Appendix G

Climate Change Trends and Management Strategy for the San Juan National Forest and Tres Rios Field Office Land and Resource Management Plan

APPENDIX G: CLIMATE CHANGE TRENDS AND MANAGEMENT STRATEGY FOR THE SAN JUAN NATIONAL FOREST AND TRES RIOS FIELD OFFICE LAND AND RESOURCE MANAGEMENT PLAN

The principle components of "climate" are the air temperature and precipitation that characteristically prevail in a region. Although our understanding of climate change in the planning is evolving, we do know that the observed temperature record in southwest Colorado shows average annual warming of about 2 degrees Fahrenheit over the past 30 years. Additional warming is predicted for the future (Western Water Assessment 2008). In comparison, the observed precipitation record in Colorado does not show long-term trends in annual precipitation. This is due to the wide variations in elevation and complex terrain of Colorado, which complicate past and future precipitation trend analysis (Western Water Assessment 2008).

Because we do not understand every complex interaction between a warming climate and the ecosystems of the San Juan National Forest (SJNF) and Tres Rios Field Office (TRFO), the vision and strategies for climate change in the Land and Resource Management Plan (LRMP) focus primarily on ecosystems that have already demonstrated sensitivity or are considered most at risk because we are already observing changes. In the short term, we plan to continue improving our understanding of ecosystem changes. We also intend to pursue long-term monitoring projects. We do know there are many flora and fauna populations that are vulnerable because of their narrow range of habitat, small populations, or limited ability to adapt or tolerate change. Specific strategies have been developed for these vulnerable species, as well as for important ecosystems that are already undergoing rapid change.

Changes Already Observed

Between 2000 and 2005 sudden aspen (*Populus* sp.) decline has been prevalent in the planning area and has damaged over 17% of aspen forests in Colorado. This phenomenon is considered a different change compared to usual dynamic changes observed in aspen forests over the last hundred years. Aspen in the planning area has exhibited widespread, severe, rapid dieback and mortality at a landscape level over just a few years. On the Dolores Ranger District about 40,000 acres of aspen on public lands were affected. Exceptionally warm, dry conditions have weakened aspen growing on south and west aspects, low elevations, and in open stands. The stressed trees have become vulnerable to secondary insects and disease that have killed the trees over large areas (U.S. Forest Service [USFS] 2009).

Another recent ecosystem change has been the widespread and unprecedented episode of pinyon pine (*Pinus ponderosa*) mortality in the Southwest and the planning area. Between 2002 and 2005, millions of pinyon pine trees were killed by pinyon Ips bark beetles (*Ips confusus*) (Allen-Reid et al. 2008). Several years of warm-drought conditions are considered a major factor facilitating the epidemic of pinyon Ips bark beetle.

Climate is driving other landscape changes. River runoff in the planning area is primarily driven by snowmelt. The warming climate from 1978 to 2004 has caused the onset of spring snowpack melt and river snowmelt runoff to occur 2 to 3 weeks earlier in southwest Colorado (Clow 2007). Changes in the timing and amount of runoff are likely to add more stress and demand to available water supplies and may impact aquatic ecosystems. The incidence of wildfire has also changed due to increased spring and summer temperatures and an earlier onset of spring snowmelt. Since the 1980s large wildfires across the western United States have occurred with increased frequency, the duration of the fires has increased, and the length of wildfire season has increased (Westerling et al. 2006).

Species and Habitats Most At Risk

Climate change is also hydrologic change. Of particular concern are seasonal springs, seeps, small ponds, and small wetlands that occupy less than 1% of the SJNF and TRFO. Rare plant species that are dependent on these small water features include Kachina daisy (*Erigeron kachinensis*) and Eastwood's monkeyflower (*Mimulus eastwoodiae*), which are Bureau of Land Management (BLM) sensitive species; giant helliborine (*Epipactis gigantea*), which is a USFS sensitive species; and common maidenhair (*Adiantum capillus-veneris*). The critically imperiled Great Basin silverspot butterfly (*Speyeria nokomis nokomis*), which is a BLM and USFS sensitive species, and its host plant the bog violet (*Viola nephrophylla)* are also dependent on these small water features. There is also a general concern about protecting hanging garden plant communities that are associated with seeps in alcoves and on canyon walls.

