks".[21] That description seems improbable because it is a far cry from present day forest composition. The large-scale cutting has resulted in a regeneration of overly dense stands comprised of trees that are only 5 to 9 inches in diameter breast height (DBH). Presently, the forest is densely covered with an estimated 500-1000[22] trees per acre in contrast to 50-100 trees per acre prior to settlement.[23]

---

[18] ET is the cumulative effect of evaporation from soils, plant surfaces and water bodies.
[19] Sublimation: The conversion of matter from a solid state into a gaseous state.
[20] The water budget equation used to estimate ET is: ET=P-Q-ΔS-ΔL. Where ET=Evapotranspiration (mm); P=precipitation (mm) over a period of time; Q=Streamflow (mm); ΔS=Change in the amount of storage in the watershed and ΔL=Change in deep storage
[21] Vernon Bailey quoted in Allen C.D., D.A. Falk, M. Hoffman, J. Klingel, P. Moran, M. Savage, T. Schulke, P. Stacey, K. Suckling and T.W. Sweetman. 2002. Ecological Restoration of southwestern ponderosa pine ecosystems: A broad framework. Ecological Applications 12:1418-1433
[22] Set up three test plots where I counted the number of trees in a 10 by 10 meter plot and then extrapolated the evidence to calculate the number of trees per acre.
[23] Covington, W.W.; Moore, M.M. 1994. Postsettlement changes in natural fire regimes and forest structure: ecological restoration of old-growth ponderosa pine forests. J. Sust. For., 2:153-181.

In addition to the increased density of the forests, the stand structure is drastically different. An analysis by Regis Cassidy, Silviculturist Southwestern region (USFS) comparing current stocking levels with available surveys on past stocking levels shows the change:

> The diameter distributions for the four districts covered by the Jemez National Forest (Similar to the Santa Fe National Forest) are relatively similar, especially in the 13" and larger size classes.
>
> The total number of conifer tpa (4"+) has increased by a factor of 5-6 times between 1911 and the present in the ponderosa pine cover type and 6-10 times in the Doug-fir cover type.
>
> The number of conifers in the 4-12.9" diameter class has increased by a factor of 25-35 times between 1911 and the present in the ponderosa pine cover type.
>
> *The increase is even larger in the Doug-fir cover type.*
>
> The number of conifers in the 25"+ category appears to have declined from approximately 10 tree/acre on the better pine sites in 1911 to 1-3 trees/acre *as a district-wide average today.*
>
> **Conclusion**
>
> A comparison ... demonstrates the dramatic increase in the total number of trees existing in the ***ponderosa pine*** and ***dry mixed conifer*** over the past 70-80 years on the Forest. Table 3 demonstrates that most of this increase has occurred in trees **4" to 12.9"**, or trees established some 30 to 80 years ago. *The increase in total stocking would be more dramatic had trees less than 4" (seedlings and saplings) been included in this analysis.*
>
> The observed increase in the number of smaller size trees can be partially attributed to management philosophies that have excluded natural fires and harvest practices that tended to removed larger trees while failing to adequately thin the smaller size classes.

Thinning Strategies: Diameter Breast Height v. Basal Area

Given the contrast between present stocking rates and those of 1911, it is clear that thinning is necessary. Not only are the stands overly dense, they are also far different than the stands of 1911 and further compromise the health of the forest and the respective watersheds. But, how thinning should proceed has been debated since forest restoration became an issue.

Some believe that thinning should be limited by an upper limit on the size of tree that can be cut or Diameter Breast Height (DBH), while others believe that thinning should be based on a desired basal area (BA), square feet of trees per acre. Proponents of using DBH as a parameter of thinning believe that a cap will reduce potential legal battles. However, the diameter of trees is not the only factor to consider. Opponents of instituting a diameter cap claim that it is necessary to thin some larger trees to restore natural spatial patterns and allow grass and wildflower production. Furthermore, silviculture and ecological reasoning support the use of basal area because it incorporates the unique characteristics of the respective ecosystems rather than applying a standard prescription for varying ecosystems. However, using basal area rather than DBH may warrant the removal of some trees greater than 16 inches because it allows the remaining trees to grow to their potential. Lastly, the removal of larger trees may help pay for restoration or will subsidize the cost of restoration.

Therefore, Basal area is an important element to consider when managing forests. Thinning according to a desired basal area reduces the stress on the trees to compete for the available resources. Ponderosa pines in the southwest, as a general rule have their best rate of growth, given age and general site characteristics, at 80 ft^2/acre. Thinning a stand to just below 80 square ft^2 / acre allows for the stand to grow without competing for the already limited resources.[24]

Although, stocking levels vary according to management priorities. In order to establish an uneven aged stand with a generous amount of understory, a stocking rate of 35-50 ft^2/acre is recommended. On the other hand, a basal area of 60-80 ft^2/acre, promoting an even aged stand, ensures, three times as many large trees per acre for a finite period compared to the uneven age

[24] Conversation with Steven McWilliams, Former Water Program Manager of the Santa Fe National Forest. (January 21, 2004)

management scenario. However, stocking will need to be reduced to 30 to 40 ft^2/ acre to encourage pine regeneration.[25] Regardless of the desired stand structure; tree thinning should not be confused commercial logging. Thinning, according to DBH and for the purposes of this paper, is limited to vegetation having a diameter less than 16 inches,[26] but it is necessary that aspects of both basal area and DBH are employed when restoring forests.

On the other hand, the decision to cut a stand solely according to DBH may result in an overly dense stand if there are a great number of trees that are 10 to 12 inches in diameter. The use of basal area per acre allows for a broader understanding of the interconnectedness of resources and organisms. It takes into account the ability of a given area to support a given number of trees.

Water Flow

Water flow through unsaturated soils is controlled by, among other things, vegetative root systems. As the number of vegetative root systems increases, the subsurface flow to aquifers, streams and springs reduce. Water flow can be described as water potential, measured in pascals or one Newton per meter square. Water is held in the soil by matrix potential- the binding effect of soil colloids organic material and Osmotic pressure.[27] Osmotic pressure influences water potential through unsaturated soils. Plants, through their roots systems, create osmotic pressure that has the effect of holding water close to the roots for absorption through active and inactive transport of water to the atmosphere through leaves or needles stomata with the maintenance of

---

[25] Telephone Conversation with Regis Cassidy, Silviculturist, Southwestern Region, National Forest Service March 2, 2004).

[26] *See* Santa Fe Municipal Watershed Draft Environmental Impact Statement p. 16. "Thinning would retain all of the large mature trees, including all trees over 16-inch diameter, which currently average approximately 15 to 25 trees per acre, along with additional large immature trees, leaving a total of 50 to 100 of the largest trees per acre." The SF watershed is predominantly covered with trees having less than 9-12 inches in diameter. This figure was reached through a survey of the vegetation in the different elevations of the watershed. (*Site Survey July, 2003*)

[27] Osmotic Pressure is the force exerted on the movement of water by vegetative root systems creating a positive potential of water flow toward plants.

turgor pressure. As the quantity of root systems increase, osmotic pressure increases, causing a decrease in water flow to streams, aquifers and springs. The reverse of this phenomenon can be seen following a wildfire. Once vegetation is suddenly killed, the osmotic pressure is removed and only the matrix water pressure of the soil colloids holds the water. This movement of water in a soil column is understood and described through the application of Darcy's law. Simply put, Darcy's law is to water movement as Ohm's law is to the movement of electricity. Therefore, by reducing the root pressure in the soil matrix, water potential will increase and flow to the point of discharge or destination (aquifers, streams, springs). However, the baseline conditions, precipitation rates above 18 in/year, thinning to a basal area of 35 to 50 ft^2/ acre and a region designated as either frigid or cryic, otherwise classified as a sub-alpine region, need to be present for water yield augmentation.

Since changes in vegetation affect ET, a decrease in vegetation and therefore ET may increase stream flow and/or groundwater recharge; whereas, increases in ET will have the opposite effect. It is widely accepted that the increase in biomass in the forest has decreased water yields, but it remains to be seen if thinning will increase water yields.

Comparison of Past Water Yield Studies to the Santa Fe Watershed

The analysis of past studies proceeds in two areas. First, studies are presented that show the potential for water yield augmentation in the Santa Fe Municipal Watershed. Second, an analysis of past studies showing potential for water yield augmentation is distinguished from this proposal but they are presented to show the correlation between vegetation management and water yield augmentation.

Conceivably, the removal of vegetation in the Santa Fe Municipal watershed may increase water yields from the watershed. Relevant scientific studies do not definitively refute the possibility of water yield augmentation. However, some studies conclude that water yield increases through vegetation removal are insignificant. Although, those studies were designed to study water yield augmentation, they occurred in less than ideal temperature and moisture regimes and elevations capable of producing the highest yields and employed strategies drastically different than selective tree thinning.

Thinning in the Santa Fe Municipal watershed, for the purpose of this paper, is analyzed to occur throughout all elevations of the watershed, specifically including areas capable of producing increased flows. Furthermore, thinning intensity will be based on a desired basal area to account for ecosystem functions rather than on DBH.[28] Thinning in the SF National Forest may increase water yields because of its natural characteristics (temperature and precipitation), ideal for augmentation.

Many studies, as are mentioned below, focused primarily on large-scale clear cuts rather than selective thinning and were not completed in the appropriate temperature moisture region necessary for water yield augmentation. Those studies focused on the lower end of the effective spectrum, the Ponderosa Pine zone. Furthermore, those studies did not evaluate the potential for ground water recharge as a product of vegetation removal.

Ziemer in "Water Yields from Forests: An Agnostic View" analyzed whether programs to increase water yields through vegetation removal would be successful. He did this by examining the reasons for failure in numerous watershed studies throughout California and the Southwest with annual precipitation rates exceeding fifteen inches. He concluded, that although

[28] Diameter Breast Height (DBH) is generally considered to be a measure of the tree's diameter 4.5 feet above the ground on the uphill side of the pole.

watershed studies have shown water yield increases through vegetation removal, "Opportunities for increasing water yields from the alpine zone is limited by both physical and legal constraints".[29] Although, the legal and the physical constraints that Ziemer articulates are not applicable to the Santa Fe National Forest.

According to Ziemer, tree thinning in the Sierras is constrained by poor access, steep slopes, and unstable lands. In comparison, the hills of the Santa Fe Municipal Watershed present no such constraints. They are gentle with varying degrees of access by way of logging roads, and stable slopes due to high vegetation cover in the region. Furthermore, the vegetation in the Sierras "is so sparse that any management for water yield in those small areas where it is permitted would be limited to practices of managing drifting snow with structures".[30] By contrast, the upper reaches of the Santa Fe Municipal are densely vegetated and could be thinned without jeopardizing the integrity and stability of the land.

Lastly, Ziemer indicates that Wilderness land designations or administratively reserved areas limit the opportunity to manage the lands for increasing water yields. But as will be discussed later in the paper, Wilderness designation in the SF watershed does not prevent managing the area for water yields. Furthermore, Ziemer's analysis of past studies and the landmark studies in Colorado and Arizona, as will be discussed, support the contention that a tree thinning program can be designed to both restore the health of a forest and increase water yields.

The Technical Advisory Group (TAG) of the Santa Fe Watershed Association, which offers scientific oversight to the Santa Fe Municipal Watershed Forest Treatments Project,

---

[29] Robert R. Ziemer, Water Yields from Forests: An Agnostic View. Presented at the California Watershed Management Conference, November 18-20, 1986, West Sacramento, California. P. 74-78 citing Kattelmann, Richard C.;Berg, Neil H. Water yields from high elevation basins in California. (1987) [Same proceedings]
[30] *Id.* at 74

determined in their white paper[31] that thinning would not significantly affect water yields. The TAG relied on watershed studies along the western boundary of the Santa Fe Watershed, and applied those realized relationships between vegetation and water yield to estimate possible yields in the Santa Fe Municipal Watershed. However, that study is different in scope than a proposal to thin the entire Santa Fe Watershed to increase yields and should therefore be read objectively. The Technical Advisory Group (TAG) of the Santa Fe Watershed Association focused only on the effects of thinning in the lower reaches of the Santa Fe Municipal Watershed. Additionally, the TAG focused on reducing the risks of catastrophic wildfires through tree thinning rather than the effects of thinning on water yield augmentation.

The TAG based their water yield estimates on the thinning of only 4,500 acres in the 17,000-acre watershed with only a 20% to 40% reduction in canopy. Furthermore, the TAG based their estimates on the limited thinned acreage, all of which is below 7,880 ft. Their analysis did not include the higher reaches of the watershed. Their study was therefore limited by the scope of the treatment area. The TAG focused their analysis on an area that receives the lowest precipitation rates and has the highest temperatures in the watershed. Given the lower precipitation and higher temperatures in the project area, their conclusions are in agreement with other water yield studies that yields will be insignificant; but, had they considered the effects of thinning in the higher elevations of the watershed, their conclusions might have been different.

