Santa Fe Mountains Landscape Resiliency Project: Riparian Vegetation Effects Analysis

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Issues Addressed

This section includes issues pertaining to riparian resources that have been identified for detailed analysis. "An issue is a statement of cause and effect linking environmental effects to actions" (FSH 1909.15).

Issue 1: Conifer abundance in riparian areas substantially exceeds the characteristic canopy cover of the ecological reference model (= reference condition) identified in the Santa Fe Terrestrial Ecological Unit Inventory (TEUI) (USDA Forest Service 1993). Increased conifer abundance has altered riparian habitat conditions and increased the risk of high severity fire. With fire exclusion and denser vegetation in the surrounding uplands, there is a risk of wildfire burning in riparian areas with greater frequency and severity than the historic fire regime, limiting the recovery potential of these areas and favoring the encroachment of non-native invasive vegetation.

Issue 2: There is currently an overabundance of late seral conditions in comparison to desired conditions as a result of land use history, increasing conifer abundance, and drier conditions. Ecological integrity and habitat conditions depend on a balance of all seral state conditions.

Issue 3: With prescribed burning in surrounding uplands, backing fire could come into riparian areas and kill or topkill some woody vegetation (see design features, Appendix A).

Methodology

Baseline analysis of several riparian indicators (Table 1) was conducted to evaluate current condition and trends in ecological integrity, to inform the Affected Environment, and to help identify management opportunities. Appendix B to this specialist report includes some assumptions and uncertainties along with methods, data sources, metadata, and references. Some analysis results were corroborated through field surveys of the project area.

The scope of the baseline analysis was the project area, except where the size of the project area was inappropriately small for a given analysis (e.g., analysis of connectivity). The area applied for each indicator is given in Appendix B. The area analyzed for *effects* by Santa Fe Mountain Landscape Resiliency Project (SFMLRP) was more constrained according to proposed management activities:

- Riparian Restoration in the Tesuque Creek main drainage (Figure 1), mostly Narrowleaf Cottonwood/Shrub Ecological Response Unit (ERU) plus 100' buffer: **310 acres**
- Riparian Restoration in the Arroyo Hondo main drainage (Figure 2), mostly ephemeral riparian (unmapped), represented by stream courses plus 100' buffer: **370 acres**

Figure 1. Proposed riparian restoration area along Tesuque Creek composed mostly of Narrowleaf Cottonwood/Shrub ERU.

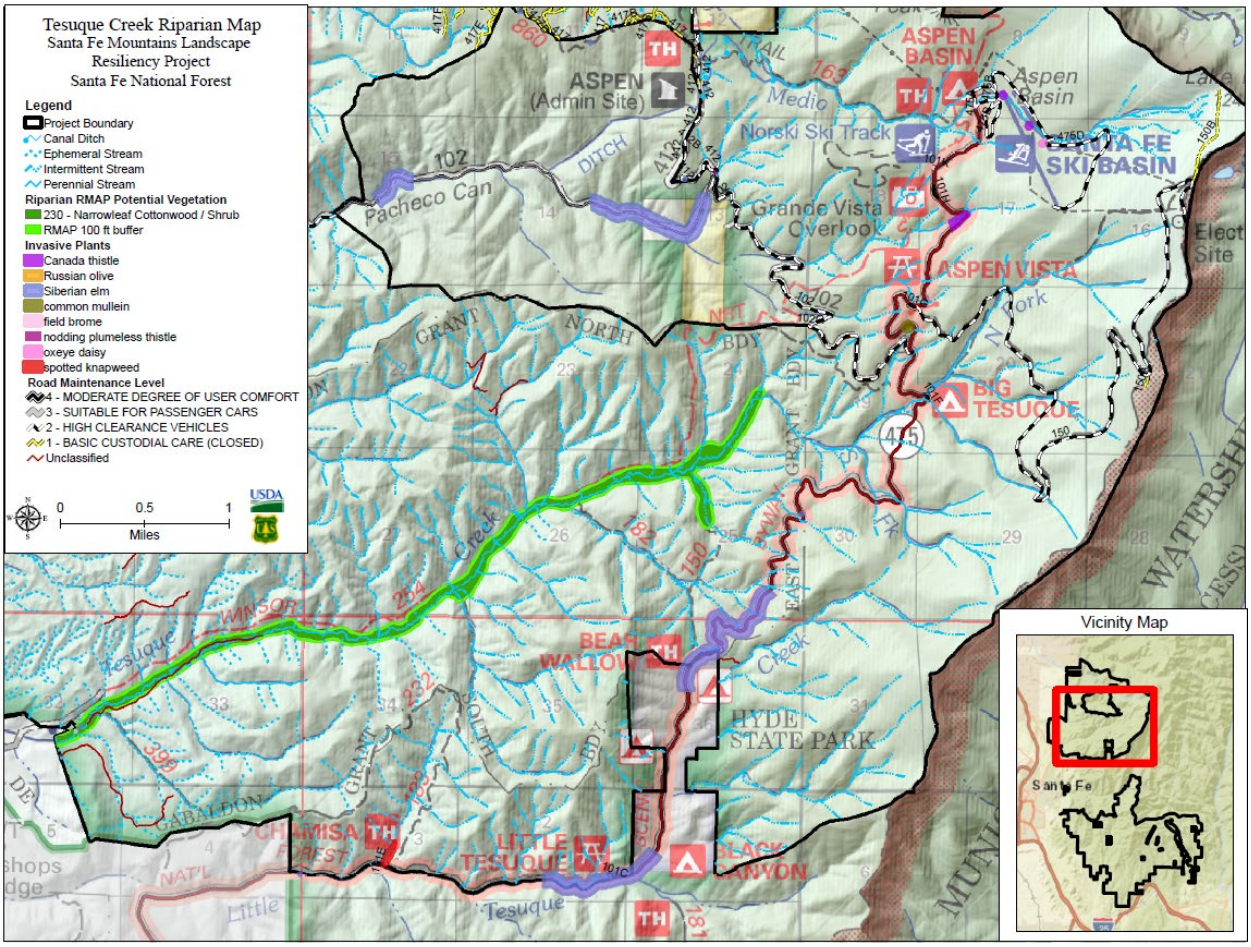
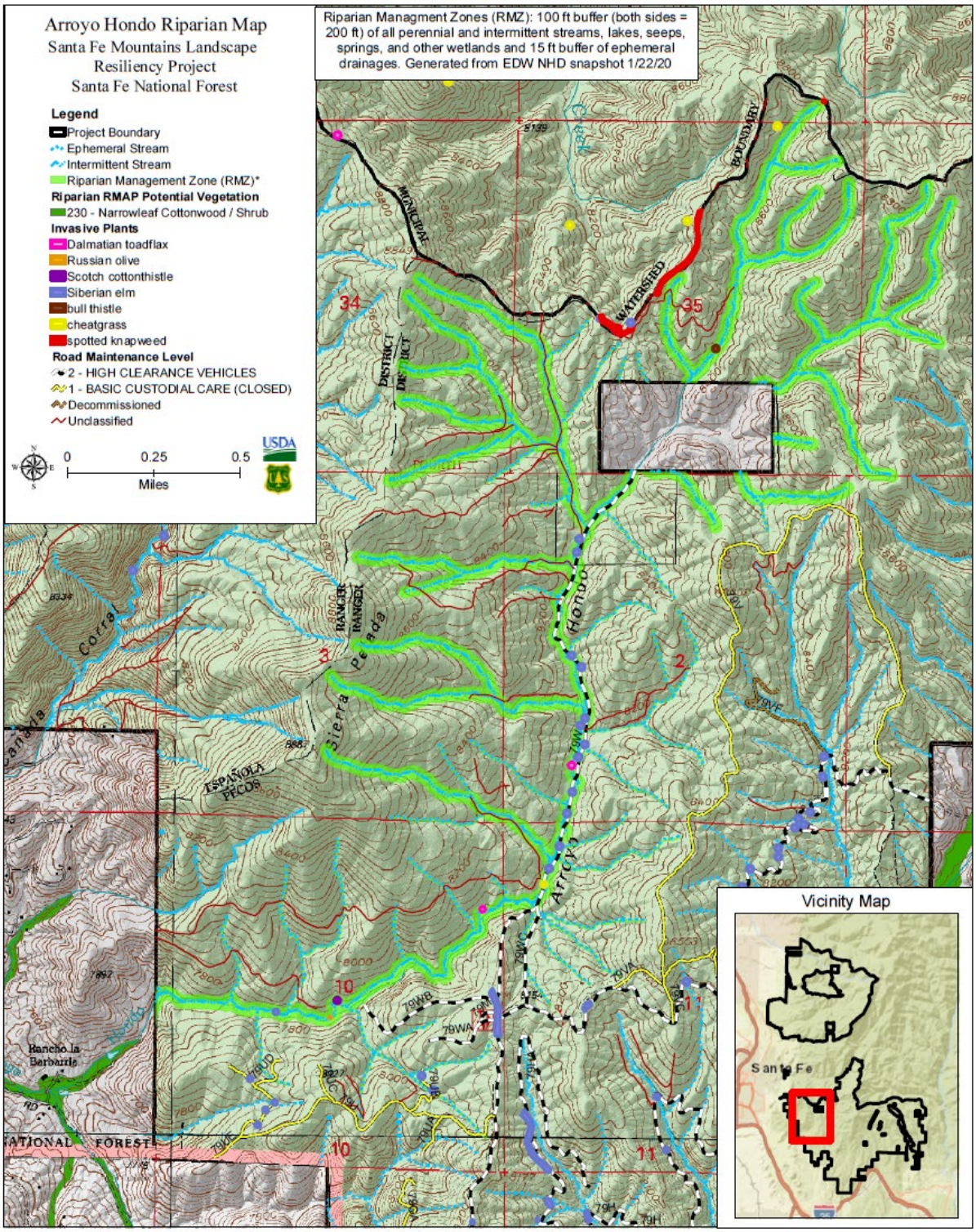


Figure 2. Proposed riparian restoration area along Arroyo Hondo composed mostly of ephemeral (unmapped) ERUs.



Resource Indicators and Metrics

Indicators of ecological integrity allow for analyses of current condition and trends (affected environment) and effects of proposed activities (environmental consequences) in a way that is measurable, understandable, and quantifiable. To assess ecological integrity a minimum set of indicators and metrics (see Table 1) are used that represent the "four pillars" of ecological integrity – structure, composition, process, and connectivity (FSH 1909.12, CHAP. 40, SEC. 43.12). Indicators allow us to analyze baseline ecosystem conditions, identify issues and opportunities, and help determine effects of proposed activities.

Table 1. Resource condition indicators for assessing current condition and project effects

Indicator (and metric)	**Issues** (see above)	**Source** (references for description and desired conditions)
STRUCTURE		
Seral state diversity (percent area of each seral state on the landscape)	Seral state diversity imbalance.	USDA Forest Service 2020b, LANDFIRE 2010, Barrett et al. 2010, O'Brien et al. 2003, TNC 2006, Ullsten et al. 2005
Riparian woody regeneration (percent area on the landscape)	No associated issues.	USDA Forest Service 2020b, LANDFIRE 2010, Muldavin et al. 2011
Coarse woody debris (pieces per mile)	No associated issues.	USDA Forest Service 2020b, USDA Forest 2016, Bragg et al. 2000, Ruediger and Ward 1996, Potts and Anderson 1990, Sedell et al. 1988, Gregory et al. 1991, House and Boehne 1987
COMPOSITION		
Exotic woody species cover (percent area on the landscape)	No associated issues.	USDA Forest Service 2020b, USDA Forest 2016, Joyce and Heitschmidt 2003, Muldavin et al. 2011, Patterson et al. 2013, Smith et al. 2018
Functional group diversity (percent of each functional group on the landscape)	Increased conifer encroachment (evergreen trees).	USDA Forest Service 2020b, USDA Forest 1993, Burton et al. 2011, Hamilton et al. 2003, O'Brien et al. 2003, Pellant et al. 2005, Pyke et al. 2002, USDA Forest Service 1989, USDA Forest Service 1997, WAAEDS 2012, Weixelman et al. 1999, Winward 2000
PROCESS		
Flood regime (flood magnitude and frequency)	Seral state diversity imbalance.	USDA Forest Service 2020b, Glenn et al. 2017, LANDFIRE 2010
Fire regime (fire frequency and severity)	No associated issues; however, encroaching conifers, increasing conifer density and fuel ladder conditions pose a risk to increased fire frequency and severity in riparian areas.	USDA Forest Service 2020b, Glenn et al. 2017, LANDFIRE 2010, Stromberg and Ortiz-Zuazaga 1998, Wright and Bailey 1982, Barrett et al. 2010, DeMeo et al. 2015, Forbis et al. 2007, Friedrichsen et al. 2005, Ganguli et al. 2011, Haufler et al. 1999, Joyce and Heitschmidt 2003, Morgan et al. 1994, Noss 1990

Indicator (and metric)	**Issues** (see above)	**Source** (references for description and desired conditions)
CONNECTIVITY		
Connectivity (percent disruption of riparian corridors)	No associated issues.	USDA Forest Service 2020b, Collins et al. 2008, Faber-Langendoen et al. 2012, Muldavin et al. 2011

Affected Environment

Overview

The Santa Fe Mountains Landscape Resiliency project (SFMLRP) area extends from approximately 7,000 ft above sea level near Tesuque, to 12,300 ft above sea level near Lake Peak. It includes several riparian Ecological Response Units (ERUs; Triepke et al. 2018, Wahlberg et al. 2019) but is comprised mostly of the Narrowleaf Cottonwood/Shrub type (Figure 1) and ephemeral riparian (Figure 2). Together the ephemeral types and the Narrowleaf Cottonwood/Shrub will be the focus of this analysis, particularly where Narrowleaf Cottonwood/Shrub occurs in the Tesuque Creek watershed.