Alpine ecosystems are also changing with the earlier onset of spring snowmelt, warmer temperatures, and the upward encroachment of tree and subalpine plant species (Clow 2007; Moir et al. 1999; Crawford et al. in review). Uncompahgre fritillary butterfly (*Boloria acrocnema*), white-tailed ptarmigan (*Lagopus leucura*), American pika (*Ochotona princeps*), and many alpine plant species are vulnerable as alpine habitat is impacted or lost.

Spruce-fir forests are currently exhibiting an insect and disease epidemic moving generally from east to west at higher elevations of the Weminuche wilderness at a scale that may be uncharacteristic. Old stand age combined with warmer winters and summers and perhaps a long fire suppression history may be contributing factors to the epidemic. The fact that many insect and disease agents are working simultaneously at a large scale to kill several species of trees also seems outside the norm. This epidemic includes *Armillaria* root disease, which weakens/kills true firs (*Abies* sp.); fir engraver beetle (*Scolytus ventralis*), which kills white fir (*A. concolor*); balsam fir bark beetle (*Pityokteines sparsus*), which kills subalpine fir (*A. lasiocarpa*); and spruce bark beetle (*Ips typographus*), which kills Englemann spruce (*Picea engelmannii*).

Coldwater fish species, especially native lineage greenback cutthroat trout (*Oncorhynchus clarki stomias*), a U.S. Fish and Wildlife Service (USFWS)-listed threatened species, and Colorado River cutthroat trout (*O.c. pleuriticus*) a USFS sensitive species, may be especially vulnerable to increasing water temperatures and hydrologic changes such as reduced late-season base flows. Changes in physical hydrology may actually favor some non-native or invasive aquatic species and may increase the incidence of disease such as whirling disease, adding more stress to these endangered and sensitive aquatic species.

Changing climate may favor many invasive species that can outcompete and displace native species. Of special concern are highly competitive invasive annual plant species such as cheatgrass (*Bromus tectorum*), which already occupies hundreds of acres of the SJNF and TRFO, and is actively moving into higher-elevation ecosystems. Continued drought combined with high-intensity wildfires would likely provide increased opportunities for annual weed spread and establishment.

Our Strategy

Maintaining the health, diversity, and productivity of the SFNF and TRFO is a primary mission. Our response to ecosystem change as a result of climate change includes a variety of adaptation and mitigation strategies. Our primary strategy is to manage for healthy, resilient ecosystems. It is also recognized that ecosystems have always been dynamic. Early detection of ecosystem changes that result from climate change would require detailed, regularly scheduled monitoring.

Desired conditions and objectives for climate change are interrelated with managing for healthy ecosystems. LRMP components related to climate change are dispersed throughout the resource sections of the LRMP and are also listed below:

Terrestrial Ecosystems

Desired Conditions

2.2.2 Non-climate ecosystem stresses (e.g., high road densities, water depletions, air and water pollution) are reduced to improve the resilience and resistance of ecosystems to the future dynamics of a changing climate.

2.2.3 Key ecosystems that are not functioning properly are realigned/restored/renovated to survive the near-future dynamics of changing climate.

2.2.4 Future biodiversity, especially for endangered, rare, or dwindling species, is protected in the face of a changing climate by safeguarding habitats, preserving genetic diversity, and cooperating with seed banking efforts that provide secure, long-term storage of plant genetic resources.