However, in their white paper, TAG provided a window into increasing water yields through tree thinning. The authors concluded that water yields would increase .24% in dry years and .92% increase in wet years. However, these increases cannot be documented through stream gauging because gauges are only accurate to +/- 5% and therefore cannot accurately measure

[31] Technical Advisory Group. White Paper: Effect of Forest Thinning Within the Santa Fe Municipal Watershed on Stream Discharge. April, 2003

increases less than 5% and the area to be thinned lies below the gauging stations. These increases may seem insignificant, but they become significant since the prediction was based on forest thinning on only 4,500 acres, all below 7,880 ft, with only a 20 to 40% decrease in canopy.[32] Had the study forecasted results based on thinning in the upper reaches of the watershed with higher precipitation rates and decreasing the canopy by more than 40%, results may have been different.

Different than the TAG's study on the lower elevations of the Santa Fe Municipal Watershed, the Beaver Creek study, in Arizona,[33] examined the effects of tree thinning in a Ponderosa Pine watershed and showed great potential for increasing water yields. These studies included a variety of thinning strategies over 10 years. One such study reduced the basal area by 77%, which in turn increased the yield by 29%, and remained significant for 10 years. Increased yields in the other experiments remained significant from three to seven years but involved clear cuts and strip clear cuts. Supporting the findings in the Beaver Creek study, other studies[34] demonstrated water yield increases of 20-30% from moderate thinning treatments. One such study in the Sturgis Watershed decreased the basal area by 30 to 50% in the Ponderosa Pine zone. Even though the thinning occurred out of the appropriate temperature moisture regime, flows increased on average of 4.9 cm, or 32%. Also, increased flows remained significant for more than 8 years in that study.[35]

Similarly, the Santa Fe Draft Environmental Impact Statements (DEIS) for the thinning project designed to reduce the risk of catastrophic fire and the supplemental technical report on

---

[32] White Paper: Effect of Forest Thinning Within Santa Fe Municipal Watershed on Stream Discharge. April 2003
[33] Brown, H.E.; Baker Jr.,M.B.; Rogers, J.J. Clary, W.P.; Kovner, J.L.; Larson, F.; Avery, C.C.; Campbell, R.E. 1974. Opportunities for Increasing Water Yields and Other Multiple Use Values on Ponderosa Pine Forest Lands. USDA FS. Res. Pap. RM-129, 36 p. Rocky Mt. For. & Range Exp. Stn., Fort Collins
[34] Ffoliot and Thorud, 1977; Bosch and Hewlett, 1982; Troendle, 1983; Alexander et. al., 1985; Whitehead and Robinson, 1993 (HYDROSPHERE PAPER)
[35] Anderson (1980) cited in Troendle (1983)

the soil and water effects of management in the Santa Fe watershed indicate water yield increases. The DEIS, in accordance with the National Environmental Policy Act (NEPA), analyzed the site-specific effects of the United States Department of Agriculture/Forest Service proposal. It stated, "water yield would be expected to increase only slightly under this alternative, since only 36 percent of the project area and only 13 percent of the 17,000 acre would be mechanically thinned to create openings in the overstory canopy".[36] Therefore, similar to the TAG report, water yields are not significant if only a small area of the watershed is managed. A measurable increase, however, may be possible if the entire watershed is managed and more than 20 to 40% of the canopy is reduced.

The Soil and Water Specialist Report[37] is an analysis of hydrologic and soil behavior in the SF Municipal Watershed under various management alternatives, proposed actions, in the EIS. The Santa Fe National Forest contracted the Hydrosphere Resource Consultants to examine the effect of thinning on soil and water resources within the watershed. Of course, the primary purpose of the proposed action was to reduce the risk of catastrophic fire, and therefore, was not intended to produce increased water yields. However, it reports significant possibilities for increasing water yields from the watershed:

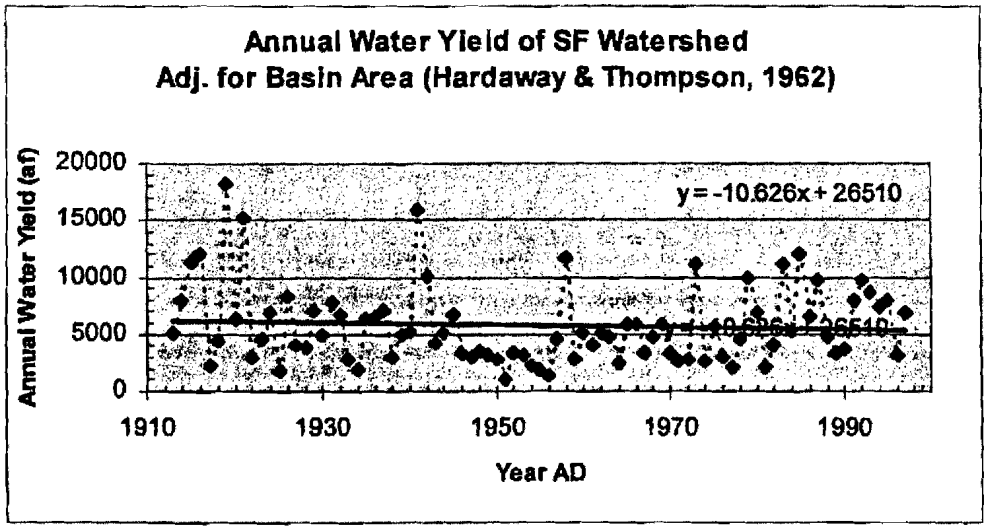
The expected increase in water yields for the treated portions of the watershed are expected to range between 20-50%. Given that less than one-half of the entire watershed is planned for treatments, the net water yields is expected to be between 10 and 20%.[38]
The estimation is based on an alternative that allows for treatments in only one-half of the entire watershed. Should the treatments expand to the entire watershed, the yields are likely to increase. Furthermore, the report speaks to the secondary benefits of thinning. "If active management of fuel loading in the watershed continues indefinitely, increases in annual water yield are likely to have significant indirect cumulative effects:

---

[36] Santa Fe Municipal Watershed Draft Environmental Impact Statement, p. 70
[37] Soil and Water Effects Analyses for the Santa Fe Municipal Watershed Response to Proposed Management Alternatives; McCord, James T., Winchester, John N., Clark, Jodi A. (Hydrosphere Resource Consultants) Prepared for the Santa Fe National Forest
[38] *Id.* at 53

- Increased annual water yield can be utilized to keep the Santa Fe River "wet" (or maintain regular in stream flows within the city) and thus facilitate restoration of a healthy riparian habitat along the river
- Increased in stream flows can lead to enhanced recharge to the unconfined aquifer connected to the Santa Fe River
- Increased annual water yields can help assure a more reliable supply of acequia irrigation water to downstream traditional communities (e.g. La Cienega).[39]

According to historical records, specific to the Santa Fe Watershed, water yields in 1914 were 6,000 acre/feet per year. Present water yield from the watershed is approximately 4,000 acre/feet per year.[40]



Since 1914, only two things have changed in the watershed. The location of the gauging station was moved in 1930, and the number of trees per acre increased. Although the gauging station moved, the yields were adjusted to accurately represent the different drainage area. Therefore, decreased water yields were not the result of the change in location of the gauging station. The only other aspect of the watershed that changed since 1913 is the amount of trees per acre.

[39] *Id.* at 59

[40] *Id.* at 15 (Normalized annual water yield from the watershed. The yield measured at the Santa Fe Rives near Santa Fe Gauge was normalized by Santa Fe precipitation and the drainage area above the gauge)

Presently there are more 500 trees per acre with some areas as dense as 1000 trees per acre[41] as compared to 50-100 trees per acre in 1913. That increased tree-density resulting in higher ET has decreased the yield since all other elements have remained the same or have been accounted for. The decrease in water yields is directly correlated with an increase in tree and canopy density[42] and can be reversed with an effective and successful tree thinning program designed to focus on the potential of increasing water yields simply by a return to historical densities.

Vegetation changes at higher elevations create an even greater chance for increases in water yield. The upper elevation of the watershed is designated as the Pecos Wilderness Area. "Only the northeasterly thumb of the Wilderness receives enough precipitation to produce a net annual gain over ET losses, so this is the portion of the landscape that generates most of the streamflow and much of the recharge to the groundwater."[43] A reduction in the number of trees at higher elevations results in a decrease in the leaf area and therefore a decrease in evapotranspiration. Mixed-conifer and spruce forests dominate the upper watershed. In this region, annual precipitation is estimated at 30-40 inches, satisfying the minimum requirement of 18 in/yr for water yield augmentation, and temperatures remain cool throughout the year, thereby lowering ET rates. A tree-thinning campaign in this region may yield more than 6 in. per acre. This boils down to a water yield increase of about 20%.[44]

Similarly, thinning in the Ponderosa Pine zone, or the lower end of the ideal temperature moisture zone, results in increased water yields. This zone receives more than 22 inches precipitation per year. If actively managed to replicate historical densities, the increase in water may be as much as 15% or ¼ acre-foot per acre (3 inches/acre). According to Steven

---

[41] Santa Fe Municipal Watershed Draft Environmental Impact Statement, p. 4
[42] *Id.*
[43] Grant, Paige, Santa Fe River Watershed Restoration Action Strategy (WRAS), January 2002. p. 16
[44] *Conversation* with Steve McWilliams, Former Water Program Manager of the Santa Fe National Forest.

McWilliams, Former Water Program Manager of the Santa Fe National Forest, the possibility of increasing water yields by 15% in the ponderosa pine zone is achievable.

Tree thinning may be a viable way of increasing water yields, but studies from Arizona (Castle Creek and Workman Creek) and Colorado (Colorado Front Range) do not expressly support this contention. However, those studies show the strong correlation between vegetation and water yields. The hypotheses in those studies purported to explicitly study water yield as a dependent measure of vegetation removal rather than just an incidental effect. Furthermore, those studies are relevant because of similar setting conditions (semi-arid), baseline conditions, and procedures employed during the studies. These studies were done over a lengthy timeframe, had precipitation and temperature patterns similar to the Santa Fe National Forest, and adhered to specific procedures including controls to test the affects of vegetation removal. However, those studies are distinguishable from tree thinning in the SF watershed for several reasons. They did not address selective tree thinning of the understory in the Spruce and mixed conifer zone. Instead, those studies[45] focused on large-scale tree removal, such as, clear-cutting,[46] promoting early seral[47] conditions at lower elevations. In contrast, studies to increase water yields through selective thinning of the understory to promote a late seral[48] condition are scarce. A comprehensive study by Martha Schumann of the Forest Trust[49] revealed that those studies resulted in statistically insignificant water yields. However, those studies did not discuss the

[45] Studies performed include the Beaver Creek Watershed in northern Arizona, Castle Creek in eastern Arizona, Workman Creek in Arizona, and the Colorado Front Range in the eastern foothills of the Rocky Mountains.
[46] Long, J.W. 2000. Cibecue Watershed Projects: Then, now and in the future. USDS Forest Service Proceedings RMRS-P-13. P 227-233.
[47] Is a stand structure that is comprised mainly of younger trees. This is accomplished through the removal of the overstory.
[48] Late Seral Condition is predominantly comprised of older trees. This condition is accomplished through a reduction of younger trees thereby creating stands of mature trees that reduce the number of canopies in the forest.
[49]

potential of water yield augmentation through tree thinning in the Spruce and mixed conifer zone and primarily focused on the effects of clear-cutting rather than thinning.

Studies in Castle Creek, Workman Creek and the Colorado Front Range focused on the affect of clear-cutting or large-scale extraction rather than thinning based on a desired basal area. The Castle Creek study, located in semi-arid eastern Arizona, reduced the basal area by 73% through the removal of commercial timber in clear-cut blocks and selective harvesting. That study demonstrated an increased yield of 29% in annual water yields that remained significant for seven years.[50] In that study, yields significantly varied according to annual precipitation rates. This states nothing more than the obvious: Water yields are higher in wet years and lower in dry years. However, unlike other studies where water yield increases are estimated (regression equation, based on the impact in other watershed studies etc.), this study employed the use of a stream gauge to validate the results. "In the Fool Creek experiment in Central Colorado, the annual water wield increase ranged from 1.6 inches in the very dry year of 1963 to 6.4 inches in the exceptionally wet year of 1957."[51] Although this study was based on clear-cutting rather than thinning it should be noted that: simply because yields are substantially lower in the dry years than in the wet years, water yield augmentation should not be dismissed. Yields, when normalized for varying precipitation, show an increase at each increasing level of precipitation.