Riparian areas of the project area generally occur within drainage bottoms surrounded by steep hillslopes. They are generally narrow, steep, and confined by bedrock. At lower elevations, the drainages widen and slope gradients decrease, allowing for broader floodplains and increased riparian vegetation. Depending on micro-site habitat and disturbance processes, evergreen species (e.g., blue spruce (*Picea pungens* Engelm.), ponderosa pine (Pinus ponderosa Lawson & C. Lawson), Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), Rocky Mountain juniper (*Juniperus scopulorum* Sarg.)) are naturally present within the riparian area though these species have increased in abundance in the last century at the expense of native obligate riparian species such as narrowleaf cottonwood (*Populus angustifolia* James). The understory may contain willows (*Salix* L.), herb species, and even xeric shrubs.

The Narrowleaf Cottonwood/Shrub ERU is concentrated between 1,900 and 10,000 feet elevation. Plant species in this ERU include narrowleaf cottonwood, thinleaf alder (*Alnus incana* (L.) Moench ssp. *tenuifolia* (Nutt.) Breitung), Rocky Mountain maple (*Acer glabrum* Torr.), various willows and shrub species, and the conifers mentioned above. Characteristic abundance of tree species for conifers ranges 1-30% canopy cover while deciduous tree range from 10-25% depending on the site conditions (USDA 1993).

Condition and Trends

This section describes the current condition and trends for several key ecological indicators (Table 1) in the context of desired conditions for the Santa Fe NF described in the current and revised draft Forest Plans. Analysis results are given with a focus on the Narrowleaf Cottonwood/Shrub, given its relevance in effects, issues, and management opportunities. In addition to the qualitative evaluation below, please refer to Table 2 in the following Environmental Consequences section for a summary of current condition and trends.

Natural disturbances like wildfire and floods maintain riparian ecosystems by contributing sediment, nutrients, and downed wood, dispersing seeds, building floodplains, and scouring fresh surfaces for new plant growth (Fierke and Kauffman 2005, King and Louw 1998, Miller et al. 1995, Standford et al. 2005). Changes in these cycles of natural disturbance in combination with land use can impact ecosystems and favor departure from desired conditions.

Flooding is a natural physical disturbance which is related to climate. Minor floods of 5-10 year frequency barely inundates the floodplain and results in some scour and burial of herbaceous cover and seedlings (LANDFIRE 2006 and 2010, Lolley et al. 2006). Moderate floods of 15-30 year frequency significantly inundate the floodplain and remove vegetation, mainly shrubs and small trees. Severe flooding that occur at intervals of over 50 years results in major scour and deposition on the floodplain, removing mature trees (stand replacing events). Flood frequency of the project area appears to have decreased over the last century or so (USGS 2019). Analysis and field observation suggest that minor and moderate floods have significantly declined within all ERUs while severe floods are slightly less frequent. These conditions may be a result of a continuing drying trend expected with warmer climate (Gutzler 2013, Triepke et al. 2020). Land use (acequias and stream diversions for agriculture) may also limit flooding in some streams within the project area. Drier conditions and decreased flood disturbance has likely promoted increased establishment of conifers on floodplains, particularly for lower elevation riparian areas typically dominated by deciduous trees (Dwire et al. 2016).

Fire is also affected by climate and affected by landform, where fire behavior in riparian ecosystems that occur within narrow steep canyons can bear more on local terrain than on soil moisture and the character of riparian vegetation (Webb et al. 2019). This condition is especially representative of higher elevation streams within the project area. Lower elevation settings in broader valley bottoms likely have fire regimes that differ from those of surrounding hillslopes, with riparian areas having infrequent and patchy high severity fires, consistent with the desired conditions and as with current conditions of the project area. Records for the project area show a current average fire return interval of about 400 years (based on a 50-year Forest record; Eidenshink et al. 2007, USDA Forest Service 2016), with stand-replacing fires occurring infrequently as expected, but with low-moderate severity fires occurring less frequently than they were thought to have historically. The shift in seral state distribution to more late seral conditions may be related to these shifts in fire and flood regime.

Overall seral state diversity is moderately departed from desired conditions with an excess (46-97%) of late seral plant communities and lack of riparian obligate regeneration. The amount of early seral vegetation and regeneration of deciduous woody species is similar to desired conditions; but, recent field reconnaissance suggests that much of this early seral component is decadent and being overtopped by encroaching conifer trees. The abundance of conifers in riparian corridors is uncharacteristically high at the expense of deciduous trees and shrub-herb vegetation. Exotic woody species are undesired within all riparian ERUs and currently included localized populations of Russian olive (*Elaeagnus angustifolia* L.), Siberian elm (*Ulmus pumila* L.), and other invasives. Analysis shows that the overall canopy cover of exotic woody vegetation is less than one percent and within desired conditions to the benefit of native plant communities. Spatial connectivity of riparian corridor habitat is largely intact which is important for dispersal, access to new habitats, perpetuation of genetic diversity as well as nesting and foraging for special status species. Coarse woody debris is somewhat less than the desired conditions, but still within characteristic levels for these ecosystems to provide roles for habitat for riparian and aquatic species.

Only those indicators likely to be affected by the proposed action or related to the issues addressed, namely seral state diversity and functional group diversity (conifer abundance), are considered with the following environmental consequences. Fire regime is also considered: while the current riparian fire regime is within desired conditions, encroaching conifer trees and fuel conditions in the surrounding uplands may put the riparian areas at risk to loss of ecological integrity and delivery of ecosystem services.

Environmental Consequences

What follows is an evaluation of direct and indirect effects for the No Action' and Proposed Action alternatives of the SFMLRP. In addition to the narrative descriptions below, please refer to Table 2 for a summary of likely effects for each of the riparian indicators previously discussed. Departure from desired conditions is measured and categorized as low (<33% departure), moderate (33-66% departure), or high (>66% departure).

No Action Alternative

This section discloses the environmental impacts of not implementing the proposed action, and assumes management continuing under current authorizations.

Direct and Indirect Effects of the No Action Alternative

Likely effects of the no action alternative on riparian vegetation include a continued increase in conifer encroachment (e.g, Figure 3), reflected in further departure from desired conditions for *seral state diversity* and *functional group diversity* indicators (see Table 2). In lieu of other disturbance agents such as flooding, conifers would continue to regenerate and infill available canopy gaps at the expense of other functional plant groups including deciduous trees and shrubs. Overall departure in seral state diversity is likely to increase as well in the coming decades as conifers mature and become more dense to favor an overabundance of late seral conditions. These processes of late succession, conifer encroachment, and homogenization of ecosystem structure and composition would likely be concentrated where evergreen trees already exist and would be facilitated by the drier climate conditions of recent and foreseeable decades on the Santa Fe NF (Triepke et al. 2019). Increased abundance of evergreen trees in riparian areas and the surrounding upland forest would increase the risk of high severity fire in the riparian which, in turn, would predispose these areas to invasive vegetation and woody exotic species.

Figure 3. Encroachment of Rocky Mountain juniper in patches of seedling and sapling trees with riparian zones of Tesuque Creek, February 2020.

Table 2. Summary of current condition and trends for each resource condition in comparison to desired conditions. Departure from desired conditions is measured and categorized as low (<33% departure), moderate (33-66% departure), or high (>66% departure).

Indicator	Departure from desired conditions	Current trend from desired conditions	Outlook for likely effects of proposed action
Seral state diversity	Moderate to high, due to conifer encroachment and uncharacteristically high levels of late seral conditions.	Away	Beneficial effect. Project could reduce conifer encroachment and proportion of late seral conditions.
Riparian woody regeneration	Moderate, current levels of regeneration are somewhat elevated.	Away	No effect. Project would not affect the level of riparian woody regeneration appreciably. Efforts to regenerate woody vegetation as replacement for conifers would be minor/localized.
Coarse woody debris	Low, current levels of coarse woody debris are similar to desired conditions.	Stable	Beneficial effect. Project could increase the level of coarse woody debris closer to desired conditions.
Exotic woody species cover	Low, current levels of woody invasive vegetation is low and localized.	Away	No effect. Project is not likely to decrease the current amount of exotic woody species.
Functional group diversity	Overall departure is low, but the abundance of the 'evergreen tree' group is substantially elevated.	Away	Beneficial effect. Project could reduce the levels of evergreen trees (conifers), increasing the abundance of deciduous trees.
Flood regime	High, due to reduced flood frequency.	Stable	No effect. Flood regime will not be affected.
Fire regime	Low, current fire regime is similar to desired conditions; however, encroaching conifers, increasing conifer density and fuel ladder conditions pose a risk to increased fire frequency and severity in riparian areas.	Stable	Beneficial effect. Project would address fuel conditions in the surrounding uplands to reduce the risk of high severity fire and departure from desired conditions.
Riparian corridor connectivity	Low, current levels of riparian corridor fragmentation is low.	Stable	No effect. Project is not likely to affect current levels of riparian corridor connectivity.

Proposed Action

This section discloses the environmental impacts to riparian vegetation of the proposed action described section 2.2.2.

Direct and Indirect Effects of the Proposed Action

Likely effects of the proposed action alternative on riparian vegetation include decreased abundance of evergreen trees and positive trends for the seral state and functional group diversity indicators (Table 2). The proposed action includes riparian restoration activities of thinning and removal of conifer trees from riparian areas and other measures (see following Design Features) on up to approximately 870 acres, to allow riparian vegetation to thrive and expand. The proposed action would help reverse or slow trends in

the departure of seral state diversity from desired conditions, favoring increased woody regeneration and more early- and mid-seral deciduous vegetation (e.g., Figure 4). Native species such as willow, cottonwood, alder, grasses and forbs would be planted or coppiced (cut to promote regrowth) if natural regeneration is determined to be insufficient following conifer and non-native species removal (see design features, Appendix A). Fencing may be installed if needed to protect restored areas if it is determined that riparian vegetation regeneration is being hampered by ungulate browsing and grazing in project areas of Tesuque Creek and Arroyo Hondo (figures 1 and 2). The ecological processes associated with new plant succession, added growth of deciduous trees and shrubs, and diversifying structure conditions would be concentrated where evergreen trees are targeted for thinning coincident with measures to plant or stimulate growth of deciduous plant functional groups. Overall effects of the proposed action would be to favor desired conditions for improved seral and functional group diversity.

Figure 4. An example of early-mid seral structure and riparian deciduous obligate trees and shrubs, an objective for conifer-dominated sites that are treated with the proposed action (Tesuque Creek, February 2020).

With the decrease in conifer abundance by this alternative in both riparian areas and surrounding forest, there would be decreased risk of catastrophic fire because of treatments aimed at reducing the continuity of evergreen trees and favoring the maintenance of desired conditions for infrequent and patchy fires in the riparian. Low intensity prescribed fire would be targeted in riparian areas to promote the growth of riparian obligate vegetation. Some backing fire could creep into riparian areas and kill or top-kill obligate vegetation; however, these effects are expected to be localized and may occasionally be beneficial as fire

can stimulate the regeneration of woody species. With design features of this project (see Appendix A), fire line would not be installed parallel to stream channels or drainage bottoms. Fire lines that must intersect stream bottoms would be installed to perpendicular to the stream in a manner that minimizes the stream and riparian area affected and that would prevent the fire line from becoming a channel. To limit erosion and retain the long-term productivity of riparian areas, burning would be implemented when the duff layer (decomposed organic matter in contact with the soil surface) is moist enough so ensure a cool burn. Collectively, design features and reduced fire risk by the proposed alternative would help to ensure desired conditions for fire regime are maintained.