More importantly, not only do water yields vary from year to year, they vary significantly throughout the year. Streams in the Santa Fe National Forest become dry in the summer whereas streams flow due to recharge to the soil from snowmelt and rain in the spring and the summer monsoons in July and August. However, recharge to ephemeral streams from snowpack accounts

---

[50] Rich, L.R. 1972. Managing a Ponderosa Pine Forest to Increase Water Yield. Water Resource Research. 8: 422-428

[51] MacDonald Lee H., Effects of Forest Harvest on Water Yields.

for more that two-thirds of the annual precipitation in the region.[52] Openings in the forest concentrate snowpack and reduce evaporation. "The reduction in winter interception is directly proportional to the amount of the canopy that is removed. In these snow-dominated areas, nearly all of the water yield increase occurs in early spring when less water is taken up by soil moisture recharge and more of the early snowmelt is converted into runoff."[53] The increased concentrations of snow pack increase the contribution of snowmelt to streamflow[54] by slowing down the conversion of snow to water. Furthermore, a greater reduction in canopy reduces interception and thus evaporative and sublimation losses. Therefore, yields are affected by both precipitation rates and forest openings conducive to reducing evaporation and sublimation losses.

Similarly, intensive stand conversion on the Workman Creek Watershed, demonstrated water yields increases. Workman Creek, located in semi-arid Arizona, encompassed studies on the North Fork and the South Fork to determine the effects of vegetation changes in the Ponderosa Pine Zone and the mixed conifer zone on water yield and sedimentation. In that study, the North fork experiment yielded an increase of 104%,[55] through the conversion of 100 acres of Ponderosa Pine with grass. However, that yield occurred even after grasses replaced the ponderosa pine and began consuming the available water supplies. In the South Fork, the site was converted from a mixed conifer forest to a pure ponderosa pine stand and only saplings and seedlings were left to inhabit the area at a basal area of 40 ft^2/acre. This cut demonstrated an increase of 128%.[56] The Workman Creek study and the Castle Creek study are distinguishable

---

[52] Troendle, C.A. 1983. The Potential for Water Yield Augmentation from Forest Management in the Rocky Mountain Region. Water Res. Bull. 19: 359-373.
[53] Lee H. MacDonald, Forest Harvest Effects on Water Yields, p. 84
[54] Troendle, C.A.; Leaf C.F. 1980. Hydrology, Chapter III. In: An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources. Environmental Research Laboratory, Athens, Georgia, EPA 600018-80-012, 173pp.
[55] Rich, L.R.; Thompson, J.R. 1974. Watershed Management in Arizona's Mixed Conifer Forests: The Status of our Knowledge. USDA FS Res. Pap. RM-130, 15 p. Rocky Mtn. For. & Range Exp. Stn., Fort Collins
[56] *id.*

from the proposal to thin in the Santa Fe, since they both concentrated on the effects of clear-cuts rather than thinning, and the effects of stand conversion. However, they both illustrate the correlation between vegetation density and water yield.

Different than thinning the Santa Fe Municipal Watershed, the Colorado front-range study, in the eastern foothills of Colorado, evaluated the removal of commercial 'quality' Douglas Fir and Ponderosa Pine. Thinning in the Santa Fe Municipal Watershed, on the other hand, will focus on the reduction of smaller diameter vegetation rather than on commercial timber. Furthermore, the Colorado Front Range study focused largely on the removal of Ponderosa Pine, which is a taproot species on the lower end of the effective temp/moisture regime scale (Ustic and frigid); whereas thinning in the Santa Fe Municipal watershed will include Spruce and other mixed conifer in the higher elevations of the watershed. The higher elevations are in the desired temperature/moisture regime (udic and cryic) and are therefore crucial to increasing water yields. The Colorado front-range study concluded that it was necessary to create clear-cut openings to affect water yields,[57] possibly because the study occurred in a temperature/ moisture regime incapable of providing additional yields, and focused on the removal of Ponderosa pine. Thinning in the Santa Fe will occur in the Spruce and Mixed conifer zone, an area capable of producing higher yields.

The aforementioned studies, although different than this study, show a strong correlation between vegetation removal and water yield augmentation. Furthermore, these studies spanned numerous years, encompassed different precipitation and temperature patterns, and occurred in regions similar to areas in the Santa Fe Municipal Watershed. A summary of which can be

[57] Gary, H.L. 1975. Watershed Management Problems and Opportunities for the Colorado Front Range Ponderosa Pine Zone: The Status of our Knowledge. Rocky Mtn. For. & Range Exp. Stn., Fort Collins. Res. Pap. RM-139, 32 pp.

found in Table 1. Relative application of those studies to this study catalyzed the organization of the table. The first two studies directly relate to the Santa Fe Municipal Watershed and provide insight into the possibility of increasing yields in the watershed. The Beaver Creek studies show the significant potential of increasing water yields through different treatments, specifically, thinning. Finally, the last set of studies reaffirm the correlation between vegetation and water yields.

Appendix Table 1: Summary of Relevant Water Yield Studies

* References for this table are from the respective studies and from Martha Schumann, Southwest Community Forestry Research Center, Forest Trust.

Studies	Year	Location	Objectives	Moisture/Temperature Zone	Thinning Procedures	Measurement Procedure	Yield
Technical Advisory Group	2003	Santa Fe, NM	Analyze the effects of thinning to reduce the risk of catastrophic wildfire in the Santa Fe Municipal Watershed	Ponderosa Pine	20-40% proposed decrease in basal area	Estimates based on past studies (Tesuque and Santa Fe Watersheds)	.24% increase in dry years; .92% increase in wet years
Draft Environmental Impact Statement: Soil and Water Specialist Report	2001	Santa Fe, NM	Analyze the effects of thinning to reduce the risk of catastrophic fire on the soil and water resources of the Santa Fe Municipal Watershed	Ponderosa Pine Zone and Spruce and Mixed Conifer Zone	20% proposed decrease in basal area	Estimate based on observed impacts in other watersheds	20 to 50% increase yields in the treated portions; 10 to 20% increase because less than one half of the entire watershed will be treated
Beaver Creek	1974	Northern Arizona	Water yield Augmentation	Ponderosa Pine Zone	100% Basal Area removed	Predicted Water Yield: Difference bt. Actual and predicted streamflow	41% increase; remained significant after 7 years
Beaver Creek	1974	Northern Arizona	Water Yield Augmentation	Ponderosa Pine Zone	Thinning: 77% Basal Area removed	Predicted Water Yield: Difference bt. Actual and predicted streamflow	29% increase; remained significant after 10 years
Beaver Creek	1974	Northern Arizona	Water Yield Augmentation	Ponderosa Pine Zone	Strip Clear Cut: 33% Basal Area removed	Predicted Water Yield: Difference bt. Actual and predicted streamflow	35% increase; remained significant only for 6 years
Beaver Creek	1974	Northern Arizona	Water Yield Augmentation	Ponderosa Pine Zone	Irregular Strip Clear Cut and thinning in between: 57% Basal Area removed	Predicted Water Yield: Difference bt. Actual and predicted streamflow	24% increase; remained significant only for 4 years
Beaver Creek	1974	Northern Arizona	Water Yield Augmentation	Ponderosa Pine Zone	Irregular Strip Clearcut and thinning in between: 68 Basal Area removed	Predicted Water Yield: Difference bt. Actual and predicted streamflow	45% increase; remained significant only for 3 years
Castle Creek	1972	Eastern Arizona	Water Yield Augmentation and sedimentation	Ponderosa Pine Zone	Commercial Timber harvest: 73% Basal Area removed (235 ft^2/acre to 63 ft^2/acre)	Stream Gauge	29% increase; remained significant for 7 years
Workman Creek North Fork	1953	Arizona	Water Yield Augmentation and sedimentation	Ponderosa Pine Zone / Mixed Conifer	Complete replacement of 100 acres of Ponderosa Pine with grasses	Regression Equation	104% increase
Workman Creek South Fork	1953	Arizona	Water Yield Augmentation and sedimentation	Ponderosa Pine Zone / Mixed Conifer	Conversion of mixed conifer to Ponderosa Pine: stocking rate of 40 ft^2/acre	Regression Equation	128% increase

Past and present studies cover a broad range of conclusions regarding water yield augmentation. On one hand, studies focused primarily on water yields through large scale extraction show opportunities for water yield augmentation, but fall short in demonstrating an increase from thinning; whereas, thinning in other studies has shown a potential for water yield augmentation. The Soil and Water Specialist Report, the Technical Advisory Group of the Santa Fe Municipal Watershed, the Beaver Creek Study, and Lee MacDonald's study all show that thinning for water yield augmentation is possible especially in the ideal temperature and moisture zone yields increases water flow. However, water yield augmentation has not been affirmatively proven in the Santa Fe National Forest and therefore remains speculative in nature. Although, the weight of the evidence leads one to believe that water yield augmentation is possible.

Policy Considerations to Increasing Water Yields

The notion of increasing water yields is promising, but limiting factors exist and may decrease the chances for increasing water yields. Revegetation (or use of increase yields by other resources), aspect must be considered. Furthermore, there are several policy considerations regarding water yield augmentation. Among them are decreasing other sources of evaporation, promoting existing and new conservation practices, increasing public participation and knowledge about the issues, scientific modeling, and the associated costs of thinning.

Once the watershed is thinned, grasses and herbaceous vegetation will likely colonize the newly created openings in the forest floor. The new vegetation may increase demands on available precipitation. Furthermore, the length of a plant's growing season affect potential yields or annual transpiration losses. Different from deciduous and coniferous trees, grasses and

herbaceous vegetation have shorter growing seasons and thus transpire less. However, "In the absence of any other management activities, these increases in runoff will decline over time with forest re-growth",[58] and therefore necessitates continued treatments. "Water yield increases in the Pacific Northwest are shortlived because of favorable conditions that support rapid regrowth of forest and other vegetation".[59] Different than the Northwest, the Southwest is not as hospitable to revegetation because it receives substantially less rainfall and will therefore require substantially more time to regenerate.

Similar to the decrease in yields from revegetation, the aspect of the watershed may limit increases in water yields. The Santa Fe Municipal watershed, similar to other watersheds, is comprised of both north and south facing slopes. South facing slopes are warmer than north facing slopes due to their increased exposure to sunlight. This in turn, increases soil temperatures, soil evaporation, and soil moisture recharge. In contrast, a northern exposure remains cooler and has a deeper soil mantle, which will generally provide increased water yields for a longer time than south-facing slopes or sites with shallow soil development.[60] Although differences exist between north and south facing slopes, the north facing slopes offset any negative effects that the south facing slopes have on water yield.

A policy of reinfiltration ponds or recharging the aquifer must be considered in the SF Municipal Watershed. Although the reservoirs, McClure and Nichols, are at higher elevations

---

[58] Lee H. MacDonald. Effects of Forest Harvest of Water Yields. Colorado State University. P. 85 (Water yields will diminish according to the respective temperature and moisture regimes. In the upper portions of the watershed where the climate is relatively cold and dry, water yields will return to their pre-treatment values in approximately 65-70 years; whereas, water yield increases in ponderosa pine forests is eliminated within 10 years)

[59] Keppler and Ziemer citing Harr, R.D., A Levno, and R. Mersereau, Streamflow changes after logging 130 year-old Douglas Fir in two small watersheds, Water Resourc. Res. 18(3), 637-644, 1982

[60] Gottfried, G.J. and L.F. DeBano. 1990. Streamflow and water quality responses to preharvest prescribed burning in an undisturbed ponderosa pine watershed. Pp. 222-228 in *Effects of fire management of southwestern natural resources*, tech. Coord. J.S. Krammes. General Technical Report RM-191. Fort Collins, Colo.: Forest Service.

with cool year round temperatures, the waters in the reservoirs are subject to evaporation. If increasing water yields is a priority, reducing all storage losses must also be a priority.

However, when applying evaporation rates from a class A pan at 8000 ft (approximated elevation of the reservoir and at 24 inches taking into consideration the location and setting of the reservoirs) and the surface area of the ponds approximated at 30 acres, the evaporation rates would be about 60 acre feet. Considering that we are estimating an increase of 2000-acre feet augmentation from thinning and that evaporation from the two reservoirs is a current, the effect of evaporative losses is zero when comparing results. Evaporation remains as a background component. The expected increases in water will not be lost to evaporation. However, it is useful to study the application of infiltration ponds or water injection fields to mitigate evaporative losses in order to capture all the increased yields and to decrease losses.

Similarly, existing and new conservation practices must be encouraged to further decrease inefficient water use. Conservation is the first step towards increasing water supplies and should be considered a priority, above all else, in region. Increasing water flow without promoting water conservation is antithetical to this proposal. Conservation and water yield augmentation are not discrete and distinct priorities; they must be implemented and encouraged concurrently. The possibility of increasing water yields should not be an excuse to encouraging and implementing water conservation programs.

Next, public opposition may curtail management practices intended to increase water yields. "Beginning in the late 1970s, increasing environmental concerns have curtailed large-scale implementation of many of the vegetation management practices proposed for water-yield improvement".[61] Past and present environmental concern manifested in the passage of

[61] Peter F. Ffolliott, Malchus B. Baker, Jr., and Vicente L. Lopes. Watershed Management Perspectives in the Southwest: Past, Present, and Future. USDA Forest Service Proceedings RMRS-P-13. 2000

environmental legislation during the same that period may limit any large-scale management or the use of basal area as a basis for thinning.

The use of basal area as opposed to diameter basal height may create public opposition. The use of basal area as a parameter of vegetation removal may permit trees greater than 16 inches in diameter to be cut, provoking controversy over the lack of parameters limiting the size of trees to be cut. Although, the majority of trees removed will be small diameter trees. These small diameter trees could then be utilized in the production of value-added wood products such as custom-milled timbers, vigas, boards, and peeled pole products that can be sold locally.[62] The benefits and necessity of using basal area, as discussed earlier, must be articulated to the public to decrease public opposition.

Natural resource management opportunities are especially beneficial in New Mexico, where much of the land mass is federally owned and is not revenue generating. Tribes in New Mexico would benefit from training in forest management and restoration and would produce some marketable wood products. The Walatowa Woodlands Initiative is one such enterprise rooted in restoration and production of wood products. The same is possible in the Santa Fe Watershed.

A discussion of water yield augmentation as a policy is moot without a consideration of the costs. The costs of restoration are significant and need to be considered. Tree thinning for water yield augmentation has many direct and incidental benefits. These benefits, however, cannot be quantified but are required in a cost-benefit analysis of a tree thinning management program. Thinning, given the necessity of preventing disturbances to the environment, is more

[62] Whatley, W.J. 2001. "A Collaborative proposal for community based forest restoration and wood product development involving small diameter timber recovered from within the Valles Caldera National Preserve and from the Pueblo of Jemez Tribal trust lands, Sandoval County, New Mexico." Proposal submitted to USDA Forest Service Collaborative Restoration Program, Albuquerque, N. Mex., June 254, 2001

labor intensive than commercial logging and requires the application of non-commercial thinning practices. "In areas with road access, costs for non-commercial thinning would be approximately $60 to $70 per acre; in steeper areas and areas without an existing road network, the costs would be considerable higher. For example, the estimated cost of treating the Santa Fe watershed is approximately $1,000 per acre, due in part to the steep slopes."[63] Given the high cost of thinning the watershed, all the benefits must be realized to complete a cost-benefit analysis. The cost of thinning is offset by the benefits derived from thinning: decreased need for fire suppression, increased water flow, the benefits of ecological restoration, revenue from any marketable timber removed from the watershed, and the benefit of increasing local employment.

A cost benefit analysis is difficult to complete without valuations for ecosystem health and recreation, but fire suppression has many associated costs. According to the U.S. Forest Service, the fires of 2003 covering more than 2.3 million acres cost more than $550,000,000 to fight. This boils down to a cost of $229 per acre[64] for fire suppression that would not be needed if thinning were to be encouraged. Furthermore, the value of each additional acre-foot of water is as high as $30,000 and conceivably more than 1,000 acre-feet may be realized through thinning amounting to a benefit valued at $30,000,000. The value of the increased water flow, if the increased flows become a reality, far exceeds the costs of thinning. Furthermore, the benefits must then include valuation for the other direct and indirect benefits of tree thinning for water yield augmentation.

The vast literature establishes that a thickening of forests decreases water flow, but it is not as well established that thinning increases flows. Furthermore, considering the

---

[63] Lee MacDonald and Mike Wirtz, in association with Daniel B. Stevens & Associates, Inc., with contributions from Alletta Belin and Sugarman (legal) and Ernest Atencio, Land and Culture Consulting (Socioeconomic) Jemez y Sangre Water Plan. White Paper February 2002.

[64] http://www.fs.fed.us/projects/hfi/2003/august/documents/hfi-fact-sheet.pdf (Accessed February 10, 2004)

aforementioned limitations, scientific studies focused on water yields are necessary to provide an accurate forecast of water yields from varying levels of management. Therefore, prior to the implementation of any management plans, it will be necessary to construct a model of the region to provide a better perspective on tree thinning for water yield augmentation. This model will allow planners to understand the repercussion of this proposal.

In a society where land management activities are scrutinized, a model of the environment is necessary for management decisions. The aim of a model in the Santa Fe is to increase water yields through tree thinning while maintaining a healthy ecosystem for the respective flora and fauna of the region and ensuring the stability and integrity of the natural processes of the watershed. This will provide decision makers with the knowledge to make choices that affect the future of the watershed. Of course, modeling by itself, will not provide definitive answers about water yield augmentation, but will provide a greater understanding of the behavior of the system.

In order to model the Santa Fe Municipal watershed, the first step must include an analysis of the baseline data. The baseline data does not need to be complete, but will provide a starting point to validate the model. Stream flow data, vegetation cover percentages, precipitation rates, infiltration rates, and soils data may provide provisional support to a policy of tree thinning for water yield augmentation. Then it is possible to change the variables and test the hypothesis that tree thinning increases water yields.

In addition to a model, it is imperative that studies are done in a region similar to or within the Santa Fe National Forest. The ideal test site should have similar geological features and temperature and moisture characteristics. Only then will the study indicate the possibility of increasing water yield in the Santa Fe National Forest. The lack of scientific studies and

monitoring in an area similar to the Santa Fe has further catalyzed the most recent round of arguments for and against tree thinning for water yield augmentation. Not only are these studies imperative to an understanding of forest dynamics, they are mandated by the National Forest Management Act (NFMA), when managing timber resources.[65]

Once studies are completed in an area (Higher reaches of the watershed exhibiting the ideal temperature and moisture characteristics) suitable for water yield augmentation then only will we be able to accurately estimate the ability of these treatments to enhance stream flows as a function of tree thinning.

Mandates of Management

Tree thinning for water yield augmentation in the SF Municipal Watershed must comply with existing environmental laws and promote the objectives of the earliest mandates of public lands. Compliance is both realistic and feasible, however, certain considerations and measures will need to be taken to avoid certain management limitations. The requirements of the Multiple Use Sustained Yield Act (MUSYA) requirements,[66] and the National Forest Management Act (NFMA) do not prohibit tree thinning; in fact, both a plain-meaning reading and the congressional intent of the Organic Act encourage it. In essence, the mandate condoning activities that provide favorable flows has not been altered since the creation of national forests and remains intact. Furthermore, a "wilderness" designation within the watershed does not restrict or interfere with activities supporting the goals of the municipal watershed. Lastly, thinning of the forests decreases the probability of higher fire intensities, increases wildlife

[65] 36 CFR § 219.18-219.25 (The regulations require studies on land suitability for timber production and consideration of all other resources in the forest)

[66] The MUSYA is defined as the "achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various resources". The increase in water yields will enable the Forest Service to manage the national forests for all of its intended purposes. Increased water yields through tree thinning will provide for increased recreational opportunities, wildlife habitat, forage, and decreased fire intensities. Furthermore, management to increase water yields will not impair the productivity of the land.

habitat, promotes recreational opportunities and enables the forests to return to a healthy state. However, the National Environmental Policy Act, the Endangered Species Act, and the Clean Water Act may limit tree thinning.

Tree-thinning to increase water yields in the Santa Fe National Forest fulfills the early philosophies of forestland management. The mission of the National Forest Service is rooted in two diverging philosophies:[67] Wise Use and Public Use. Wise Use advocates encourage economic and commodity uses of federal lands; whereas, public use advocates promote environmental values on federal lands. Although these two philosophies are diametrically opposed, a tree thinning campaign accomplishes the missions of both philosophies.

Tree thinning increases the amount of commodities produced from the National Forest lands: small diameter timber and increased water yields, thereby supporting the mission of wise use advocates. Furthermore, increased water yields greatly increase recreational opportunities; Recreation on National Forest lands occurs in great majority on or near water. Increased commodity production and economic benefits derived from the land is a hallmark of wise use philosophy is realized through tree thinning for water yield augmentation.

On the other hand, tree thinning enables ecological restoration by allowing the forests to return to historical densities necessary to support a healthy ecosystem, which is in accordance with the public use philosophy. However, it is imperative that natural processes are restored in order to comply with the mission of public use advocates. Tree thinning to restore the natural functioning of the ecosystem requires an investment of resources for monitoring and scientific studies. Restoration of a forested watershed cannot be considered as such if the natural processes

[67] Federal Land Management in the Twenty-First Century: From Wise-Use to Wise Stewardship. Scott W. Hardt, 18 Harv. Envtl. L. Rev. 345, 358

of the forest are not restored. Any management program must stay focused on the objective: The restoration of natural processes to fulfill the public use mission.

The Organic Act

The Organic Act of 1897 is rooted in both philosophies and mirrors the philosophy of the first Chief of the U.S. Forest Service, Gifford Pinchot.[68] Pinchot intended that management of forests should limit over-exploitation and simultaneously provide economic and social benefits.[69] The Pinchot letter of 1905 encapsulated his vision of the Forest Service: " All the Resources of forest reserves are for *use*...under such restrictions only as will insure the permanence of these resources...*Conservative use* of these resources in no way conflicts with their permanent value...You will see to it that the water, wood, and forage of the reserves are conserved and wisely used for the benefit of the home builder first of all...In the management of each reserve local questions will be decided upon local grounds; the dominant industry will be considered first, but with as little to minor industries as may be possible; sudden changes in industrial conditions will be avoided by gradual adjustment after due notice, and where conflicting interests must be reconciled the question will always be decided from the standpoint of the greatest good of the greatest number in the long run".[70] (emphasis in original) Tree thinning promotes Pinchot's philosophy. Selective harvesting of trees increases water yields and provides small-diameter timber products for future generations. However tree thinning should not be expanded to include large-scale extraction of forest resources in order to ensure the permanence of resources.

---

[68] 18 Harv. Envtl. L. Rev. 345, 358, Federal Land Management in the Twenty-First Century: From Wise-Use to Wise Stewardship. Scott W. Hardt

[69] *id*

[70] Gifford Pinchot, Breaking New Ground 119 (1947) at 192.

Federal lands were intended to provide resources at a rate that was sustainable for the future.[71] That idea of sustainable resources was echoed in the two priorities articulated in the Organic Act: to secure favorable conditions of water flow, and to furnish a continuous supply of timber.[72] "Congress intended national forests to be reserved for only two purposes—'[to] conserve the water flows, and to furnish a continuous supply of timber for the people".[73] The Organic Act of 1897[74] mandates 'favorable flows' of water from national forest lands to the surrounding lands.

Two interpretations of "favorable water flow" existed in the Creative Act of 1891,[75] a predecessor to the Organic Act. Congressmen from Colorado believed that forest reserves had the express purpose of providing for a slow release of water for agricultural purposes, whereas, Congressmen from California interpreted the phrase as a provision to moderate flood flows.[76] The different meanings of the phrase "favorable water flow" may have arisen due to the requirements of the respective regions. However, both Colorado and New Mexico share similar needs due to the arid climate and water scarcity of both states. Given the climatic similarities of the states, one is lead to believe that interpretation of "favorable water flow" by the Colorado delegation applies to New Mexico's forests as well. The interpretation of "favorable water flow" parallels the intent of the congressmen from Colorado to ensure water flows for consumptive uses rather than flood control.

---

[71] *See* Gifford Pinchot, Breaking New Ground (1947) (autobiography) and Harold W. Wood Jr., Pinchot and Mather: How the Forest Service and Park Service Got That Way (1976).
[72] 16 U.S.C. § 475
[73] *id.*
[74] Organic Act 30 Stat. 11
[75] Wengert, Norman, A. A. Dyer, and Henry A. Deutsch, 1979. The Purposes of the National Forest-A historical Re-interpretation of Policy Development. Colorado State University, Fort Collins, Colorado, pp. 31-32
[76] *Id.*

The Organic Act of the Forest Service did not reserve lands for aesthetic, environmental, recreational or wildlife preservation purposes.[77] However, the U.S. Court of Appeals for the fourth Circuit took a different view of the Organic Act in the context of timber cutting on the Monongahela National Forest. The Court of Appeals stated "the primary concern of Congress in passing the Organic Act was the preservation of the national forests."[78] Regardless, the Supreme Court's interpretation on the intent of Congress in creating the Organic act controls.

The Organic Act governs all national forests including the Santa Fe National Forest. This mandate has not been altered or repealed, however, supplemental mandates now exist and affect the management of the Santa Fe National Forest to include other priorities.

Subsequent to the Organic Act, Congress recognized the importance of the other resources. Subsequent acts reflected a priority to protect those resources. These acts, now collectively dictate the management of National Forest lands. The Santa Fe Municipal Watershed is governed by the rules of the Santa Fe National Forest, created in 1892. Nearly all national forests, including the Santa Fe National Forest, are managed according to congressionally created legislation: the Organic Act, the Multiple Use Sustained Yield Act (MUSYA), the Wilderness Act, the National Forest Management Act (NFMA), and other acts, such as, the National Environmental Policy Act (NEPA), the Endangered Species Act and the Clean Water Act. These acts, collectively, dictate the management of National Forest Lands.