Any non-native woody vegetation encountered such as Siberian elm, Russian olive, and salt cedar (*Tamarix* L.) would be cut and removed. Design features of this project (Appendix A) include measures to limit the spread of invasive vegetation, including the exclusion of equipment staging, fueling, and repair or maintenance activities from riparian and buffer areas – i.e., riparian management zones (RMZs). Vehicles and heavy equipment would be operated within RMZs only when absolutely necessary, and then only on designated routes and crossings. An incidental benefit of conifer removal would increase the abundance of coarse woody debris habitat, as larger tree boles that are cut would be left in and near the active floodplain. Road closure planned with this alternative could help maintain desired conditions for riparian corridor connectivity, and may reduce the likelihood of vehicle traffic spreading invasive and exotic vegetation to riparian areas.

Effects from Proposed Forest Plan Amendments

Forest Plan amendments would provide specific guidelines regarding how vegetation would be manipulated within Mexican spotted owl (MSO) and goshawk habitats (see Draft EA, Chapter 2). Proposed Forest Plan amendments comprise four types: (1) amendments that allow vegetation treatment related to MSO protected activity centers; (2) amendments that adopt aspects of the new proposed MSO recovery plan; (3) amendments that clarify activity restrictions during MSO breeding seasons; and (4) amendments that clarify the need for interspaces for Goshawk habitat. Decreased abundance of evergreen trees, positive trends for the seral state and functional group diversity indicators, and a decreased risk of catastrophic fire are possible outcomes with or without the Plan amendments. Therefore, these Amendments are not expected to result in significantly different effects to riparian vegetation than those likely by the proposed actions themselves.

Cumulative Effects of the Proposed Action

Cumulative effects are defined as the impact on the environment which results from the incremental impact of the proposed action when added to the impacts of other past, present, or reasonably foreseeable future actions. Cumulative effects of the proposed action overlap the effects of the other past, present, or reasonably foreseeable future actions in both time and space (FSH 1909.15, chapter 10, section 15.2). Table 3 outlines the actions considered in the cumulative effects analysis for this project.

When considering cumulative effects, short-term effects are those which occur and disappear within approximately five years, with long-term effects persisting beyond five years. Cumulative effects analysis considers activities which have occurred within approximately the past 15 years and foreseeable 15 years. Past activities include reported acres in the SMLRP project area of implemented land management actions including:

- Broadcast burning
- Pile burning
- Invasive species treatments
- Pre-commercial thinning

- Free thinning for fuels reduction

Ongoing activities include:

- The Pacheco and Hyde thinning and prescribed fire projects (to date, the projects have cumulatively implemented 47% of the 4,040 acres proposed)
- Grazing allotments (affects some riparian vegetation)
- Existing roads and trails

Potential adverse effects of past and ongoing activities include the potential spread of invasive/exotic plant species. Also, grazing by domestic or wild ungulates can limit the regeneration of deciduous vegetation, diminish soil productivity, and impact riparian habitat quality. Concentrated recreation can have similar effects. Potential beneficial effects of thinning and prescribed burning include reduced risk of high severity fire in riparian and neighboring areas of upland forest.

Past disturbance includes several wildfires:

- Soldier Fire- 2009
- Pacheco Fire- 2011
- Pequeño Fire- 2011
- Tres Lagunas Fire- 2013
- McClure Fire- 2016

Potential adverse effects of these disturbance events include localized mortality of riparian obligate vegetation along with the potential for spread of invasive/exotic plant species. Potential beneficial effects of these activities include reduced risk to high severity fire in forests that neighbor riparian areas.

Reasonably foreseeable actions include the Northern New Mexico Riparian, Aquatic, and Wetland Restoration Project (NNMRAW) which includes a suite of proposed restoration activities (e.g., riparian planting, beaver habitat restoration) aimed at improving aquatic and riparian habitats as well as upland treatments (e.g., road decommissioning) which should reduce road related sediment sources.

At the scale of the SMLRP project area, the NNMRAW project is expected to have comparable adverse and beneficial effects as the SMLRP given the similarities in purpose and need regarding the restoration of riparian ecosystems. However, NNMRAW is likely to have added beneficial effects to riparian ecosystems as a result of efforts to decrease upland sediment sources, stabilize stream channels and restore hydrologic connectivity between stream channel and riparian areas.

Proposed decommissioning roads or mitigating impacts (e.g., maintenance, improvements, reroutes) by the NNMRAW project would likely have beneficial effects on riparian areas by improving habitat quality and connectivity, and by reducing vectors for the spread of invasive and exotic vegetation. Nevertheless, with trends in vegetation management, recreation, and other vectors, there is always some likelihood of the spread of invasive vegetation despite policy and design features (Appendix A) to limit spread, short of deliberate efforts to completely eradicate unwanted plant species.

The most apparent cumulative effects on riparian vegetation include the overall reduction in the risk of catastrophic fire by the proposed action, in combination with activities anticipated in neighboring fire-adapted forests, including fuels treatments and forest restoration that are likely to occur in the current and future planning cycles. These management trends are likely to continue as long as needed resources are available.

The draft revised Santa Fe NF Forest Plan includes an objective to implement 15 miles of improvements to riparian areas and ecosystems every 10 years. Actions that could improve riparian areas would be site–

specific, but could include several of the following: removing invasive plant species, stabilizing the stream channel, restoring hydrologic connectivity between stream channel and riparian area, planting native species, promoting natural revegetation of bare ground, redirecting other uses (e.g., providing other watering sources, closing areas to camping).

Table 3: Actions that May Have Cumulative Impacts to Resources within the Study Area

Action	Summary of Action
Pacheco Canyon Forest Resilience Project	The scope of the project is to thin and use prescribe fire on approximately 2,042 acres northeast of the City of Santa Fe, near several popular recreation sites, including the Big Tesuque Campground, Aspen Vista Picnic Area, and the Santa Fe Ski Basin. Tesuque Pueblo lands are within and northeast of the project area. The purpose of the project is to change stand conditions in predominantly ponderosa pine forests in the Pacheco Canyon area. The actions proposed to accomplish this change would be thinning and burning about 2,042 acres. Decision signed on June 1, 2018.
La Cueva Fuelbreak Project	The purpose of the project is to change fire behavior in treated areas to reduce the risk of a large-scale, high intensity wildfire spreading to or from the communities of La Cueva, Dalton Canyon, and the Santa Fe Watershed. This project proposes creation of a shaded fuelbreak by thinning 995 acres and conducting prescribed burns (pile and broadcast burning) on approximately 1,100 acres. Decision signed on February 4, 2005
County Line Fuel Wood Treatments	The purpose of the project is to improve forest health and wildlife habitat through a combination of thinning and prescribed burning across approximately 900 acres on Borrego Mesa. Decision signed on August 6, 2010
Southern Rowe Mesa Restoration Project	The purpose of this project is to promote a mosaic of healthy forest stands and natural grasslands through thinning and prescribed burning activities on approximately 17,500 acres on Rowe Mesa. Decision signed on February 21, 2013.
Hyde Park Wildland Urban Interface Project	The scope of the project is to thin and use prescribe fire on up to 1,840 acres. The project area is dominated by dense stands of ponderosa pine forests with a lesser component of mixed conifer and pinon-juniper. The project area is located in forests east of the community of Hyde Park Estates, near Hyde Memorial State Park, and adjacent to Black Canyon campground. The purpose of this project is to reduce the risk of uncharacteristic, stand-replacing wildfire and reduce the risk for insect and disease related tree mortality within the project area. Decision signed on March 21, 2018.

Action	Summary of Action
Santa Fe Municipal Watershed	The scope of the project is to use a combination of tree thinning and prescribed burning on up to 7,270 acres of national forest and city lands in the Santa Fe Municipal Watershed. The proposal is designed to reduce the risk of a severe crown fire and to restore sustainable forest and watershed conditions in the Watershed. Record of Decision signed in October 2001.
Santa Fe Municipal Watershed Pecos Wilderness Prescribed Burn Project	The project proposes to perform prescribed burns of between 200 and 2,100 acres at one time in ponderosa pine and mixed conifer stands within an approximately 2,900-acre, mid elevation (8,500 – 10,000 ft) treatment area within the Pecos Wilderness. Decision signed on April 28, 2015.
Rowe Mesa II (U.S. Forest Service n.d.)	Fuel treatment to promote a mosaic of healthy forests stands and natural grasslands by thinning and prescribed burning in pinon/juniper, and ponderosa pine trees that have encroached into the understory of woodlands and into meadows of Rowe Mesa. Project initiation 12/19/2018; expected implementation 4/2020.
Century Link/PNM Santa Fe to Los Alamos Fiber Optic Project (U.S. Forest Service n.d.)	Proposal to bury a fiber optic line along Forest Road 24 on Santa Fe National Forest land to a PNM transmission line where it will be carried to DOE facilities to improve service to Los Alamos National Lab and Los Alamos community. Notice of initiation 10/1/2018.
Issuance of Forest-wide Temporary and Priority Special Use Permits (SUPs) for Non-Motorized Over-Snow Activities (U.S. Forest Service n.d.)	Proposal to approve issuance of temporary and priority SUPs for outfitter and guides throughout the Santa Fe National Forest to conduct guided recreation activities related to over-snow uses, including but not limited to cross country skiing and snow shoeing. Notice of initiation 12/1/2019.
Rio Chama Aquatic and Wetland Habitat Restoration Project (U.S. Forest Service n.d.)	Species habitat improvement project to increase diversity and quality of aquatic habitat for fish and invertebrates in Rio Chama downstream from Abiquiu Dam approximately 5.6 miles between Santa Fe and Carson National Forests to point 1.34 miles upstream of Highway 84 bridge. Notice of initiation 10/1/2019; expected implementation 4/2020.
Comexico Jones Hill Exploration (U.S. Forest Service n.d.)	Exploratory drilling operation on unpatented mining claims in Pecos/Las Vegas Ranger District of SFNF. Proposal will cause approximately 5-7 acres of surface disturbance in an area that has been previously disturbed by earlier exploration date. All activities will occur within 1 year of the state date. Scoping was conducted in December 2019; expected implementation 10/2020.
Pecos Bike Trails (U.S. Forest Service n.d.)	Project to develop trail system and impress access and promote visitor safety in Canada de Los Alamos/Glorieta area. Notice of initiation 11/1/2019; expected implementation 2/2020.
Pecos Rio Grande Cutthroat (RGCT) Trout Restoration (U.S. Forest Service n.d.)	Project to restore RGCT populations to Willow Creek and upper Cow Creek by adding 9 miles of stream to currently occupied distribution. Scoping occurred February 2019.

Action	Summary of Action
Non-Forest Service Projects	
Aztec Springs, Phase 2 & 3 (City of Santa Fe, The Nature Conservancy, New Mexico State Forestry)	150 acres of thinning, piling, and prescribed burning activities.
Aspen Ranch (Pueblo of Tesuque)	160 acres of thinning, piling, and prescribed burning activities in ponderosa pine and mixed conifer.
Vigil Grant (Pueblo of Tesuque)	158 acres of thinning, piling, and prescribed burning activities in ponderosa pine and mixed conifer.
Hyde Memorial State Park (New Mexico State Forestry)	Thinning, piling, and prescribed burning across 276 acres in Hyde Memorial State Park.
City of Santa Fe Planned Communities and Infrastructure Projects	Three master planned communities that is projected to absorb most of Santa Fe's growth through 2030 • Tierra Contenta Master Plan (1995) approved as many as 5,200 housing units and to date is 50% completed with up to 2,500 homes and apartment units completed. The western portion of Phase 2 and Phase 3 await construction and includes 400 acres of developable land and 100 acres of open space/parks. • Las Soleras Master Plan (2008) covers 400 acres with most of the land along I-25 slated for commercial and mixed use. Internal portion of master plan are reserved for residential units which could be developed with 1,000-1,500 housing units. • Northwest Quadrant (2010) covers approximately 160 acres of 2,000 acres the city owns in the northwest corner of the city. The Master Plan calls for 750 housing units to the southeast of Highway NM 599. Roadway improvements, trails and urban mixed use and parks (Southwest Activity Node, Las Soleras Park, and South Meadows Park) (City of Santa Fe 2017). Multiple drainage projects are proposed by City of Santa Fe in Council Districts 1, 2, 3, and 4 to be completed in three phases between 2019 and 2022 (City of Santa Fe n.d.).
Santa Fe River Greenway R&PP Lease Project	EA (released 11/21/19) for the conveyance of 23.5 acres of BLM-administered public lands to Santa Fe County under the Recreation and Public Purpose Act (R&PP) for the construction and maintenance of a short segment of the greenway and for bank stabilization of the Santa Fe River. The proposed project will create a greenway of public parks and multi-use recreational trails along the Santa Fe River from Two-mile Reservoir in eastern Santa Fe west to the Santa Fe County wastewater treatment plant, which is located just west of New Mexico Highway 599 (BLM 2019a).