Wilderness Act

Although multiple acts govern the management of national forest lands, certain tracts within the system are governed for a discrete purpose. That specific purpose or dominant use

---

[77] *United States v. New Mexico*, 438 U.S. 696 (1978)
[78] *West Virginia Div. Of the Izaak Walton League of America, Inc. v. Butz*, 522 F.2d 945 (4th Cir. 1975)

principle normally eclipses the multiple use framework outlined in other acts. One such manifestation of a dominant use principle is a designation as "wilderness". The creation of the Pecos Wilderness, upper elevations of the SF National Forest,[79] promoted preservation as the primary goal. Oddly, however, the Wilderness Act, encompassing all wilderness areas, grandfathered in grazing and mining[80] rights. A "wilderness" land designation supposedly reduces the number of acres subject to multiple use principles but it is apparent that exceptions were made to account for historical uses. Given the broad exceptions for grazing and mining in the Wilderness Act, it is appropriate that the Pecos Wilderness be open to water yield augmentation since the region historically depended on the yields from the watershed. However, unlike mining or grazing, tree thinning for water yields is not protected as a pre-existing use of the lands, but the water flowing from Forest Service lands had a pre-existing use and rights to those flows must be acknowledged.

Similarly, the Pecos wilderness area is part of the Santa Fe watershed and should be managed as such. A watershed is defined as a region where all the rainfall and snowmelt flows toward a single outlet. The Santa Fe River is the outlet of the Santa Fe Municipal Watershed. Therefore, priorities and management directives must be the same throughout the watershed, regardless of land designation or jurisdictional differences. The boundaries of a watershed do not change with different land designations; A watershed is a discrete entity and must be managed as a whole.

The Wilderness Act of 1964 established the Pecos Wilderness in the Santa Fe National Forest. In the Wilderness Act of December 1980, the Pecos Wilderness Area was expanded to

[79] 16 USCA § 1132 H.Rep. No 1538, 88th Cong., 2nd Sess., (1964), reprinted in 1964 U.S.C.C.A.N. 3615, 3616
[80] P.L. 88-577 § 4 (d)(3)(4)

comprise 40% of the municipal watershed.[81] A wilderness designation normally limits the uses of the land area, but in the case of the Pecos Wilderness, an additional use was implied. The wilderness designation does not conflict with the purposes for which the National Forests were established as set forth in the Organic Act, or subsequently in the Multiple Use Sustained Yield Act.[82] "Certain lands in the Carson and Santa Fe National Forests, New Mexico, which comprise approximately fifty-five thousand acres...are hereby incorporated in and shall be deemed a part of the Pecos Wilderness as designated by Public-Law 88-577: *Provided*, that nothing in this Act shall interfere with the management of, or rule, regulations and law applying to the Santa Fe Municipal Watershed."[83] The Pecos Wilderness, therefore, has dual roles of preservation and supporting the mission of the municipal watershed to provide waters.

The exception mandating the wilderness area's support of the municipal watershed, carved out in the language of Public-Law 96-550, seems to have arrived without discussion, debate, or hearings. This public law is accompanied by several senate reports,[84] but none of these reports refer to the municipal watershed. The Senate hearing (311-75) does not mention the Pecos Wilderness area or the exception provided for the management of the Santa Fe Municipal Watershed. Additionally, the house did not make a record on HR 8298, which eventually became PL 96-550. Therefore, the exception allows the application of the Santa Fe Municipal Watershed rules throughout the watershed and enables a continuation of the mission to provide waters to the Santa Fe municipality without interference from the wilderness designation.

---

[81] Santa Fe Municipal Watershed Draft Environmental Impact Statement, p. 1, chapter 1.
[82] Nothing in this chapter shall be deemed in interference with the purpose for which the national forests are established as set forth in the Act of June 4, 1897 (30 Stat. 11), and the Multiple-Use Sustained Yield Act of June 12, 1960 (74 Stat. 215) (16 U.S.C. 52-531). P.L 88-577, 78 Stat. 890; 16 U.S.C. 1 1 21 Sec 4 (a)(1)
[83] PL 96-550, 1980 HR 8298, 94 Stat. 3221
[84] S. Rp. 313-42, and S.Rp. 313-56

Although the Wilderness designation was intended to parallel the management of the Municipal watershed, the reduction of multiple use principles, coupled with fire-suppression has allowed the area to become "dog-hair thickets"[85] affecting water flows. These dog-hair thickets, found in the Pecos Wilderness (Northern reaches of the Santa Fe Municipal Watershed, Santa Fe National Forest) developed after extensive logging and over-grazing followed by an elimination of timber harvesting.

Municipal watersheds, as their name suggests, are meant to provide water supplies to a given municipality. "In 1930, the City of Santa Fe issued an ordinance prohibiting bathing, camping, fishing, picnicking, and grazing in the Santa Fe Canyon below Monument rock. By November 1932, The Santa Fe Municipal Watershed was officially closed, at the request of the City of Santa Fe, to public entry by a Closing Order issued by the Secretary of Agriculture under the authority of the Organic Administration Act of 1897".[86] In 1932, the priority to protect water quality was certainly the catalyst for the closure of the watershed, now, however, the quantity is of grave concern and corrective treatments must be applied.

Unlike Wilderness areas in general where preservation is the dominant goal, preservation in the Pecos Wilderness is constrained by the mandates of the Santa Fe Municipal watershed. The overlapping boundaries of the Pecos Wilderness Area and the Santa Fe Municipal Watershed shift the governance of the watershed to coincide with the rules of the Municipal watershed. The Pecos wilderness is not constrained by a dominant use principal. Instead the rules of the municipal watershed apply to the Pecos Wilderness, which has the express purpose of providing and delivering quality water to the City of Santa Fe.

---

[85] Foot Survey completed on July 20, 2003...Only a couple hundred acres are above tree line in the alpine tundra zone. The majority of the area does resemble a "dog-hair" thicket with areas exceeding tree densities of 1,000 trees/acre.

[86] Santa Fe Municipal Watershed Draft Environmental Impact Statement, p. 127

The Santa Fe watershed, including the areas within the Pecos Wilderness, is governed by rules other than the "wilderness" rules due to its enacting legislation. The enacting legislation of the Pecos Wilderness allows the management of the watershed to parallel the rules of the municipal watershed. Therefore, even though the Forest Service is responsible for the management of the entire watershed encompassing different land designations, their activities must promote the mission of the municipal watershed. The Wilderness designation within the 17,384-acre watershed does not prevent the application of the municipal watershed mission throughout the entire watershed, but it begs the question, why was this land area even designated a wilderness area if it was simply in furtherance of the goals of the municipal watershed? But, in the absence of any conference or committee reports referring to the municipal watershed we must settle for a plain meaning reading of the act, as restrictive as that is.

Although there are provisions in the Pecos Wilderness designation providing for the needs of the locality and the management of the Municipal Watershed, the provision seems to stray from the spirit of the "wilderness" idea. Public opposition to the active management of the wilderness area may limit thinning in the area. Asserting that active management is not within the spirit of the law may serve as a fundamental argument to enjoin a plan endorsing the active management of a Wilderness area. However, the plain language indicates that management is allowed and there is no legislative history indicating otherwise.

Multiple Use Sustained Yield Act (MUSYA)

Similar to the Pecos Wilderness designation, the MUSYA does not prohibit tree thinning for water yield augmentation. Broader in scope than the Wilderness Act, MUSYA governs all National Forest lands. "Sustained yield", as the act's name suggests, is central to the act.

However, the origin of "sustained yield" is somewhat unclear. Sustained yield first appeared in the language of the Oregon and California Lands Act (OCLA) of 1937. OCLA mandated timber management on BLM lands on a sustained yield basis. Sustained Yield, under OCLA, provided for a continuous source of timber and economic stability in the region.[87] This concept then appeared in Forest Service regulations under the Sustained Yield Forest Management Act.[88] However, neither the OCLA nor the Sustained Yield Forest Management Act clearly defined "sustained yield". Although, given the meaning of the phrase in OCLA, it appears that the "sustained yield" implies commodity production with a keen emphasis on economic stability. Commodity production further commits management activities to maintain a steady output of resources.[89]

MUSYA increased the scope of management activities on National Forest lands. The MUSYA is "supplemental to, but not in derogation of, the purposes for which the national forest were established as set forth in the Organic Act".[90] The mandate to provide continuous timber supplies and favorable water flows remains unaltered after the passage of the MUSYA, but provides for additional uses for which the forests may be managed.[91] "It is the policy of the Congress that National Forests are established for outdoor recreation, range, timber, watershed and wildlife and fish purposes".[92]

The broad discretion given to the Forest Service in managing the National Forests under the MUSYA does, however, provide "guidance". First, MUSYA requires the "management of

---

[87] Oregon and California Railroad Grants Land Act, ch. 876, 50 Stat. 874 (1937)
[88] 16 U.S.C. § 583 (1988)
[89] 43 U.S.C. §§ 1702(h) "The term sustained yield means the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the public lands consistent with multiple use."
[90] 16 U.S.C. 528
[91] National Forests-Multiple Use and Sustained Yield, Hearing on H.R. 10572, at 38. 86th Cong., 2d Sess. 37 (1960). *See Also* H.Rep.No. 1551, 86th Cong., 2d Sess 5 (1960)
[92] 16 U.S.C. 529

all of the various renewable resources of the national forests so that they are utilized in the combination that will best meet the needs of the American People".[93] Second, Forest Service programs are to "conform to changing needs and conditions".[94] Third, local conditions are to determine the uses of particular forests[95] and consideration should be given to the relative value of the resources in the region.[96]

Although, these directives guide the management of the Santa Fe National Forest they do not limit management activities. *Sierra Club v. Hardin*[97] illustrates the broad discretion given to the Forest Service. In that case, the court held that "Congress had given (In the MUSYA) no indication as to the weight to be assigned" to resources and the court left the decision to "the sound discretion and expertise of the Forest Service" as to whether they should allow clear-cutting at the expense of the other forest resources. Court have been hard pressed to find that a Forest Service management plan violated multiple use mandates in finding that a respective plan was within the administrative discretion given to the agency[98]

According to the MUSYA and case law,[99] the Forest Service may manage the Santa Fe National Forest based on the needs of the locality and assign values to the resources of the land at their discretion. Waters originating on the Santa Fe Watershed are highly valued and are crucial to the existence and development of Santa Fe.[100] Since the surrounding community places a high value on increasing water yields, management plans may be created with the goal of

---

[93] 16 U.S.C. S. 531 (a) (1988). *See* H. Rep. No 1551, 112 at 2378
[94] 16 U.S.C. S. 531 (a) (1988)
[95] *See e.g.* Rocky Mountain Oil and Gas Ass'n v. Watt, 696 F.2d 734, 738-739 (10th Cir. 1982) (evaluating multiple use sustained yield act standard)
[96] *See* H. Rep. No. 1551
[97] 325 F. Supp. 99, 107-112 (D. Alaska 1971)
[98] see e.g. Perkins v. Bergland, 608 F.2d 803, 806 (9th cir. 1979) (the MUSYA "can hardly be considered as concrete limits upon agency discretion"); Big Hole Ranchers Ass'n, Inc. v. United States Forest Service, 686 F. Supp. 256, 264 (D. Mont. 1988) (MUSYA provides the agency with discretion to weigh and decide proper uses for an area)
[99] *id*
[100] Conversation with local residents in Santa Fe suggesting that the value of an acre-foot of water in Tesuque, a town 10 miles north of Santa Fe, is nearly $30,000.

increasing water yields. Additionally, tree thinning will respond to the concerns of the locality by decreasing the probability of high-fire intensities, increasing wildlife habitat, and increasing recreational opportunities, enabling MUSYA's mandate for integrated resource management. Furthermore, the Santa Fe National Forest may formulate plans based on changing conditions, such as a period of drought and be able to respond to different priorities. Tree thinning to increase water yields, is within the discretionary authority of the Santa Fe National Forest and supports the "directives" stated in MUSYA. Therefore, it seems that MUSYA is not a statutory constraint on managing the Santa Fe National Forest to benefit commodity production and increase water yields.

Rangeland Renewable Resources Planning Act

Similar to MUSYA, commodity production is further promoted in the Forest and Rangeland Renewable Resources Planning Act (RPA).[101] RPA takes commodity production one-step further, and calls for output goals to be achieved on forestlands. The RPA places a priority on the Secretary of Agriculture to assess the availability and demand for renewable resources and to devise a program with objectives and output goals.[102] A tree-thinning program in the Santa Fe Municipal Watershed would provide for timber production, albeit small diameter timber, and may enable the watershed to produce additional quantities of water. This efficient commodity production coupled with the management of species would accomplish the objectives of both the RPA and the MUSYA.

[101] 16 U.S.C. §§ 1601-1610 (1988).
[102] 16 U.S.C. 1602

National Forest Management Act (NFMA)

Similar to the RPA and the MUSYA, the NFMA does not prohibit tree thinning for water yield augmentation. The National Forest Management Act (NFMA) echoes the values set forth in the MUSYA and the RPA but also includes a directive to protect the flora and fauna,[103] elevates public participation,[104] limits the broad authority and discretion given to the Forest Service in the MUSYA, and gives equal weight to each resource in order to holistically manage the lands for all the resources in the region.[105] These directives, albeit more sensitive to the environment do not expressly prohibit thinning of forests to increase water yields but reduce agency discretion.