Consistency with Relevant Laws, Regulations, and Policy

The SFMLR Project will comply with relevant law, regulation, and policy by:

- Implementing Forest Plan guidance;
- Consulting the Forest Service Manuals and Handbooks for implementation guidance;
- Observing federal laws and regulation;
- Observing state and local laws, regulation, and policy.

A review of the following applicable and relevant laws, regulations and policies has been conducted to ensure the proposed action compliance.

Forest Plan Guidance

The Santa Fe NF Forest Plan (LRMP) (1987, as amended 1992, 1997 and 2010) provides standards and guidelines for watershed resources (soil, water quality, and flow regime) within the project area. Table 4 displays the applicable LRMP management areas, standards and guidelines, SFMLR project activities and compliance. The SFMLR Project is consistent with the Santa Fe National Forest LRMP (as amended).

The *draft* Forest Plan's desired conditions, objectives, and guidelines focus on restoring and maintaining vegetation structure and composition within the desired conditions to ensure these areas continue to provide ecosystem services (e.g., water storage, cooling and filtration, wildlife habitat). Proposed activities aim to move the project area closer to desired conditions and reduce the risk of catastrophic fire. Site specific field verification will be used to identify the proper locations and prescriptions for vegetation improvement including thinning conifers and promoting the growth of riparian obligate vegetation including herbaceous species and deciduous woody trees and shrubs. Prescriptions will be consistent with desired conditions identified for the Santa Fe NF and consistent with the site potential described by the Santa Fe TEUI (USDA Forest Service 1993).

Table 4. SFMLR project compliance with the 1987 Santa Fe NF LRMP

Management Area	Watershed Related Standard/Guideline	Project Activity Affected	Compliance and Rationale
Forest Wide	Log landings will be located outside of sensitive land areas, including riparian areas, wetlands, and natural meadows	(Possibly) gathering logs for public firewood distribution	See design features (Appendix A).
Forest Wide	Manage to perpetuate or maintain aspen stands along stream course reaches with less than a 6% gradient	See riparian section within the EA	See design features (Appendix A).

Management Area	Watershed Related Standard/Guideline	Project Activity Affected	Compliance and Rationale
Forest Wide	Riparian areas should be managed to meet the following guidelines- • Ground cover should be 80% of natural • Shade should be 80% of natural per 2 mile reach • Bank Cover should be 80% of natural, especially woody shrubs • Streambank sedimentation should exceed natural by less than 20% • Plant composition- 60% of the riparian area should have >3 woody riparian species • Plant Structure- should include 3 age classes (with at least 10% seedling and 10% mature/over-mature) • Crown Cover- should be 80% of natural levels within a 2 mile reach	Proposed Action includes: • Hand thinning in the riparian management zone (RMZ) • Limited pile burning in the RMZ • Limited broadcast burning in the RMZ • Planting in the RMZ • Invasive species removal in the RMZ • Protection by fencing (from graze and browse) of the RMZ	See BMPs and numerous design features (Appendix A) aimed at protecting and enhancing the RMZ.

Federal Law and Regulation

Water Resources Planning Act of July 22, 1965

Encourages the conservation, development, and utilization of water and related land resources of the United States on a comprehensive and coordinated basis by the Federal government, states, localities, and private enterprises.

Watershed Protection and Flood Prevention Act of August 4, 1954

Establishes policy that the Federal government should cooperate with states and their political subdivisions, soil or water conservation districts, flood prevention or control districts, and other local public agencies for the purposes of preventing erosion, floodwater, and sediment damages in the watersheds of the rivers and streams of the United States; furthering the conservation, development, utilization, and disposal of water, and the conservation and utilization of land; and thereby preserving, protecting, and improving the Nation's land and water resources and the quality of the environment.

Executive Order 11988 (Floodplain Management (42 CFR 26951, May 25, 1977)

The purpose of this Order is "…to avoid to the extent possible the long and short term impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative." Section 1 states: "Each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for (1) acquiring, managing, and disposing of Federal lands, and facilities; (2) Providing federally undertaken, financed, or assisted construction and improvements; and (3) Conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities."

Executive Order 11990 (Protection of Wetlands)

This Executive Order was written "…in order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands… Section 1. (a) Each agency shall provide leadership and shall take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for… (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities. Sec. 5: In carrying out the activities described in Section I of this Order, each agency shall consider factors relevant to a proposal's effect on the survival and quality of the wetlands. Among these factors are: (b) maintenance of natural systems, including conservation and long-term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources; and (c) other uses of wetlands in the public interest, including recreational, scientific, and cultural uses."

US Forest Service Directives

Forest Service Manuals and Handbooks codify the agency's policy, practice, and procedure. The system serves as the primary basis for the internal management and control of all programs and the primary source of administrative direction to Forest Service employees. The Forest Service Manual (FSM) contains legal authorities, objectives, policies, responsibilities, instructions, and guidance needed on a continuing basis by Forest Service line officers and primary staff in more than one unit to plan and execute assigned programs and activities. Forest Service Handbooks (FSH) are the principal source of specialized guidance and instruction for carrying out the direction issued in the FSM. Specialists and

technicians are the primary audience of Handbook direction. Handbooks may also incorporate external directives with related USDA and Forest Service directive supplements.

Forest Service Manuals

- FSM 2500 – WATERSHED AND AIR MANAGEMENT
    - Region 3 (Southwestern Region): Regional Issuances
- Forest Service Manual 2510 - WATERSHED PLANNING
- Forest Service Manual 2520 - WATERSHED PROTECTION AND MANAGEMENT
- Forest Service Manual 2530 - WATER RESOURCE MANAGEMENT
- Forest Service Manual 2540 - WATER USES AND DEVELOPMENT

Forest Service Handbooks

- Forest Service Handbook 2500 – Watershed and Air Management
    - Region 3 (Southwestern Region): Regional Issuances
- 2509.16 - Water Resource Inventory Handbook
- 2509.21- National Forest System Water Rights Handbook
- 2509.22- Soil and Water Conservation Handbook
- 2509.23- Riparian Area Handbook
- 2509.24- National Forest System Watershed Codes Handbook
- 2509.25- Watershed Conservation Practices Handbook

Other Relevant Law, Regulation, or Policy

The SFMLR Project will comply with relevant law, regulation, and policy by:

- Coordinating with the City of Santa Fe municipal water utility in planning activities within the municipal watershed and monitoring for potential impacts after implementation.
- Protecting and/or improving floodplains and wetlands through riparian treatment, mitigation and avoidance.

Conclusion

The no action alternative would favor current condition and trends and continued departure from desired conditions for some indicators (Table 2) including seral state diversity, riparian woody regeneration, and exotic woody species cover. Also, conifer tree encroachment and changing fuels conditions of surrounding forests are likely to pose increased risk of catastrophic fire in riparian areas. The no action alternative is not likely to affect the other indicators positively or negatively, including coarse woody debris, flood regime, or riparian corridor connectivity.

With the no action alternative, the third issue regarding the effects backing fire from the proposed action no longer applies. However, without significant restoration in riparian, trends towards an overabundance of late seral conditions and reduced abundance of woody obligate regeneration are likely to continue. The encroachment of conifer trees and drier conditions in riparian corridors are primary forces driving departure from desired conditions for functional group and seral state diversity (Table 2). Seral conditions could change quickly and substantially with a given fire event. Without treatment to fuels and forest structure in surrounding uplands there is an elevated risk of large, high intensity wildfire, departure from desired conditions for fire regime in riparian (currently in low departure), and loss of ecosystem services associated with riparian areas.

The proposed action would address two main issues identified for riparian vegetation of conifer encroachment and an imbalance of seral conditions and overabundance of late seral vegetation. The

proposed action directly responds to these issues through conifer removal and regeneration of the preferred obligate deciduous trees and shrubs through coppicing (cutting) and planting of preferred species, promoting desired conditions for seral and functional group diversity. This alternative also includes fuels treatments for surrounding upland forest to reduce the overall risk of catastrophic fire. Prescribed burning and backing fires associated with these treatments likely means at least a temporary loss of some riparian woody vegetation. Incidental benefits of the proposed action would likely include the removal of exotic woody species encountered during project activities and increased coarse woody debris as a byproduct of removing conifer trees from riparian areas.

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Appendix A: Design Features

The design features below refer to activities within the "Riparian Management Zone" (RMZ), a land area defined by either a site-appropriate delineation of the riparian area (e.g., one site potential tree height) or a buffer of 100 feet from each bank of all perennial and intermittent streams, lakes, seeps, springs, and wetlands, or 15 feet from each edge on an ephemeral channel. The exact width of RMZs may vary based on ecological or geomorphic factors or by waterbody type but includes those areas that provide riparian and aquatic ecosystem functions and connectivity. Any intervening water bodies are considered part of the RMZ.

Perennial streams are those that flow year round, while intermittent streams flow for an extended duration for some part of the year or flow all year but are sub-surface for some portions of the channel, and ephemeral streams flow only for short duration following large storm events or extended periods of continued precipitation.

Hydrology and Riparian Resources

Best Management Practices

Purpose: Communicate project and policy requirements to all parties involved in implementing management activities.

Water-1. Activities in drainage bottoms (i.e., near stream channels and within swales) would be coordinated with wildlife, fisheries, and watershed personnel.

Purpose: To maintain water quality

Water-2. To prevent introducing chemical pollutants to waterbodies and soils, all equipment would be washed, clean and free of leaks prior to entering the project area. Regularly inspect equipment for leaks during use.

Water-3. Spill containment materials (e.g. impermeable containment berms, absorbent pads, etc.) would be required on site to ensure that spilled fuel would not leave the staging and fueling areas.

Water-4. Fueling and equipment staging/maintenance areas would be located outside of Riparian Management Zones (RMZ) and would only be the minimum size needed for their function. Existing landings and non-system routes within RMZs may be used (given aquatic, biologic, or watershed specialist coordination) if water quality concerns can be abated through prevention measures.

Design Features

Purpose: To minimize noxious weed spread and re-establish native vegetation.

Water-5. Where livestock have access to seeps and springs, trees would be felled directionally around the RMZ of these features to protect them from livestock access.

Water-6. For riparian planting activities:

- Where possible, source plants from local, native stock.

- Plant appropriate riparian species for the ERU.
- Monitor plantings shortly after implementation; where necessary, fence plantings from herbivory (especially within active range allotments).
- Do not plant in periods of drought, during or prior to dry seasons.

Mitigation Measures

Purpose: To minimize erosion, promote soil productivity, and to maintain water quality.

Water-7. The RMZ is largely an equipment exclusion area. Vehicles, including heavy equipment (such as dozers, masticators), plows and ATV/UTVs, would be only minimally operated within RMZs when absolutely necessary. If vehicles must enter the RMZ, they would not be driven within a stream channel but would stick to designated routes and crossings as described in Water-6. Operation plans would be coordinated with watershed personnel.

Water-8. Motor vehicles (including ATV/UTVs and heavy equipment) would only cross stream channels at designated crossing areas; perennial stream crossings would be designated in consultation with a watershed or aquatic habitat specialist. Where routes cross ephemeral or intermittent channels, crossing would be done when channels are dry. Stream channels would not be crossed where equipment would cause bank breakdown. Woody debris or rock may be placed into crossings to reduce soil disturbance and compaction. Upon completion of use, the crossing would be rehabilitated to maintain a stable channel.

Water-9. New and existing landings, campsites, helipads, and drop points, would be located outside of RMZs and would only be the minimum size needed for their function.

Water-10. New and existing landings, campsites, helipads, drop points, fueling and equipment staging/maintenance areas would be evaluated post-treatment (and decommissioned when no longer needed) to facilitate soil recovery and prevent erosion.

Water-11. Water-bars would be installed with the maximum spacing dependent on slope gradient (see Table below), have an open outlet, constructed lead-off, berm tied into the cut-bank, a 2-4% outslope, and a skew of 30-45 degrees (from perpendicular to the travel route), with a height (crown to trough) of 12-18 inches.

Waterbar Construction Guidelines

Gradient	Spacing
< 5 %	200 ft.
5-10 %	150 ft.
10-20 %	100 ft.
21-40 %	50 ft.
> 40%	25 ft.

Prescribed Fire and Slash Pile Burning in Riparian Areas

Best Management Practices

Purpose: To minimize soil erosion, maintain soil productivity and maintain water quality.

Rx-1. If water drafting sites are needed for the project, they would meet BMPs prior to use, during use and after final use for this project's completion.

Rx-2. Water drafting sites would only be used after coordination with a Biologist. Drafting sites would not be used where they contain whirling disease or Chytrid fungus. To avoid the inadvertent spread of these organisms, water drafting equipment would be decontaminated before use in the project area, between different water sources, and after implementation is complete. Refer to guidance found in Preventing Spread of Aquatic Invasive Organisms Common to the Southwest Region Technical Guidelines for Fire Operations, Interagency Guidance Rev. August 2009 or more recent, and the Guide to Preventing Aquatic Invasive Species Transport by Wildland Fire Operations (https://www.nwcg.gov/publications/444).

Rx-3. Screens would be used to prevent organism entrapment during water drafting.

Rx-4. Drafting would not completely dewater any water feature; enough water would remain for aquatic and wildlife species.

Design Features

Purpose: To minimize soil erosion, maintain soil productivity and maintain water quality.

Rx-5. To reduce fuel loads around stream channels and water bodies but maintain vegetation and duff, low-intensity prescribed fire may occur within the RMZ. Fire ignition however would not take place within the RMZ. Fire would be allowed to back down in the RMZ.

Rx-6. Pre-treat (hand thin vegetation) within the RMZ as needed to avoid moderate and high intensity fire within the RMZ.

Rx-7. Wherever possible, slash piles would be built outside of the RMZ, drainage bottoms, and swales (valley bottoms). If slash piles mush be constructed in these areas, consult a watershed specialist for best placement. If slash must remain in these areas, scattering slash is preferred to piling. If piling must occur within these areas, the following would apply:

a) Piles would be stacked as far from the channel and riparian vegetation as possible; where no riparian vegetation exists, piles would be stacked as far away from the channel as possible (at least 25 feet from the channel and outside the high-water zone).
b) Piles would be built small (<100 sq. ft. each) in order to minimize fire residence time and subsequent soil impacts.
c) Not all piles would be burned; maintain some unburned piles. within stream channels.
d) Piles would be burned when soil moistures are high, or when snow is on the ground.
e) If slash must be piled in windrows, rows would be along the contour and would not be in drainage bottoms.

f) Burn pile composition should contain a mixture of fuel sizes. Large woody fuels, over 8.9 inches in diameter, should be limited to less than 40 percent of the composition of the pile to prevent adverse impacts to the soil.

Mitigation Measures

Purpose: To minimize soil erosion, maintain soil productivity and maintain water quality.

Rx-8. Follow the implementation strategy for avoiding adverse cumulative watershed effects by the proposed action, as described in Appendix A.

Rx-9. Water sources would not be contaminated with foaming agents.

Rx-10. Fireline would not be installed parallel to stream channels, and would intersect stream channels as perpendicular as possible; fireline width would be minimal, only as large as needed.

Riparian Thinning Activities

Best Management Practices

Purpose: To maintain water quality and minimize soil erosion.

Thin-1. Operators of masticators and other heavy equipment should strive to disturb the soil as little as possible; wherever possible, machines should not execute abrupt pivot turns, but instead make as broad of an arc as the terrain will allow. Machines should not cause ruts more than 4'' deep. Masticators would use low psi tracks/tires.

Design Features

Purpose: To maintain and re-establish native vegetation.

Thin-2. Outside active floodplains but within buffered riparian corridors: 1) where deciduous trees exist, remove all conifers <12"; 2) where deciduous trees do not exist remove all conifers <5"; 3) where willows and openings exist, cut, treat, and plant willows. Cut alder to stimulate growth. Pile and burn slash or lop and scatter.

Thin-3. Other riparian species (willows, cottonwood, aspen, etc.) would not be cut or removed unless for transplanting, with the exception of some, but not all, aspen could be cut to promote regeneration in areas where health and vigor are insufficient.

Purpose: To maintain streambank stability and water quality

Thin-4. To maintain natural bank protection and shade, large downed wood in stream channels would remain in place and bank stability trees (large trees >12 in dbh with roots in the bank and/or branches directly over the bank) would be left.

Thin-5. Maintain stream shade within the RMZ; consult a watershed specialist if thinning activities may substantially reduce stream shade. Where necessary or desired, plant site appropriate riparian species.

Thin-6. Galisteo Creek is not meeting state water quality standards for temperature and has an associated TMDL which recommends increasing the percentage total shade from 8 to 81. Consult a watershed specialist when developing thinning prescriptions which may affect shade over this stream. Promote stream shade.

Mitigation Measures

Purpose: To maintain water quality and minimize soil erosion.

Thin-7. So as to prevent disturbance by motor vehicles, do not promote fuelwood gathering by the public within the RMZ.

Thin-8. Machine piling of activity-generated slash would be conducted in a manner that minimizes the amount of soil displaced into burn piles. Duff and litter layers would be left as intact as possible.

Thin-9. Where it would not cause fuel loading or Ips beetle concerns, use slash to help infiltrate runoff, prevent erosion, and treat eroded areas.

Thin-10. Wherever possible, fell hillslope trees on contour; leave large sections of the boles (1000-hour fuels) in contact with the soil for the purpose of slowing overland flow as well as catching eroded soil, seeds, and nutrients. These logs should serve to quickly re-generate vegetation and filter water. This is especially important on south and west facing slopes.

Thin-11. Depth of masticated materials should not exceed an average of 4 inches and materials should be discontinuous at the quarter-acre scale to protect the soil and allow for natural revegetation.

Thin-12. Designate skid (or other equipment) trails.

Soils

Best Management Practices

Purpose: To minimize soil erosion and maintain soil productivity.

Soil-1. UTVs and ATVs may be used for transportation around the project area during implementation. To the extent possible, travel on existing routes and trails; if off-route travel must occur, avoid travelling across side-slopes; attempt to travel on ridges.

Soil-2. To protect road infrastructure from rutting, travel to and from the project area on Forest roads and trails would be limited during periods when resource damage could occur.

Soil-3. To the extent possible, existing disturbance areas (e.g. staging areas, access trails) would be utilized rather than creating new ones.

Soil-4. Where desired for ground cover and erosion control, access routes, firelines, staging areas and other disturbed areas may be scarified and seeded, mulched, and/or covered with slash.

Design Features

Purpose: To minimize soil erosion and maintain soil productivity.

Soil-5. Machine piling operations would remove only enough activity-generated slash to accomplish surface fuel reduction needs.

Soil-6. The depth of scattered slash would be the minimum needed to limit soil erosion, so as not to impede understory growth of grasses, forbs and brush.

Mitigation Measures

Purpose: To minimize soil erosion and maintain soil productivity.

Soil-7. Prior to and during mechanical treatments, soil moisture conditions would be evaluated and monitored for operability. To prevent soil compaction and displacement, equipment (e.g., masticators, ATVs, UTVs, trucks) would only operate off of constructed roads when soil moisture is low, the ground is adequately frozen, or covered with sufficient snow.

Soil-8. For the retention of long-term soil productivity and to reduce erosion, burning would be implemented when the lower duff layer (decomposed organic matter) in contact with the soil surface is moist enough so a cool burn can be assured to avoid hydrophobic soil conditions.

Prior to periods of wet weather, and immediately after an area has been treated, erosion control measures (e.g. waterbars, rolling dips) would be installed on all fireline, access routes, and staging areas.

Appendix B: Methods, Data, Assumptions, and Uncertainties of the Riparian Vegetation Analysis

This appendix summarizes results, methods, data sources, and some assumptions and uncertainties involved with the baseline analysis of affected environment for riparian vegetation. Analysis results are summarized in the table below, followed by a series of worksheets individual riparian indicators containing data summaries, methods, and metadata.

The scope of the baseline analysis was the project area, except where the size of the project area was inappropriately small for a given analysis (e.g., analysis of connectivity). As these analyses are landscape in scale, they represent overall pattern and variability of conditions and not conditions of any particular site. Riparian vegetation and associated physical features and processes vary considerably within the area of analysis. Variability results from differences in vegetation structure and composition, elevation gradients, geology, stream flow, fire history, ground water depths and other factors including the interaction of these variables.

The baseline analysis of affected environment provides the SMLRP ID team, decision makers, and the public a status report on the ecological integrity of riparian ecosystems, their governing drivers and stressors, and the potential risks to ecosystem services. The analysis:

- Identifies the status and trend of ecosystems to inform project development and underpin the effects analysis;
- Provides a clear review of ecosystem status in relation to threats and how changes in status affects desired conditions;
- Clearly identifies the features leading to poor ecological integrity to help inform priorities for project planning; and
- Provides information necessary for the public to actively engage in planning.

To evaluate integrity, the analysis was based on information on current conditions in comparison to desired conditions representative of ecological and socioeconomic sustainability. Steps involved in the analysis each riparian indicator include:

- Determining appropriate analysis scales;
- Analyzing ecosystem status and trends according to key riparian indicators, including significant ecosystem drivers and stressors; and
- Interpreting and communicating analysis results, highlighting riparian features and ecosystem services at risk, and identifying what drivers and stressors are at play.

Ecological integrity is reflected in how well an ecosystem functions relative to its potential that is expressed in desired conditions. That analysis of ecosystem status and trends requires a minimum set of riparian indicators that includes the basic attributes of structure, composition, process, and connectivity (FSH 1909.12, CHAP. 40, SEC. 43.12). Indicators are used to determine overall ecological integrity and are not meant to replace more precise indicators for specific goals, objectives, or species. The consistent application of a set of indicators allows for synchrony and efficiency among key phases of assessment, project planning, and monitoring.

The desired condition for each indicator (see following) reflects a science-based benchmark that provides the best inference of ecological integrity. Desired conditions are often, but not always, based on the

natural range of variation (NRV) (FSM 1909.12.14.a). Desired conditions are most useful when expressed as a range rather than a specific threshold, but ranges are not always possible given the state of best available science. The NRV applied in developing desired conditions should reflect current ecosystem potential and the current climatic period existing prior to European settlement and significant disruption of disturbance regimes. The analyses reported here are each based on an index of departure from desired conditions with categories of low (<33% departure), moderate (33-66% departure), or high (>66% departure). Moderate to high departure is considered significant for risk to ecological integrity and continued delivery of ecosystem services.

Using this approach to analysis of riparian vegetation, the best available science was applied to determine both desired and current conditions. In all cases, references are provided as sources of information used to identify desired and current conditions. While these references represent best available science, each reference assumes a degree of uncertainty in the information reported. For instance, some of the riparian corridor mapping was based on Terrestrial Ecological Unit Inventory (TEUI) mapping which, at the time, was a 1:24,000 scale product of the approximate spatial distribution of ecological features. In some cases upland vegetation of hillslopes surrounding riparian was included in the mapping. Likewise, the Riparian Existing Vegetation mapping (REV), which followed the distribution of previously mapped riparian corridors, also reflects "overmapping" of riparian in some extents. As a result, some hillslope conifers are likely captured in the analysis of riparian vegetation and could skew results to show more evergreen tree cover and older seral conditions than is actual. Interpretations of following analysis results take into account data uncertainties. Also, the project implementation phase to come later provides the best opportunity to match the appropriate treatments to the correct vegetation type and conditions on the ground.

Summary of baseline analysis results

Departure from desired conditions is measured and categorized as low (<33% departure), moderate (33-66% departure), or high (>66% departure).