The objectives outlined in NFMA optimistically aim to limit agency discretion but do not, however, limit a management program focused on increasing yields. The objectives of the Forest Service under NFMA are: 1. "To evaluate USFS programs in order that multiple-use and sustained yield can be determined;" 2. "to provide for opportunities for participation in USFS programs by owners of forest and rangeland;" 3. to implement programs which "improve the quality of soil, water, and air resources;" 4. to focus on "interrelationships" and "interdependence among the renewable resources; and 5. to "evaluate the impact of the export and import of raw logs upon domestic timber supplies and prices."[106]

NFMA directs that the Forest Service "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives, and within the multiple use objectives of a land management plan adopted pursuant to this section, provide, where appropriate, to the degree practicable, for

[103] 16 U.S.C. § 1604(g)(3)(B).
[104] 16 U.S.C. § 1601(d). 65 Fed. Reg. at 67534
[105] NFMA Sec. 6 (g)(3)(B)
[106] 16 U.S.C. 1602 (5) (A)-(F)

steps to be taken to preserve the diversity of tree species similar to that existing in the region",[107] and to "maintain viable populations of existing native and desired nonnative vertebrate species in the planning area."[108] This section addresses a number of ideas; however, these provisions only guide the policies of the Forest Service, they do not set standards. Senator Randolph West, a co-sponsor of a competing bill argued that NFMA did little to reform the management policies of the nation's forests. "We provided the Forest Service with the complete authority to harvest timber in any manner it desires with little or no protection for soil, nutrients, aesthetics, wildlife, watershed protection, or slope condition. We have relegated the multiple-use concept to a secondary position while placing timber harvest on a pedestal."[109] The requirement of maintaining viable populations promotes the viability species in a management plan, but many courts have deemed the viability provision as a guideline rather than as a substantive requirement.[110]

Furthermore, the explicit provision of NFMA to protect biological diversity, however, fails to limit agency actions and/or discretion. Two qualifying phrases in NFMA allow the Santa Fe National Forest to base their management decisions on the objectives of the MUSYA and their discretion. The Forest Service must protect biological diversity "*where appropriate*" and "*to the degree practicable*...in order to meet multiple use objectives".[111] This explicit provision of NFMA, when qualified, reveals the inherent ability of the Santa Fe Forest Service to use their discretion in implementing a tree-thinning program. It would be within the discretionary authority to manage the lands according to the stated priorities in the Organic act.

---

[107] NFMA Sec. 6 (g)(3)(B)
[108] 36 C.F.R. 219.19
[109] 122 Cong. Rec. S33,838 (daily ed. Sept. 30, 1976)(Statement of Sen. Randolph)
[110] Sharps v. U.S., 28 F.3d 851, 855 (8th Cir. 1994); Environment Now! V. Espy, 877 F. Supp. 1397, 1422 (E.D. Cal. 1994)(citing Tulare Audubon Socy. V. Espy CY-90-628-OWW); Inland Empire Pub. Lands Council v. U.S. Forest Serv., 88 F. 3d 754, 760-61 (9th Cir. 1996); Sierra Club v. Martin, 168 F. 3d 1 (11th Cir. 1999).
[111] 16 U.S.C. 1604 (g) (3) (B)

Specific provisions in the NFMA apply to timber removal and therefore, tree thinning. First, NFMA requires designation of lands as suitable or unsuitable for timber sales. The unsuitable areas or marginal areas, as is the case in the Santa Fe Watershed, may be cut as long as the other multiple use values are protected.[112] Second, the Secretary of Agriculture is given authority to determine the amount of trees removed. This determination is made on an estimate of how many trees can be removed from the respective forest annually on a sustained-yield basis.[113] Third, no trees may be cut if they have not reached their average growth.[114] Fourth, the Forest Service may not manage forests in such a way as to produce even-aged stands.[115]

The Monongahela decision[116] catalyzed these provisions. The provisions responded to the urgent need to eliminate the practice of clear-cutting. The resulting directives specifically responded to the ill effects of clear-cutting. This decision was not a response to other silviculture techniques, such as selective tree thinning. The Monogahela decision must be narrowly applied to clear-cutting. Additionally, subsequent cases demonstrate the discretion afforded to agencies in the "standards" of NFMA and their application of mitigation measures.[117]

Although selective tree thinning may create uneven-aged stands and promote multiple-use objectives,[118] it is constrained by land designation. Land is designated as "unsuitable" and "suitable". Unsuitability of lands correlates to the grade of the slopes and stability of the soils. The grade of the slope in the upper portion of the watershed is, at times, greater than 30%. If this area, which receives the greatest amount of precipitation and has the greatest potential for water

---

[112] 16 U.S.C. § 1604 (k) (1988)
[113] 16 U.S.C. § 1611(a) (1988)
[114] 16 U.S.C. § 1604 (m) (1)
[115] 16 U.S.C. § 1604 (m) (2)
[116] West Va. Div. Of the Izaak Walton League of America., Inc. v. Butz, 522 F.2d 945 (4th Cir. 1975) The Fourth Circuit enjoined the clear cutting methods used by the Forest Service
[117] National Wildlife Federation v. U.S. Forest Serv., 593 F. Supp. 931 (D. Or. 1984); Northwest Indian Cemetery Protection Association v. Peterson, 764 F.2d 581, 585-587 (9th Cir. 1985)
[118] 16 U.S.C. § 1604 (m) (2)- "Exceptions to these standards for the harvest of particular species of tree in management units after consideration has been given to the multiple uses of the forest" LOOK CAREFULLY

yield augmentation is deemed unsuitable, that designation would limit the type & amount of thinning in the upper portion of the watershed if effective mitigation measures are not applied.

However, when applying the restrictions of NFMA to tree thinning, the plan may be allowed based on the benefits received by the other resources. Wilkinson and Anderson in their review of the legislative history of the NFMA find: First, it is a broad mandate to bring timber production into balance with wildlife and ecological values. Second, forest conversion may be justified by the benefits to nontimber resources (ie. Water resources). Third, monoculture is prohibited.[119] Although, given current conditions,[120] one would be lead to believe that monoculture stands are a priority; whereas reducing the presence of monoculture stands is in line with this interpretation of NFMA and would be achieved through tree thinning.

Essentially, these three elements found in §6(g)(3) of NFMA requires the Forest Service to take an ecological perspective when managing the forest, and to prevent the forest lands from becoming tree farms. Tree thinning necessitates the management of the forest to include the continued diversity of flora and a provision to account for the benefits to nontimber resources. Tree thinning on forestlands prevents monoculture stands from developing. However, if tree thinning does reduce diversity, it can still be shown that other ecological results do justify planned type conversion.[121] Furthermore, the Committee of Scientists, appointed by the Secretary of agriculture stated: Provision for "diversity as required by NFMA is one of the most perplexing issues dealt with in the draft regulations. We believe it is impossible to write specific

[119] Wilkinson, C.F. and H.M. Anderson. 1987. Land and Resource Planning in the National Forests. Island Press. Covelo, CA.
[120] The watershed is dominated by thick conifer stands. Monoculture stands of Ponderosa Pine in the lower portion of the watershed are especially illustrative of monoculture stands.
[121] 36 C.F.R. 219.27(a)(5), (g) (emphasis in original)

regulations to "provide for" diversity".[122] Which may be the reason that courts, as mentioned earlier, have given agency determinations great weight.

In addition to the guideline in NFMA, it also requires Long Range Management Plans (LRMPs). LRMPs are forest-planning guidelines that address the suitability of lands for resource management,[123] provide for obtaining inventory data on the various renewable resources,[124] and the intended goals of plan.[125] The plan provides details of all the uses of the forest and specifies the amount of timber to be harvested.[126] These timber plans require that timber be harvested only where soil, slope, or other watershed conditions will not be irreversibly damaged and where wetlands and water quality are protected.[127] A tree-thinning program must respond to the mandates for population viability, water quality and wetland protection.

Forest plans have been challenged with varying degrees of success, whereas, other cases have lead to the rewriting of plans and management practices.[128] However, those forest plans, to which NFMA refers, were wide land-use plans, not resource specific programs or specific activities like tree thinning. Therefore, a plan to thin the Santa Fe National Forest will not be challenged according to the requirements of LRMPs.

In addition to demonstrating increased water yields, secondary benefits to other forest resources must be proven. Agency discretion would allow the Forest Service to support the program so long as it "provides for the diversity of plant and animal species". Furthermore, a LRMP must ensure research and evaluation of effects of each management system to assure no

---

[122] *Final Report of the Committee of Scientists*, 44 Fed. Reg. 26, 609 (1979)
[123] 16 U.S.C. 1604(g)(2)(A)
[124] 16 U.S.C. 1604 (g)(2)(B)
[125] 16 U.S.C. 1604(g)(3)
[126] 16 U.S.C. 1604 (1988).
[127] 16 U.S.C. 1604 (g)(3)(E)
[128] Litigation over the northern spotted owl in the late 1980s stopped timber sales in the Pacific Northwest and other regions inhabited by endangered species held up plans for roadbuilding and logging.

"*substantial and permanent impairment*" of land productivity.[129] Timber harvests are only permitted where the watershed condition will not be *irreversibly* damaged.[130] Therefore, the stability of both the land and wildlife populations is incorporated into planning.

The advent of unnaturally dense tree stands has affected existing private water rights. Both the NFMA and the FLPMA, the statute governing BLM lands, intended to preserve existing state water rights. Adjudication of water rights has traditionally been a state function. However, present land management practices creating overly dense tree stands affects the ability of states to appropriate water. The Forest Service may not "control the use of water allocated to and owned by non-federal water users under state laws, or interfere with state allocation and administration systems".[131] In allowing for increased consumption of water by vegetation, the Forest Service affects water rights and is a violation of the Due Process clause of the Fifth Amendment. And in essence the federal government is increasing its water rights by allowing for the increased consumption of water by vegetation. However, this argument fails because these management practices are land use regulations and are not actually water rights being claimed by the Federal government.

Besides the absence of prohibitions against tree thinning for water yield augmentation in MUSYA and NFMA, other initiatives such as the Healthy Forest initiatives support tree thinning, albeit for a different goal. However, there are statutes/acts that may limit the ability of the forest service to selectively thin to increase water yields. Those acts include, the Clean Water Act, the National Environmental Policy Act, and the Endangered Species Act. The Clean Water Act, if applied to the Santa Fe Watershed, may apply to the watershed only if the best

---

[129] 16 U.S.C. 1604 (g)(3)(c) (Emphasis added)
[130] 16 U.S.C. 1604 (g)(3)(E)(i)
[131] *See* Federal Water Rights Task Force, Report of the Federal Water Rights Task Force. Created Pursuant to Section 389(d)(3) of P.L. 104-127 (1997)

management practices are not adhered to. Furthermore, the existence of endangered, listed and/or threatened species near the project area may also affect tree-thinning programs. However according to the wildlife section in the current Santa Fe Municipal Watershed plan there are no ESA species within the municipal watershed so the ESA does not apply.[132] Lastly, the NEPA may limit the implementation of a tree-thinning scheme only if all of the procedural requirements of NEPA are not met.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act is a codification of administrative procedures necessary for a major federal action.[133] Prior to the creation of other environmental acts, such as the Endangered Species Act, NEPA was recognized as an inherently strong conservation policy. However, NEPA is nothing more than a series of steps that must be followed in order to inform the public prior to, during and completion of an activity.[134] Accordingly, the Santa Fe National Forest may actively thin its forests if, among other things, it follows the procedures required by NEPA. They simply must describe the methods of implementation, impacts, and mitigation efforts. By creating a forest plan that responds to the environmental disturbances, the plan or activity may be enjoined *only* if it is deemed "arbitrary and capricious" or an "abuse of discretion".[135] However, a decision to thin is entitled to a "presumption of regularity" or in other words, benefit of the doubt.

---

[132] The Federally listed species known to occur in Santa Fe County are not known to occur in the project area. Santa Fe Municipal Watershed Draft Environmental Impact Statement, p. 99

[133] 42 U.S.C.A. § 4332 (c)

[134] In *EDF v. TVA*, 419 F.Supp 793, the court granted an injunction for failure to complete a detailed EIS, one of the required procedures of NEPA.

[135] *Citizens to Preserve Overton Park v. Volpe*, 401 U.S. 402 (1971)

The National Environmental Policy Act of 1969 mandates that all major that all federal management plans achieve the following: "1. Fulfill the responsibilities of each generation as trustee of succeeding generations; 2. Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings; 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable or unintended consequences; 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, en environment which supports diversity and variety of individual choice; 5. Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources".[136] As written, these directives lack specificity and are therefore difficult to mandate. The intent behind these directives may have been genuine, but NEPA remains as a "to-do" list. Tree thinning to provide increased water yields will satisfy the goals of the National Environmental Policy Act of 1969 so long as the Forest Service performs all the necessary analyses.