Indicator	Narrowleaf Cottonwood / Shrub (230)	Ponderosa Pine / Willow (350)	Upper Montane Conifer / Willow (280)	Willow - Thinleaf Alder (290)
Flood regime				
Desired condition	The disturbance regime promotes a diverse plant structure consisting of herbaceous, shrub and tree species of all ages and size classes necessary for the recruitment of riparian-dependent species. Flooding and scour occur at a frequency and magnitude characteristic of the watershed. See following flood regime worksheet.			
Flood frequency and magnitude Minor Moderate Severe	 5-10 15-30 50-100+	 5-10 15-30 40-100+	 2-10 15-30 40-100+	 2-10 15-30 40-100+
Desired condition reference	LANDFIRE 2006, 2010			
Current condition Flood frequency and magnitude Minor Moderate Severe	 >30 >80 >80	 >30 >80 >80	 >30 >80 >80	 >30 >80 >80
Current condition reference	See following flood regime worksheet.			
Departure from desired condition	High	High	High	High
Lowermost scale of analysis	Watershed – Multiple 12-digit (6th-level) HUs			
Analysis area (acres)	7,168ac	7,168ac	7,168ac)	7,168ac

Indicator	Narrowleaf Cottonwood / Shrub (230)	Ponderosa Pine / Willow (350)	Upper Montane Conifer / Willow (280)	Willow - Thinleaf Alder (290)
Fire regime, frequency and severity				
Desired condition	Fire is infrequent and patchy owing to characteristics such as surface water and saturated soils. The desired conditions is low departure from historic fire regime (i.e., 0-33% similarity to ecological reference model, fire regime V(III)).			
Desired condition reference	See following fire regime worksheet.			
Current condition	Estimate 411 year interval (based on 50-year Forest record)	Estimate 411 year interval (based on 50-year Forest record)	Estimate 411 year interval (based on 50-year Forest record)	Estimate 411 year interval (based on 50-year Forest record)
Current condition reference	Santa Fe NF Plan Final Assessment report (USDA Forest Service 2016)			
Departure from desired condition	Low	Low	Low	Low
Lowermost scale of analysis	Watershed – Multiple 12-digit (6th-level) HUs			
Analysis area (acres)	Santa Fe Assessment, NE Zone and SE Zone (11,977ac)	Santa Fe NF (665ac)*	Santa Fe NF (494ac)*	Santa Fe Assessment, NE Zone and SE Zone (1,604ac)
Seral state diversity				
Desired condition	All age classes are present and contributions from all seral stages and low overall departure from reference proportions are positive indications of ecosystem condition.			
	Approximate mid points (for departure calculations): State A, early - 25% State B, mid - 50% State C, late - 25% State D, novel - 0%	Approximate mid points (for departure calculations): State A, early - 65% State B, mid-late - 35% State C, novel - 0%	Approximate mid points (for departure calculations): State A, early - 65% State B, mid-late - 35% State C, novel - 0%	Approximate mid points (for departure calculations): State A, early - 65% State B, mid-late - 35% State C, novel - 0%
Desired condition reference	LANDFIRE 2010, USDA Forest Service 2020b			
Current condition**	State A, early - 3-38% State B, mid - 0-16% State C, late - 46-97% State D, novel - 0% (see Seral State and Woody Regeneration worksheet)	State A, early - 0-57% State B, mid-late - 43-100% State C, novel - 0% (see Seral State and Woody Regeneration worksheet)		
Current condition reference	Clark et al. 2020			
Departure from desired condition	Moderate-High (see Seral State and Woody Regeneration worksheet)	Low-Moderate (see Seral State and Woody Regeneration worksheet)		
Lowermost scale of analysis	Watershed – Multiple 12-digit (6th-level) HUs			
Analysis area (acres)	Santa Fe Assessment, NE Zone and SE Zone (799ac*)	Santa Fe Assessment, NE Zone and SE Zone (74ac*)		

Indicator	Narrowleaf Cottonwood / Shrub (230)	Ponderosa Pine / Willow (350)	Upper Montane Conifer / Willow (280)	Willow - Thinleaf Alder (290)
Riparian woody regeneration				
Desired condition	Regeneration, growth, and persistence of obligate vegetation is ensured by natural variation in depth to groundwater, volume of surface water, and timing and the magnitude of their fluctuations. Riparian woody regeneration is sustainable, approximating reference conditions according to the overall percentage of early-mid seral states (low departure). See seral state and woody regeneration worksheet.			
	25% of ERU occurring as native deciduous early seral	65% of ERU occurring as native deciduous/mixed early-mid seral	65% of ERU occurring as native deciduous/mixed early-mid seral	65% of ERU occurring as native deciduous/mixed early-mid seral
Desired condition reference	LANDFIRE 2010, USDA Forest Service 2020b			
Current condition	33% of ERU	8% of ERU	4% of ERU	26% of ERU
Current condition reference	Clark et al. 2020			
Departure from desired condition	Moderate (excess)	High	High	Moderate
Lowermost scale of analysis	Watershed – Multiple 12-digit (6th-level) HUs			
Analysis area (acres)	Santa Fe Assessment, NE Zone and SE Zone (11,977ac)	Santa Fe NF (665ac)*	Santa Fe NF (494ac)*	Santa Fe Assessment, NE Zone and SE Zone (1,604ac)
Coarse woody debris				
Desired condition	Coarse woody debris is present to provide habitat for riparian-dependent species. The amount, spatial distributions, and sizes of coarse woody debris and fine particulate organic matter is sufficient to sustain physical complexity and stability. In lieu of more precise information a default desired condition value of >30 pieces per mile (>18/km), diameter >12" (>30cm), length >35' (>10m) is based on what is considered proper functioning condition.			
Desired condition reference	Prichard et al. 1998, USDA Forest Service 2003			
Current condition	21 pieces/mile	3 pieces/mile	36 pieces/mile	21 pieces/mile
Current condition reference	USDA Forest Service 2016 (Santa Fe NF In-Stream data).			
Departure from desired condition	Low	High	Low	Low
Lowermost scale of analysis	Subwatershed – Groups of one to few 12-digit (6th-level) HUs			
Analysis area (acres)	Santa Fe Assessment, NE Zone and SE Zone (11,977ac)	Santa Fe Assessment NE Zone and SE Zone (127ac)	Santa Fe Assessment NE Zone and SE Zone (439ac)	Santa Fe Assessment NE Zone and SE Zone (1,604ac)
Exotic woody species cover				
Desired condition	Less than 1% of the total canopy cover of vegetation is made up of invasives and exotic woody vegetation.			
Desired condition reference	Muldavin et al. 2011			
Current condition	<1% total canopy cover of exotic woody vegetation			
Current condition reference	Santa Fe NF Plan Final Assessment report (USDA 2016) (see Exotic Woody Species Cover worksheet).			
Departure from desired condition	Low			
Lowermost scale of analysis	Subwatershed – Groups of one to few 12-digit (6th-level) HUs			
Analysis area (acres)	Santa Fe Assessment, NE Zone and SE Zone (11,977ac)	Santa Fe NF (665ac)*	Santa Fe NF (494ac)*	Santa Fe Assessment NE Zone and SE Zone (1,604ac)

Indicator	Narrowleaf Cottonwood / Shrub (230)	Ponderosa Pine / Willow (350)	Upper Montane Conifer / Willow (280)	Willow - Thinleaf Alder (290)
Riparian corridor connectivity				
Desired condition	Spatial connectivity is provided within or between watersheds and, where appropriate, riparian ecosystems provide connectivity important for dispersal, access to new habitats, perpetuation of genetic diversity as well as nesting and foraging for special status species. Within riparian ecosystems connectivity is exhibited between and within aquatic, riparian, and upland components that reflect their natural linkages and range of variability. Less than 15% disruption of riparian corridor; inherent interior-to-edge value of 43 (ecological reference model) calculated for all riparian corridors of the Fireshed analysis area and surrounding landscape (see riparian corridor connectivity worksheet).			
Desired condition reference	Muldavin et al. 2011			
Current condition	13% disruption based on interior-to-edge ratio of 38			
Current condition reference	Santa Fe NF roads layer and Triepke et al. (2018)			
Departure from desired condition	Low (13% disruption)			
Lowermost scale of analysis	Watershed – Multiple 12-digit (6th-level) HUs			
Analysis area (acres)	Santa Fe Assessment, NE Zone and SE Zone (14,147ac)			
Functional group diversity				
Desired condition	The species composition and structural diversity of native plant communities provides adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration. High levels of plant diversity provide food, cover, and nutrients for wildlife including terrestrial and aquatic invertebrates and vertebrates. Overall plant composition similarity to site potential (FSH 2090.11) is greater than 66%, with the calculation for of similarity based on USDA Forest Service (1997, 2020b) and an area-weighted summary for ecological units within an analysis area.			
	Approximate mid points (for departure calculations): Tree-deciduous 21% Tree-evergreen 12% Shrub-herb 66%	Approximate mid points (for departure calculations): Tree-deciduous 0% Tree-evergreen 58% Shrub 42%	Approximate mid points (for departure calculations): Tree-deciduous 0% Tree-evergreen 58% Shrub 42%	Approximate mid points (for departure calculations): Tree-deciduous 0% Tree-evergreen 29% Shrub-herb 71%
Desired condition reference	USDA Forest Service 1993, 2020a, 2020b			
Current condition	Tree-deciduous 16% Tree-evergreen 31% Shrub-herb 53%	Tree-deciduous 4% Tree-evergreen 63% Shrub-herb 33%	Tree-deciduous 17% Tree-evergreen 53% Shrub-herb 30%	Tree-deciduous 20% Tree-evergreen 32% Shrub-herb 48%
Current condition reference	Clark et al. 2020, Triepke et al. 2018			
Departure from desired condition	Low	Low	Low	Low
Departure notes:	Results averaged across two TEUI units (see FGD worksheet). Significant increase in evergreen trees.	TEUI unit not available so results based on average for all TEUI units within MCWG.	TEUI unit not available so results based on average for all TEUI units within MCWG.	Results averaged across three TEUI units (see FGD worksheet).
Lowermost scale of analysis	Subwatershed – Groups of one to few 12-digit (6th-level) HUs			
Analysis area (acres)	Santa Fe Assessment, NE Zone and SE Zone (11,977ac)	Santa Fe Assessment NE Zone and SE Zone (127ac)	Santa Fe Assessment NE Zone and SE Zone (439ac)	Santa Fe Assessment NE Zone and SE Zone (1,604ac)

Reference Condition (historic flood regime) 19 APRIL 2019

Average frequency, years between events…

Magnitude	Walnut-Evergreen Tree Group[1]	Cottonwood Evergreen Tree Group[2,6]	Cottonwood Group[1,6]	Desert Willow Group[3]	Walnut-Evergreen Tree Group[1]	Montane-Conifer Willow Group[4,5]	Description
Minor	7 (5-10)	7 (5-10)	7 (5-10)	5 (2-10)	5 (2-10)	2 (2-10)	Water on floodplain, some scour with removal and burying of some herbaceous cover and removal of seedlings
Moderate	20 (15-30)	20 (15-30)	20 (15-30)	10 (10-30)	15-30	15-30	Significant water on floodplain sediment deposition, with removal of some vegetation up to the size of shrubs and small trees
Severe	50 (50-100+)	50 (50-100+)	50 (50-100+)	50 (40-100+)	50 (40-100+)	50 (40-100+)	Major scour and deposition on the floodplain, removal of vegetation including mature trees trees (stand replacing)
Post-fire debris flooding					103	103	Debris flow following upland fire. Flooding can occur within the same year of the fire and deposit gravels and debris that cover willows. Sprouting of willows can occur within days after the fire event.[7]

1 - LANDFIRE. 2010. LANDFIRE 1.1.0 vegetation dynamics models and Biophysical Setting descriptions, North American Warm Desert Riparian Systems (2511550, 2511551, 2611550). Model files and reports available online <www.landfire.gov>. USDA Forest Service, US Department of the Interior.

2 - LANDFIRE. 2010. LANDFIRE 1.1.0 vegetation dynamics models and Biophysical Setting descriptions, Rocky Mountain Montane Riparian Systems (1511590). Model files and reports available online <www.landfire.gov>. USDA Forest Service, US Department of the Interior.LANDFIRE National

3 - LANDFIRE. 2006. LANDFIRE Rapid Assessment potential vegetation, succession, & fire regime products, Riparian Deciduous Woodland (R3RIPAgr). Model files and reports available online <www.landfire.gov>. USDA Forest Service, US Department of the Interior.

4 - LANDFIRE. 2010. LANDFIRE 1.1.0 vegetation dynamics models and Biophysical Setting descriptions, Montane Riparian Systems (2411590, 2511190). Model files and reports available online <www.landfire.gov>. USDA Forest Service, US Department of the Interior.LANDFIRE National

5 - LANDFIRE. 2010. LANDFIRE 1.1.0 vegetation dynamics models and Biophysical Setting descriptions, Rocky Mountain Subalpine/Upper Montane Riparian Systems (2511600). Model files and reports available online <www.landfire.gov>. USDA Forest Service, US Department

6 - Personal communication Livia Crowley, Cibola NF watershed program coordinator

7 - Lolley, M.R., C. McNicoll, J. Encinas, J. Monzingo, C. Koury, G. Partido, M. Levesque, A. Bradley, P. McCarthy. 2006. Restoring the functionality of fire adapted ecosystems, Gila National Forest, restoration need and opportunity. Unpublished report. Gila National Forest.

Current Condition (approach used to download and process stream gauge data)

USGS 09432000 GILA RIVER BELOW BLUE CREEK, NEAR VIRDEN, NM (USGS 2019)

To download and process data

Go to USGS stream gauge data for the state http://waterdata.usgs.gov/nm/nwis/current/?type=flow

Click on station number, for watershed of choice

Scroll down and click on 'Summary of all available data for this site'

Click on 'Daily Data'

Click on 'Tab-separated' and change 'Begin date' to first year of gauge records, then click 'Go'

Copy data from web page, then paste into worksheet using 'Paste Special…' unicode text

Good data years: Any year with over 340 days of data

To convert dates to text, then to number…

Enter the following formula in the second row of the "Date-Text" column to convert the date to dd-mmm-yy format:

=TEXT(A2,"dd")

This returns the day in a text format, for instance 1/10/2010, is returned as 10. Use “mm” for month, and “yyyy” for year

Then, notice that in the cell itself, the error correction gives you the option of converting text to number, or can do this with formatting cells.