A proposal to thin in the Santa Fe National Forest to increase water flows triggers the NEPA process.[137] The Santa Fe National Forest may draft several tree-thinning proposals prior to deciding upon a final agency action.[138] However, once the tree-thinning proposal to increase

[136] National Environmental Policy Act of 1969, 42 U.S.C. § 4321 et seq.

[137] "An EIS need not be prepared simply because a project is contemplated, but only when the project is proposed. In this circuit, a rational basis test is applicable in determining whether the time is ripe for an EIS that eventually will clearly be required. Certainly the project must be of sufficient definiteness before an evaluation of its environmental impact can be made and alternatives proposed. *Park County Resource Council v. U.S. Dep't of Agriculture,* 817 F. 2d 609, 622-24 (10th Cir. 1987).

[138] "Plaintiffs are thus correct in asserting, in theory, that preparation and consideration of an EIS should precede the adoptions of the actual federal action proposed. It does not follow however, that an agency cannot formulate a proposed action, or even decide that it wishes to take the proposed action, before preparation of an EIS. Indeed, agency regulations contemplate the selection of a preferred course of action prior to completion and filing of the DEIS". *Natural Resources Defense Council, Inc. v. Hodel,* 624 F. Supp. 1045, 1049 (D. Nev. 1985), aff'd 819 F.2d 927, 929 (9th Cir. 1987)

water yields is recommended, an EIS will be required.[139] To survive the scrutiny of a NEPA analysis, the Santa Fe National Forest must determine all of the impacts on the resources of the forest and plan to mitigate the negative impacts.

Tree thinning of the understory of the Santa Fe National Forest will result in a stand resembling a late seral condition capable of producing increased water yields and more grass growth. The environmental effects of promoting a late seral condition must be determined and articulated in the EIS. In addition, an EIS is required, because a tree-thinning program would necessitate a commitment of resources, small-diameter timber. In *Lane County Audubon Soc'y v. Jamison*, 958 F.2d 290, 295 (9th Cir. 1992), the court held that timber sales constitute per se irreversible and irretrievable commitments of resources. Therefore, once the Santa Fe has identified a contractor to thin the forest, an EIS is imperative.

Next, NEPA exposes project plans to public scrutiny. "One of NEPA's goals is to facilitate 'widespread discussion and consideration of the environmental risks and remedies associated with the pending project, thereby augmenting an informed decision-making process. With this approach to decision-making, agencies must scrutinize the environmental consequences before approving any major federal action"[140]. The Ninth Circuit enjoined several management plans due to procedural violations of the NEPA.[141] In those cases, the Forest Service did not adequately follow the specific procedures of NEPA. However, if the Santa Fe

---

[139] "NEPA requires consideration of the potential impact of an action *before* the action takes place." *City of Tenakee Springs*, 915 F. 2d at 1313. In this case, the three sales were reasonably foreseeable, therefore, the Forest Service was obligated to assess the cumulative impact of all sales on the availability of old growth habitat for the pileated woodpecker

[140] LaFlamme v. FERC, 852 F. 2d 389, 398 (9th Cir. 1988)

[141] Save the Yaak Comm. v. Block, 840 F.2d 714 (9th Cir. 1988); Sierra Club v. United States Forest Service, 843 F. 2d 1190 (9th Cir. 1988)

National Forest follows the procedural requirements of NEPA and prepares a complete EIS, a court will not question the choices made by the Forest Service.[142]

Endangered Species Act (ESA)

NFMA promotes biodiversity whereas; the ESA prevents species extinction: While the diversity provision in NFMA accounts for the health of populations, the ESA is the only law capable of averting the extinction of species and has the "teeth" to do so. The ESA states "that all federal departments and agencies shall seek to conserve endangered and threatened species and shall use their authorities in furtherance of the purposes of this act".[143] The Supreme Court confirmed species protection as a priority in 1978.[144] The court interpreted the ESA as "a conscious decision by Congress to give endangered species priority over the primary missions of federal agencies."[145]

However, no listed species exist within the Municipal watershed so the requirement of ESA is less involved, but given the presence of threatened and endangered species near the project area and the watershed, proactive measures must be taken to avoid ESA-related controversy. A tree-thinning program must not negatively impact listed species or the ecosystems upon which they depend.[146] The critical habitat of the listed species within the Santa Fe National forest, adjacent to the project area, creates a duty for the Santa Fe National Forest to avoid adverse modification of critical habitat. Section 7 of the ESA directs all federal agencies "to insure that actions authorized, funded or carried out by them do not jeopardize the continued existence of...endangered species and threatened species, or result in the destruction or

---

[142] G. Coggins, Public Natural Resources Law Ch. 1 at 12.02[1] (1990, Release No. 1, 1991)
[143] 16 U.S.C. 1531 (c)(1).
[144] Tennessee Valley Authority v. Hill, 437 U.S.153, 185 (1978).
[145] *Id.*
[146] 16 U.S.C. 1531 (b)

modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with the affected States to be critical".[147]

The designation of critical habitat is in line with the ESA mandate of ecosystem and habitat protection. However, there are provisions within the ESA that decreases the mandate to designate critical habitats. The Santa Fe National Forest may "consider the economic impact of designations and are authorized to exclude any area from critical habitat" if they "determine that the benefits of such exclusion outweigh the benefits of specifying such area".[148]

This provision allows modifications to critical habitat designations for the management of the watershed to promote increased water yields. The economic benefits, increased water flows, of excluding an area from designation are significant. Furthermore, those benefits may outweigh the benefit of designating areas within the watershed as critical habitat. However, any change in critical habitat designation in the Santa Fe National Forest may then be subject to citizen petition and active opposition by the broader environmental community.

Modifications to habitat designation are difficult to accomplish and may limit a tree-thinning program. In *Babbitt v. Sweet Home Chapter of Communities for a Greater Oregon*,[149] the Supreme Court held that the protection of species included the protection of their habitat. However, *Sweet Home* was a clash between private and public land use law, whereas, this thinning program would occur only on public lands and would benefit the public, not just developers.

As an alternative, the Santa Fe Municipal Watershed may seek an Incidental Take Permit by creating a Habitat Conservation Plan to allow for a tree-thinning operation to be implemented if species were to suddenly appear with in the watershed, but a program would be enjoined

---

[147] Pub. L. No. 93-205, SSS 7, 87 Stat. 884, 892 (1973) (current version at 16 U.S.C. SSS 1536 (a) (2)).
[148] 16 U.S.C. § 1533 (b)(2)
[149] 515 U.S. 689 (1995)

otherwise.[150] This plan must include the potential impacts on the listed species and the steps that will be taken to minimize those impacts. Tree thinning may create disturbances to wildlife; however, the creation of additional habitat may supplement a habitat conservation plan.

Management Indicator Species (MIS)

Tree thinning for water yield augmentation must include an analysis of the effects on the MIS. There are several MIS in the Santa Fe National Forest. These MIS were adopted in the 1987 Santa Fe National Forest Plan. "MIS are species that enable forest managers to observe the effects of changing plant communities and associated habitats."[151] If the MIS appeared threatened, the Forest Service is to make adjustments to its management. The Santa Fe National Forest should monitor MIS and make any adjustments to a tree-thinning program whenever there is a threat to population viability or distribution. However, MIS are only administrative designations and must be applied as such.

A program to thin the Santa Fe National Forest represents a complex interplay between wildlife and human needs. Not only do the people of Santa Fe depend on the Santa Fe National Forest for the water that it produces, the native flora and fauna depend on the forest to provide necessary habitat for their survival. However, many times this belief is not embraced by the entire population and inevitably, debates arise over the "importance" and "value" of wildlife in the creation of a program designed to benefit people. However, it is important to note that tree thinning will reduce the negative impacts of the developing monocultures of ponderosa pine and

[150] Section 7 of the ESA establishes a formal consultation process requiring the approval of any plan by the U.S. Fish and Wildlife Service for activities that could adversely affect a listed species. Furthermore, the Forest Service must defer management activities during consultation. Therefore, a showing of no-impact is necessary and will be relatively simple given that there are no listed species currently in the project area.
[151] 36 C.F.R. 219.19 (a)(1)

Englemann spruce by increasing habitat for a less shade tolerant species, diverse and decreasing riparian grass and shrub communities within the watershed.

Analyzing the effects of tree thinning on a variety of species enables an ecosystem approach to management. Each of the species in the Santa Fe National Forest have specific habitat requirements, but when consolidated, these requirements may be used to create a broad habitat management plan that responds to each species' needs. Therefore, the Santa Fe National Forest must manage specifically for conservation of listed species in adjacent areas, but should also manage a forest according to the requirements of the MIS in the region.

"Populations of wildlife are extremely difficult to quantify; and in some cases vary substantially from year to year."[152] Inadequate funding for baseline research, and environmental factors influencing survival rates and adults makes it very difficult to estimate the specific number of animals in a given area. However, population estimates according to historical animal densities provide sufficient information to incorporate into a tree-thinning plan.

Indicator species in the Santa Fe National Forest include: the Mexican Spotted Owl (*Strix occidentalis lucida*), the Rio Grande Cutthroat (*Oncorhynchus clarki virginalis*), Merriam's Turkey (*Meleagris gallopavavo)*, Hairy Woodpecker (*Picoides vilossus)*, Rock Mountain Bighorn Sheep (*Ovis canadensis Canadensis*), Rocky Mountain Elk (*Cervis Canadensis*), Pinyon Jay (*Gymnorhinus cyanocepahlus*), and the Mourning Dove (*Zenaida macroura*).[153]

Many of the MIS and other species would benefit from a decrease in vegetation.[154] Furthermore, according to the MUSYA, the SF National Forest must be managed to provide for

---

[152] *Santa Fe National Forest Management Indicator Species Assessment*, March 2002

[153] *Land and Resource Management Plan*, Santa Fe National Forest, 1987

[154] Ungulates, such as, Big Horn Sheep and Elk would benefit from changes in alpine and meadow areas. Tree thinning increases the meadow areas due to a decrease in canopy closure. Big Horn Sheep and Elk rely heavily on meadows during winter months and would benefit from conditions that improve range conditions. Furthermore, "the loss of grasslands to a forested ecosystem through succession was modeled to be a negative effect on elk habitat". (Santa Fe National Forest Management Indicator Species Assessment, pg. 2 March 2002)

multiple uses. Historically, grazing has occurred on National Forest lands. Tree thinning will provide for grazing permittees to continue their use of national lands for grazing due to an increase in forage. An inverse relationship between overstory canopy cover or basal area of a tree stand and the density of production of herbaceous and shrubby understory has been noted under a wide variety of conditions.[155] This inverse relationship occurs due to the increase in temperature, light, and water to the forest floors, which are the most critical climatic factors for plants.[156] Therefore, in addition to providing for increased forage for grazing, there may be an increase in the diversity of native grasses and forbs in the watershed.

Clean Water Act (CWA)

Often times when timber management plans are proposed; they are met with fierce resistance and apocalyptic thoughts of loss of wildlife, erosion and sediment loading etc. Past clear-cutting activities catalyze those apocalyptic thoughts today. However, these concerns will subside if selective tree thinning was clearly defined and articulated. Regardless of the subsidence of fear, the upland management of a watershed may fall under the provisions of the Clean Water Act (CWA).[157]

Similarly, Merriam's Turkey benefits from tree thinning. "Timber harvest in the Ponderosa Pine Zone was the primary factor modeled to affect turkey habitat. Activities that opened forest canopy allowing grass, forbs, and mast producing vegetation to grow, improve turkey habitat". (Santa Fe National Forest Management Indicator Species Assessment, pg. 3-4 March 2002) Additionally, the Mexican Spotted Owl and the Northern Goshawk may benefit from thinning. "Because of its relatively large body size and wing span, the goshawk seldom uses young, dense forests". (Fischer, D.L. 1986. Daily Activity Patterns and habitat use of Accipter hawks in Utah. Provo, Utah: Brighman Young University. PhD dissertation) In the Santa Fe National Forest, there is insufficient space in and below the canopy required for the flight of the Goshawk and the capture of prey. Therefore, to facilitate flight and the capture of prey, it is beneficial to thin in the Forest to provide for the Goshawk. However, given the forest types occupied by the Goshawk (74% in the Ponderosa Pine, 23% in Mixed Species and 3% in Spruce-Fir) the effects of thinning above the Ponderosa Pine region will be minimal. (*Management Recommendations for the Northern Goshawk in the Southwestern United States.* USDA, Forest Service. General Technical Report RM-217.
Similar to the Goshawk, the Pinon Jay and the Morning Dove would benefit from a thinning regimen resulting in a later seral stage (Removal from below). Both the Pinyon Jay and the Morning Dove rely heavily on harvesting within woodlands.

[155] Pase, C.P. Pase, C.P. and R.M. Hurd. 1958. Understory Vegetation are related to basal area, crown cover and litter produced by immature ponderosa pine stands in the Black Hills. Proc. Soc. Amer. Foresters (1957):156-158.