Departure Matrix

	Narrowleaf Cottonwood / Shrub (230)			Ponderosa Pine / Willow (350)			Upper Montane Conifer / Willow (280)			Willow - Thinleaf Alder (290)		
	Reference	Current	% Diff	Reference	Current	% Diff	Reference	Current	% Diff	Reference	Current	% Diff
Minor	7.5	40	433%	6	40	567%	6	40	567%	6	40	567%
Moderate	22.5	80	256%	22.5	80	256%	22.5	80	256%	22.5	80	256%
Severe	75	80	7%	70	80	14%	70	80	14%	70	80	14%
Departure		High 232%			High 279%			High 279%			High 279%	

Fire Regime Worksheet

LANDFIRE fire regime classification (subclasses added)

Fire Regime	Average Fire Return Interval	Fire Severity	Subclass	Description
I	0-35 years	Non-lethal fire	I	0-35 years
II	0-35 years	Stand replacement fire	II	0-35 years
III	35-200+ years	Mixed severity fire	IIIa	<50 years
			IIIb	50-100 years
			IIIc	100-200 years
			IIId	200+ years
IV	35-200+ years	Stand replacement fire	IVa	35-100 years
			IVb	100+ years
			IVc	100-200 years
V	200+ years	Stand replacement fire	Va	200-400 years
			Vb	400+ years
			Vc	No fire
			Vd	Non-forest

ERU	HISTORIC FIRE REGIME	HISTORIC FIRE FREQUENCY in YEARS (INTERVAL or ROTATION)	SOURCE
Montane-Conifer Willow Group (MCWG)	V (III)	350 – 400	Crane, M.F. 1989. Sambucus nigra ssp. cerulea. In: Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/shrub/samnigc>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
			Pavek, D.S. 1993. Juglans major. In: Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/tree/jugmaj>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
		435	LANDFIRE. 2006. LANDFIRE Rapid Assessment potential vegetation, succession, & fire regime products, Riparian Forest with Conifers (R3RIPAfo). Model files and reports available online <www.landfire.gov>. USDA Forest Service, US Department of the Interior.
		290 (75) V (I)	LANDFIRE. 2010. LANDFIRE 1.1.0 vegetation dynamics models and Biophysical Setting descriptions, Rocky Mountain Montane Riparian Systems (2511590). Model files and reports available online <www.landfire.gov>, October 2010. USDA Forest Service, US Department of the Interior.
		Infrequent - similar to adjacent fire regimes	Crane, M.F. 1989. Sambucus nigra ssp. cerulea. In: Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/shrub/samnigc>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
			Tesky, J.L. 1992. Salix bebbiana. In: Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/tree/salbeb>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
			Uchytal, R.J. 1989. Alnus incana spp. tenuifolia. In: Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/tree/alninc>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.

ERU	HISTORIC FIRE REGIME	HISTORIC FIRE FREQUENCY in YEARS (INTERVAL or ROTATION)	SOURCE
Cottonwood Group (CWG)	V (III)	Infrequent - similar to adjacent fire regimes	Reed, W.R. 1993. Salix gooddingii. In Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/shrub/samnigc>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
			Stromberg, J., and E. Ortiz-Zuazaga. 1998. Fire effects on riparian communities of the San Pedro basin and associated species of concern. The Nature Conservancy technical report, Arizona Chapter, Tucson AZ.
			Taylor, J.L. 2000. Populus fremontii. In Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/shrub/samnigc>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
			Uchytal, R. J. 1990. Acer grandidentatum. In Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/shrub/samnigc>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
			Wright, H.A., and A.W. Bailey. 1982. Fire ecology: United States and southern Canada. New York: John Wiley and Sons, Inc.
		225	LANDFIRE. 2010. LANDFIRE 1.1.0 vegetation dynamics models and Biophysical Setting descriptions, North American Warm Desert Riparian Systems (2511550). Model files and reports available online <www.landfire.gov>, October 2010. USDA Forest Service, US Department of the Interior.
		750 (23) V (III)	LANDFIRE. 2010. LANDFIRE 1.1.0 vegetation dynamics models and Biophysical Setting descriptions, North American Warm Desert Riparian Systems - Rivers (1511551, 2511551). Model files and reports available online <www.landfire.gov>, October 2010. USDA Forest Service, US Department of the Interior.
		Infrequent - similar to adjacent fire regimes	Pavek, D. S. 1993. Juglans major. In Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/shrub/samnigc>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
			Uchytal, R. J. 1990. Acer grandidentatum. In Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/shrub/samnigc>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.
			Wright, H.A., and A.W. Bailey. 1982. Fire ecology: United States and southern Canada. New York: John Wiley and Sons, Inc.
wetland (RMAP 190)	variable (II, III, IV)	Infrequent, and affected by adjacent fire regimes	Davis, O.K., T. Minckley, T. Jull, and B. Kalin. 2002. The transformation of Sonoran desert wetlands following the historic decrease of burning. Journal of Arid Environments 50: 393–412.
		15-35	Stone, K.R. 2010. Polygonum aviculare. In: Fire Effects Information System, available online <www.fs.fed.us/database/feis/plants/forb/polavi>. USDA Forest Service, Rocky Mountain Research Station, Fort Collins CO.

Seral State and Woody Regeneration Worksheet

Crosswalking between seral states and current condition mapping (Clark et al. 2020)

COTTONWOOD GROUP (CWG) 28 MAY 2019

CURRENT TRENDS MODEL				EXISTING VEGETATION			REFERENCE CONDITION*
MODEL	STATE	DESCRIPTION		COMPOSITION		STRUCTURE	DESIRED CONDITION*
LANDFIRE National "North American Warm Desert Riparian Systems" (2611550)	A	Early Development 1 Open	=	Recently burned, sparsely vegetated, all herbaceous dominance types		(<10% tree cover, <10% shrub cover)	25%
				Native shrub deciduous dominance types	AND	All size classes, shrub cover <25%	
				Native tree deciduous dominance types	AND	<5" diam [<5m height], all tree cover classes	
	B	Mid Development 1 Open		Native shrub deciduous dominance types	AND	All size classes, shrub cover ≥25%	50%
				Native tree deciduous dominance types	AND	≥5" diam [≥5m height], tree cover <25%	
	C	Late Development 1 Closed	=	Native tree deciduous dominance types	AND	≥5" diam [≥5m height], tree cover ≥25%	25%
	D	Novel	=	Upland dominance types and exotic vegetation	AND	Various	0%

COTTONWOOD GROUP (CWG)

RIPARIAN ERU	RMAP CODE
Cottonwood / Hackberry	160
Fremont Cottonwood – Oak	170
Fremont Cottonwood / Shrub	180
Narrowleaf Cottonwood / Shrub	230
Rio Grande Cottonwood / Shrub	260
Sycamore - Fremont Cottonwood	270
Elm - Eastern Cottonwood	310
Eastern Cottonwood / Shrub	320

MONTANE-CONIFER WILLOW GROUP (MCWG) 28 MAY 2019

CURRENT TRENDS MODEL				EXISTING VEGETATION			REFERENCE CONDITION*
MODEL	STATE	DESCRIPTION		COMPOSITION		STRUCTURE	DESIRED CONDITION*
LANDFIRE National "Montane Riparian Systems" (2411590)	A	Early-mid 1 All	=	Recently burned, all corresponding herb types		N/A	65%
				All native deciduous/mixed shrub dominance types	AND	shrub cover <25%	
				All native deciduous/mixed tree dominance types	AND	<5" diam [<5m height], all cover classes	
	B	Late 1 Closed	=	All native deciduous/mixed shrub dominance types	AND	shrub cover ≥25%	35%
				All native deciduous/mixed tree dominance types	AND	≥5" diam [≥5m height], all cover classes	
	C	Novel		Upland dominance types and exotic vegetation	AND	Various	0%

* - Based on LANDFIRE (2010)

MONTANE-CONIFER WILLOW GROUP (MCWG)

RIPARIAN ERU	RMAP CODE
Arizona Alder – Willow	110
Upper Montane Conifer / Willow	280
Willow - Thinleaf Alder	290
Ponderosa Pine / Willow	350

Acres summaries for computing seral state current condition and departure

Sum of Acres	Column Labels					
Row Labels	Herb	Shrub	Sparsely Vegetated	Tree	Water	Grand Total
Narrowleaf Cottonwood / Shrub	**1,966**	**309**	**412**	**9,142**	**148**	**11,977**
0) non Tree-Shrub	**1,966**		**412**		**148**	**2,526**
0) non Tree-Shrub	1,966		412		148	2,526
1) 0-.5 meters		**8**				**8**
1) 10-25%		8				8
2) .5-5 meters		**301**		**2,273**		**2,574**
1) 10-25%		142		370		512
2) 25-50%		121		975		1,096
3) 50-75%		31		766		797
4) 75-100%		6		162		168
3) 5-12 meters				**5,661**		**5,661**
2) 25-50%				72		72
3) 50-75%				1,565		1,565
4) 75-100%				4,024		4,024
4) 12+ meters				**1,207**		**1,207**
3) 50-75%				7		7
4) 75-100%				1,200		1,200
Willow - Thinleaf Alder	**48**	**45**	**71**	**1,440**		**1,604**
0) non Tree-Shrub	**48**		**71**			**119**
0) non Tree-Shrub	48		71			119
2) .5-5 meters		**45**		**538**		**583**
1) 10-25%		15		27		42
2) 25-50%		18		104		122
3) 50-75%		8		311		319
4) 75-100%		3		97		100
3) 5-12 meters				**803**		**803**
2) 25-50%				4		4
3) 50-75%				228		228
4) 75-100%				571		571
4) 12+ meters				**100**		**100**
4) 75-100%				100		100
Grand Total	**2,015**	**353**	**483**	**10,582**	**148**	**13,581**

Sum of Acres	Column Labels				
Row Labels	Herb	Shrub	Sparsely Vegetated	Tree	Grand Total
Ponderosa Pine / Willow		**5**	**25**	**636**	**665**
0) non Tree-Shrub			**25**		**25**
0) non Tree-Shrub			25		25
2) .5-5 meters		**5**		**114**	**119**
1) 10-25%				6	6
2) 25-50%		5		34	39
3) 50-75%				56	56
4) 75-100%				19	19
3) 5-12 meters				**440**	**440**
2) 25-50%				13	13
3) 50-75%				68	68
4) 75-100%				359	359
4) 12+ meters				**81**	**81**
3) 50-75%				2	2
4) 75-100%				79	79
Upper Montane Conifer / Willow	**2**	**2**	**0**	**491**	**494**
0) non Tree-Shrub	**2**		**0**		**2**
0) non Tree-Shrub	2		0		2
2) .5-5 meters		**2**		**29**	**31**
1) 10-25%		1			1
2) 25-50%				8	8
3) 50-75%				19	19
4) 75-100%		1		3	4
3) 5-12 meters				**383**	**383**
2) 25-50%				1	1
3) 50-75%				73	73
4) 75-100%				310	310
4) 12+ meters				**78**	**78**
4) 75-100%				78	78
Grand Total	**2**	**6**	**25**	**1,126**	**1,159**

Computing departure for seral state diversity and riparian woody regeneration

Narrowleaf Cottonwood / Shrub (230)

Seral state diversity

	ACRES	CURRENT	REFERENCE	DIFF
A	4949.91	41.3%	25.0%	25.0%
B	158.63	1.3%	50.0%	1.3%
C	6868.23	57.3%	25.0%	25.0%
	11976.77	100.0%		51.3%
			DEP-->	**48.7%**

Riparian woody regeneration

ACRES	
11,977	ERU acres
2,994	Characteristic native early-deciduous/mixed area (25% of total ERU acres)
3,999	Current native early-deciduous/mixed area (acres)
33.4%	Current native early-deciduous/mixed area (%)
33.5%	**% departure**

Ponderosa Pine / Willow (350)

Seral state diversity

	ACRES	CURRENT	REFERENCE	DIFF
A	139.4	21.0%	65.0%	21.0%
B	525.8	79.0%	35.0%	35.0%
	665.2			56.0%
			DEP-->	**44.0%**

Riparian woody regeneration

ACRES	
665.2	ERU acres
432	Characteristic native early-deciduous/mixed area (65% of total ERU acres)
50	Current native early-deciduous/mixed area (acres)
7.5%	Current native early-deciduous/mixed area (%)
88.4%	**% departure**

Upper Montane Conifer / Willow (280)

Seral state diversity

	ACRES	CURRENT	REFERENCE	DIFF
A	31.6	6.4%	65.0%	6.4%
B	462.4	93.6%	35.0%	35.0%
	494			41.4%
			DEP-->	**58.6%**

Riparian woody regeneration

ACRES	
494	ERU acres
321	Characteristic native early-deciduous/mixed area (65% of total ERU acres)
21	Current native early-deciduous/mixed area (acres)
4.3%	Current native early-deciduous/mixed area (%)
93.5%	**% departure**

Willow - Thinleaf Alder (290)

Seral state diversity

	ACRES	CURRENT	REFERENCE	DIFF
A	672.14	41.9%	65.0%	41.9%
B	931.77	58.1%	35.0%	35.0%
	1603.91			76.9%
			DEP-->	**23.1%**

Riparian woody regeneration

ACRES	
1,604	ERU acres
1,043	Characteristic native early-deciduous/mixed area (65% of total ERU acres)
423	Current native early-deciduous/mixed area (acres)
26.4%	Current native early-deciduous/mixed area (%)
59.4%	**% departure**

Exotic Woody Species Cover Worksheet

Metadata from Santa Fe Forest Plan revision assessment (USDA Forest Service 2016)

Excerpt from Santa Fe NF Forest Plan Revision Assessment (USDA Forest Service 2016)

Non-native and invasive plants (also known as noxious weeds), are aggressive species that displace native plant species. The National Invasive Species Council defines invasive species as, "those (species) that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health." Whereas, Federal law, under Executive Order 13112 defines "invasive species" as: an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. An "Alien species" with respect to a particular ecosystem is defined as, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem. Invasive plant species that are particularly damaging or prolific are regulated as noxious weeds (EO 13112). Invasive species are not native to the ecosystem being described.

Invasive plants significantly alter plant composition, structure, and ecosystem functions. Invasive plants compete with desirable plants, poison animals, host insect and disease agents, and alter various ecosystem attributes by turning diverse native plant communities into monocultures (loss of biodiversity), and disrupt natural ecosystem processes such as; decreased water infiltration, increased soil erosion, decreased water quality, increased soil salinity, as well as disrupting natural fire regimes (Dick-Peddie 1993). Undesirable non-native and invasive plant species gradually out-compete native plant communities by starving native plants of space, moisture, and nutrients leading to the loss of biodiversity (Randall 1996). By reducing native plant infestations and altering natural ecosystem functions, they are also reducing the abundance and diversity of native wildlife species, and microorganisms in those ecosystems. Wildlife habitat is affected by the presence of non-native and invasive species as palatable forage is lost, and nesting and foraging cover is decreased for both aquatic and terrestrial species.

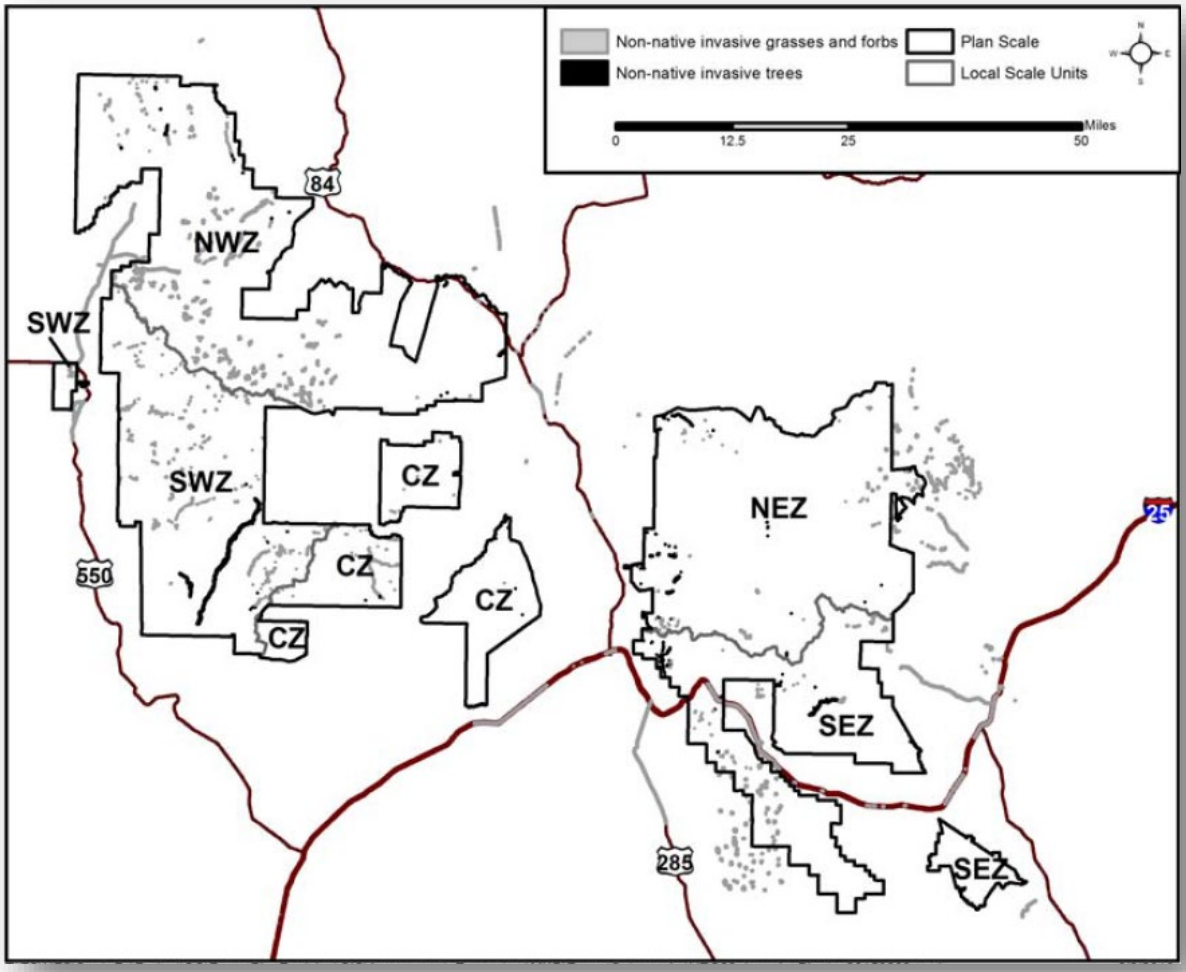
Invasives continue to invade rangelands, forests, and riparian ecosystems. Control of infestations can be challengeing with their rapid exapansion and continued introduction. The rapid expansion of exotic weed populations limits the potential to effectively restore native plant communities to conditions within the historic range of variability. If exotic plants are not kept in check, long-term devastating effects to forest ecosystems can occur. There are numerous vectors in which non-native and invasive species spread across
the landscape. Natural disturbances such as wind events, rain, floods, snow runoff, and wildfire can carry seeds vast distances. Wildlife and domestic animals can carry seeds by foot, coat, or by seeds they may have ingested and discarded by feces. Human activities contribute largely to the spread of non-native and invasive species. Clothing, shoes, vehicles, and ATVs can also carry seeds great distances.

Surveys for invasive plants on the National Forest System land have been quite limited. The identification of infestation sites on the Forest is sporadic and typically a result of employees coincidentally traveling through locations for other reasons. Monitoring of invasives is not systematic and thorough on the Santa Fe NF. It is estimated there are considerably more infestations, and species that have not been inventoried and mapped. Therefore, the data captured below is not inclusive of all invasive plants that exist on the Forest. Occurrences identified below are from the Forest's geographical information systems (GIS) invasives database for calendar years 2000 through 2014.

For all ecosystems, the desired condition is that invasive species are rarely present, or are present at levels that do not negatively influence ecosystem function.

The distribution and documented extent of non-native and invasive plants are displayed in figure 12 and table 15. The largest concentration occurs on the west side of the Forest, with the NWZ and SWZaccounting for over 8,000 acres each. The CZ is the least infested local zone with roughly 375 acres of
documented invasives primarily residing in the PPF type. Ponderosa Pine Forest, MCD and Rio Grande Cottonwood/Shrub ecosystems contain the greatest distribution of invasives of all ERUs found on the Forest. Rio Grande Cottonwood/Shrub also has the greatest annual proportion of invasion by invasives with nearly 3 percent of the ecosystem infested annually (based on 15-year average).

Generally plume thistle (Bull and Canada thistle) is the most abundant invasive found on the Forest with 46 percent of invasive plants found on the Forest being of this genera. Canada thistle being the most extensive exists in nearly every ERU found on the Forest.



Inventoried acres of invasive plants on the Santa Fe National Forest (USDA Forest Service 2016)

Common Name	Scientific Name	NWZ	SWZ	CZ	NEZ	SEZ	Forest
Bull thistle	*Cirsium vulgare*	106	1,864	48	521	685	3,224
Canada thistle	*Cirsium arvense*	5,178	224	58	6	0	5,466
Cheatgrass	*Bromus tectorum*	2	69	0	5	0	76
Common mullein	*Verbascum thapsus*	1	20	0	0	0	21
Dalmation toadflax	*Linaria dalmatica*	3	18	0	0	0	21
Diffuse knapweed	*Centaurea diffusa*	6	108	0	0	0	114
Hardheads	*Acroptilon repens*	36	51	0	0	0	87
Nodding plumeless thistle	*Carduus nutans*	2,474	558	106	15	1	3,154
Poison hemlock	*Conium maculatum*	0	22	0	0	0	22
Russian olive	*Elaeagnus angustifolia*	0	1,730	28	0	1	1,759
Tamarisk (saltcedar)	*Tamarix ramosissima*	161	1,733	46	0	0	1,940
Scotch thistle	*Onopordum acanthium*	10	35	82	4	350	481
Siberian elm	*Ulmus pumila*	22	1,813	6	251	309	2,401
Spotted knapweed	*Centaurea stoebe*	323	0	0	0	0	323
Totals		***8,322***	***8,245***	***374***	***802***	***1,346***	***19,089***

Riparian Corridor Connectivity Worksheet

Riparian corridor connectivity methods, results, references

	Interior (m^2)	Edge (m)	Interior-to-Edge[1]
Ecological reference model	73,565,123	1,695,541	43
Current condition	72,255,748	1,918,932	38
Difference		13.2%	-13.2%

Road Attribute	Amount
Number	241
Width[2] (m)	9
Length (m)	145,486
Interior (area in m^2)	1,309,375

STEPS

All RMAP units were considered collectively as riparian corridors in the NEZ and SEZ zones of the Santa Fe NF (i.e., RMAP boundaries did not represent artificial breaks in riparian corridor habitat)

Reference' layer created by dissolving all internal lines (separate RMAP units) within RMAP polygon groups; i.e., all contiguous polygons formed a given group that was combined to form one large polygon

Using the 'reference' layer, polygon 'interior' area and 'edge' fields were added, then area (m^2) and edge (m) values were computed and summarized to represent the desired condition[1]

Current layer created by intersecting roads with a copy of the 'reference' layer that created dissections that formed multiple polygons with each road intersection

Using the 'current' layer, 'interior' area and 'edge' values were computed and summarized to represent current condition

Loss in riparian area as a result of road corridors was determined by clipping the roads layers with the 'reference' layer to create a layer of road segments

Using the road segments layer, road lengths within riparian corridors were computed and summarized to represent total road length within riparian

Functional Group Diversity Worksheet

Current, reference, departure tables for Narrowleaf Cottonwood / Shrub (230)

CURRENT Tree Dec	CURRENT Tree Evg	CURRENT Shrub-herb	CURRENT Total		REFERENCE Tree Dec	REFERENCE Tree Evg	REFERENCE Shrub-herb	REFERENCE Total		DEPARTURE Tree Dec	DEPARTURE Tree Evg	DEPARTURE Shrub-herb	Departure	
Narrowleaf Cottonwood / Shrub (230)														
1,843	3,703	6,284	11,829	<-- Acres	45	26	140	211	<-- Cover total					
16%	31%	53%	100%	<-- % veg categories only	21%	12%	66%	100%	<-- % veg categories only	16%	12%	53%	19%	Low
Ponderosa Pine / Willow (350)														
5	80	43	127	<-- Acres		80	198	278	<-- Cover total					
4%	63%	34%	100%	<-- % veg categories only	0%	29%	71%	100%	<-- % veg categories only	0%	29%	48%	23%	Low
Upper Montane Conifer / Willow (280)														
74	231	133	439	<-- Acres		80	58	138	<-- Cover total					
17%	53%	30%	100%	<-- % veg categories only	0%	58%	42%	100%	<-- % veg categories only	0%	38%	42%	20%	Low
Willow - Thinleaf Alder (290)														
317	518	768	1,604	<-- Acres		80	198	278	<-- Cover total					
20%	32%	48%	100%	<-- % veg categories only	0%	29%	71%	100%	<-- % veg categories only	0%	29%	48%	23%	Low