[156] Bonner, J. and A.W. Galston. 1952. Principles of Plant Physiology. McGraw-Hill Book Co., New York. 499 pp.

[157] 33 U.S.C.A. §§ 1251 to 1387

The CWA is effective in the control of point source pollution. The act's regulatory requirements apply mostly to "point sources" of water pollution. Activities such as grazing and logging are classified as "non-point sources". However, sections 208 and 319 of the CWA direct the states to develop plans and programs to control non-point source pollution, but these sections do not provide guidance or enforcement mechanisms to control non-point source pollution.

Both fire and tree thinning have the potential of increasing erosion rates in the Santa Fe Municipal watershed. However, catastrophic fire poses an even greater threat to erosion rates than tree thinning. Post-wildfire evaluations suggest erosion rates increase by a magnitude of twenty times (271,148 tons) greater than current conditions,[158] and increased streamflow discharge due to the creation of a uniform hydrophobic soil layer reducing infiltration rates.[159] Additionally, the threat still exists even after all of the fire prevention programs in the lower watershed because only a small percentage of the watershed will be thinned. Therefore, when compared with the significant increase in erosion rates after a fire, the best approach to mitigating an increase in erosion rates and to avoid CWA violations due to fire is to thin the entire watershed.

Furthermore, an increase of water yields from the forest may provide a channel to increase federal reserved rights. These rights could then be used to provide for instream flows capable of improving water quality. The court in *United States v. New Mexico* stated that the reason for the creation of the National Forest System was "principally as a means of enhancing the quantity of water that would be available to the settlers of the arid West".[160] Furthermore, the

---

[158] Soil and Water Specialist Report. P. 25

[159] Tiedeman, A.R., C.E. Conrad, J.H. Dieterich, J.W. Hornbeck, W.F. Megahan, L.A. Viereck, and D.D. Wade. 1979. *Effects od Fire on Water: A State-of-Knowledge Review.* USDAForest Service, General Technical Report WO-10.

[160] 438 U.S. at 713. *However,* these comments referred to federal reserved water rights for stock watering and fish preservations, not the protection of watershed resources.

dissent in *New Mexico*, pointed out "the United States is not barred from asserting rights to minimum instream flows...for erosion control or fire protection on the basis of the recognized purposes of watershed maintenance and the maintenance of timber".[161] However, if New Mexico state law applied to those newly developed waters, the increased flows may simply be diverted to senior and junior water appropriators.

Wildfire Prevention

Tree thinning reduces the potential for wildfire in the Santa Fe Municipal Watershed. Catastrophic wildfire resulting in natural resource and private property damage is a significant issue in the Santa Fe National Forest. Wildfires are a common occurrence in forests and rangelands. However, many of these naturally occurring fires are suppressed according to the Forest Service philosophy of fire suppression. Fire-suppression has catalyzed an increase in stand densities and crown-fire potential in the West.[162] Regardless, the 2 to 5 percent that are not suppressed burn 95 percent of the area.[163]

In response to the disastrous fire season of 2002, a New Mexico state Senate Bill gave authority to New Mexico counties to thin overgrown national forests. Sen. Tim Jennings, D-Roswell, said this bill was a "basic constitutional issue of protecting our property".[164] The bill targeted national forests that burned during the fire season or posed a potential fire danger to bordering communities.

---

[161] *Id.* at 724-725

[162] Mutch, R.W.; Arno, S.F.; Brown, J.K.; Carlso, C.E.. 1993. Forest Health in the Blue Mountains: a management strategy for fire-adapted ecosystems. Gen. Tech. Rep. PNW-310. Portland, OR. U.S. Dep't of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. P. 14.

[163] Dodge, Marvin. 1972. Forest Fuel Accumulation. Science. 177: 139-142

[164] Senate Oks Tree-thinning. S.U. Mahesh. Liberty Matters News Service. Available at http://www.libertymatters.org/2.13.01senateokays.htm Accessed July 16, 2002

There are several different methods for thinning to reduce fire potential, but the one method that accomplishes the goals of reducing fire potential and the aforementioned benefits is low thinning. Low thinning or thinning from below removes trees from the lower canopy. In the Santa Fe Municipal Watershed, Ponderosa Pine primarily occupies the dominant canopy layer. A low thinning regimen in this region would favor the development of the dominant ponderosa pine and would mimic historical stands. Furthermore, selection thinning and crown thinning that maintain multiple crown layers will not reduce the risk of crown fires.[165] Therefore, low thinning to create only one crown layer will mitigate crown fire potential and will provide the habitat to realize the other benefits of tree thinning.

Healthy Forests Restoration Act of 2003

In November 2003, the House and the Senate passed the Healthy Forests Restoration Act of 2003.[166] This act was passed in response to the danger that wildfire poses to communities and municipal water supplies. In addition to live biomass, the initiative included a provision to increase the number of uses and commercial value of the forest biomass that is otherwise considered a contributing factor in wildfires.

The Healthy Forests Restoration Act, if applied to the Santa Fe Municipal watershed and the National Forest would not constrain or limit a tree-thinning program focusing on the removal of small diameter trees. The act focuses largely on small diameter trees to reduce the wildfire severity similar to a plan motivated by increased water yields. Although the agendas are different, the 'means' for accomplishing both missions are driven by the removal of small

[165] Graham, Russell T.; Harvey, Alan E.; Jain, Theresa B.; Tonn, Jonalea R. 1999. The effects of thinning and similar stand treatments on fire behavior in Western forests. Gen. Tech. PNW-GTR-463. Portland, OR: U.S. Dept of Agriculture, Forest Service, Pacific Northwest Research Station. P. 27
[166] P.L. 108-148, 2003 HR 1904 (117 Stat. 1887)

diameter timber. A plan to thin for the purpose of increasing water yields would, in effect, be supported by the Act.

Similarly, Santa Fe's close proximity to the National Forest and the municipal watershed, ensures the application of the act to the region.[167] The city of Santa Fe borders the national forest and the municipal watershed creating a significant wildland-urban interface. This interface is specifically defined in the act as "a group of homes and other structures with basic infrastructure and services (such as utilities and collectively maintained transportation routes) within or adjacent to Federal land."[168] More significantly, management in this region is exempt from NEPA mandates. "Wildland Urban Interface is located no further than 1.5 miles from the boundary of an at-risk community. Within this *wide* interface, the Secretary is not required to study, develop, or describe any alternative to the proposed agency action in the environmental assessment or environmental impact statement prepared pursuant to section 102(2) of the NEPA of 1969. Therefore, if NEPA were ever a constraint on management activities in the Municipal watershed, it is no longer.

In addition to increasing the value of biomass from the nation's forests, increased infestation of the pine bark beetle in the Santa Fe National Forest warrants the application of the Act to the area. "High levels of tree mortality resulting from insect infestation (including the interaction between insects and diseases) may result in (A) increased fire risk; (B) loss of old trees and old growth; (C) loss of threatened and endangered species; (D) loss of species diversity; (E) degraded watershed conditions; (F) increased potential for damage from other agents of disturbance, including exotic, invasive species, and (G) decreased timber values.[169] "Severe drought conditions in many areas of the South and West will increase the risk of forest

[167] 117 Stat. 1887, § 104
[168] 117 Stat. 1887, § 101, 1(A)(ii)
[169] Sec. 401 (a)(1)(A-G)

However, the Act has authorized appropriations for fiscal years 2004 through 2008; $25,000,000 for fiscal year 2004 and similar sums for each subsequent year.[176]

Given the support the Act gives to thinning and forest management, it is difficult to find any limits to management in this broad legislation, especially when considering the large appropriation devoted to fire suppression and timber management. However, the limitation that is most salient to the Santa Fe Municipal Watershed is the exclusion of certain federal lands. "The Secretary may not conduct an authorized hazardous fuel reduction project that would occur on a component of the National Wilderness Preservation System."[177] However, this does not change the rules that govern management activities in Wilderness area, which allows measures to be taken to control fire. Therefore, the initiative neither creates limitations nor does it provide support for management of the Pecos Wilderness Area.

Conclusion

The conversion of America's forests into dense stands of stunted and beleaguered trees has forced forest managers and planners to implement programs dedicated towards reducing the risk of catastrophic fire and restoring natural processes in the ecosystem. The condition of the forests even resulted in the dramatic passage of legislation entitled the "Healthy Forests Initiative", all in the name of reducing the risk of catastrophic fire. However, it is not for certain whether the initiative will actually reduce fire risk. Regardless, on the heels of one of the most intense and costly fire seasons, legislation appears to have passed because of the *potential* of reducing fire intensity. Similarly, after years of enduring another drought cycle in the west, other programs should be implemented because of their potential benefits. The idea is this: water

[176] Sec. 508 (1)
[177] Sec. 102 (d)(1)

damaging insects,"[170] and "in the west, more than 21,000,000 acres are at high risk of forest damaging insect infestation."[171]

Furthermore, application of the Act to a thinning program would further reduce any legal constraints. There are several categorical exclusions in the Act, one of which, applies to silviculture treatments. "Applied silvicultural assessment and research treatments carried out under this section on not more than 1,000 acres for an assessment or treatment may be categorically excluded from documentation in an Environmental Impact Statement and environmental assessment under the National Environmental Policy Act of 1969.[172] Congress attempted to limit this categorical exclusion by mandating that these treatments receiving exclusion from the NEPA requirements are not carried out in an area that is categorically excluded,[173] but fell short and did little to prevent checkerboard treatments to take advantage of categorical exclusions.

Similar to the weakening of NEPA procedural law through the broad exemptions, the Act reduces citizen involvement by requiring administrative appeals to be exhausted prior to the filing of a civil action.[174] Furthermore, Congress has given the courts a mandate to expedite review of all challenges, make a final determination as soon as practicable, and limit injunctive relief and stays pending appeal to 60 days.[175]

Lastly, as briefly mentioned earlier, forest management is expensive. Revenues from timber sales have decreased and therefore allocations towards management have decreased.

---

[170] Sec. 401 (a) (C)
[171] Sec. 401 (a) (B)
[172] 42 U.S.C. 4321 et. Seq.
[173] Sec. 403 (d)(1)(A)
[174] Sec. 105 (c)(1)(A)(B)
[175] Sec. 106 (c)(1)

yields are influenced by vegetation density, and the nation's forests are overly dense, therefore, by reducing vegetation on the nation's forests, water yields will increase. Similar to the Healthy Forests Initiative, it is not an absolute truth that tree thinning increases water yields. Although, similar to the evidence illustrating the effect of thinning on fire intensity, studies suggest that increased water yields are possible through tree thinning.

The body of information linked to water yield augmentation suggests that the influence of tree thinning on water yields is highly variable. Numerous studies concluded that even if increased yields are realized, they would be insignificant, while others suggested that additional yields will be significant and will remain so for years to come. These studies represent the spectrum of beliefs and opinions on the effects of tree thinning but also represent a potential for increased yields.

Similar to other management programs, tree thinning to increase water yields will have its detractors and supporters, each siting past and present studies to support their respective positions. Given the imprecise nature of the causal relationships discussed in this paper, at the very least, the entire watershed should be thinned to reduce fire intensity and concurrently monitored for increased water yields. This will allow for a determination to be made on the reality of increasing water yields while accomplishing a different priority.

Although a program to thin can be accomplished under the auspices of reducing fire risk rather than increasing water yields, the Santa Fe National Forest is not prohibited from thinning to increase water yields. Thinning to increase water yields is in line with the Organic act and is not prohibited by subsequent legislation. Lastly, active management whether to reduce fire risk or increase water yields is better than our current management decision not to manage or to

continue to mismanage. The lack of management decreases environmental diversity, economic benefit, and increases the threat of loss of a public asset, our national forests.

Tree-thinning to provide for additional flows is encouraged by the Organic Act, and does not conflict with subsequent legislation. However, adequate funding must be available to support scientific research on tree thinning. Deficiencies in monitoring, due to inadequate funding is an obstacle to implementing a tree-thinning program. Monitoring shall be required for tree thinning and shall ensure that the implemented programs do not create unintended consequences for the ecosystem. It is imperative that we tread carefully when trying to manage resources for one single goal. Furthermore, the possibility of augmenting water yields should not decrease water conservation practices.

As a society, we over manage and under manage our nation's forests. Many forests with abundant natural resources go unmanaged, while others are pillaged for their valuable commodities. Very few forests receive appropriate treatment after years of neglect. Meanwhile, people with overly optimistic ideas about the status of our nation's forests seek policies of zero-management to cure the 200 plus years of mismanagement; while others believe that a policy of unfettered resource extraction for commodity production is the answer to our nation's forestry foibles.

Both approaches to forest management are authentic, but both are also dangerous. What emerges clearly from an analysis of the Santa Fe Municipal Watershed is that we should act with caution when managing for water yields, but we should proceed. We must avoid management plans that can't ameliorate our nation's forests, apply management plans that can, and consider those that are capable of providing for society's greater needs.