2.2.11 Canyon escarpments, and the terrestrial ecosystems that occur on them, serve as refugia for native biota. These escarpments are associated with the following canyons: Lower Dolores River, Wild Steer, Coyote Wash Spring, McIntyre, Summit, Big Glade, Lake, Doe, Narraguinnep, Cabin, Ferris, Salter, Spruce Water, and Lost. They also include the Mesa Verde Escarpment.

2.2.15 Forested terrestrial ecosystems have stand structures and tree species compositions that offer resistance and resilience to changes in climate, including extreme weather events or epidemic insect and disease outbreaks.

2.2.16 Non-forested terrestrial ecosystems have community structure and species composition that offer resistance and resilience to changes in climate, including extreme weather events or epidemic insect and disease outbreaks

2.2.17 Local seeds of desirable native plant species are available for revegetation and restoration efforts.

2.2.18 Suitable habitats for species vulnerable to climate change exist and serve as seed sources for revegetation and restoration efforts.

2.2.19 The SJNF and TRFO forested ecosystems provide net positive carbon storage.

2.2.20 Five-needle pine species (southwestern white pine [*Pinus strobiformus*], limber pine (*P. flexilis*], and bristlecone pine (*P. aristata*]) are maintained as a component of forested ecosystems.

2.2.21 High-elevation stands dominated by aspen will be maintained or increased over time to ensure the persistence of aspen on the landscape in light of declining aspen health and loss of aspen in lower elevations associated with a warmer and drier climate.

2.2.36 Long-term levels of soil organic matter and soil nutrients (including soil carbon) are maintained at sustainable levels.

Objectives

2.2.45 Within 10 years, restore or improve soil productivity and soil carbon on at least 20 miles of road that would be closed or decommissioned on the SJNF, and 5 miles of road that would be closed or decommissioned on TRFO lands.

2.2.51 Over the next 15 years, manage 2,000 acres of high-elevation aspen stands on SJNF lands that are conifer dominated or at risk of converting to conifer-dominated stands to maintain or increase aspen forests.

2.2.57 Over the next 15 years, secure a reliable source of local seed stock for 16 or more native grass, forb, and shrub species (including Arizona fescue [*Festuca arizonica*]) to be used for revegetation and restoration after disturbance (eight species on the SJNF and eight species on TRFO lands).

2.2.58 Over the life of the LRMP, collect seed from 20 local vulnerable grass, forb, and shrub species, including some alpine species, for long-term storage to protect genetic sources (10 species on the SJNF and 10 species on TRFO lands).

2.2.59 Use locally produced biochar to sequester carbon, reduce erosion, and enhance soil productivity and water retention on a minimum of 1 acre per year (0.5 acre per year on the SJNF and 0.5 acre per year on TRFO lands) for five years.

2.2.60 After natural disturbance events or on restoration projects over the next 15 years, increase the variety of native non-commercial tree species and native shrubs used on a minimum of 100 acres (75 acres on the SJNF and 25 acres on TRFO lands).

2.8.61 Over the next 15 years, broaden tree seed collection activities on the SJNF to include non-commercial species and additional species specific elevation zones to improve genetic diversity and the resilience of forested ecosystems.

2.2.62 Over the next 15 years, revegetate and reclaim 10 acres using native early-successional plant species developed from local plant sources to accelerate restoration success (5 acres on SJNF and 5 acres on TRFO lands).

2.2.63 Over the next 20 years, enhance the resiliency of alpine ecosystems and provide refugia for alpine-dependent species on 100 acres of TRFO lands through implementing travel management decisions in the Alpine Loop zone, implementing recreation management plans, completing mine land reclamation, or conducting other management activities.

2.2.64 Over the next 20 years, enhance the resiliency of alpine ecosystems and provide refugia for alpine-dependent species by removing non-climate stressors that result in adverse impacts to alpine ecosystems (e.g., unmanaged livestock grazing, unmanaged motorized recreation) from 100 acres on the SJNF that are forb-dominated alpine habitat.

Guidelines

2.2.81 Management activities should not decrease the abundance or distribution of southwestern white, limber, or bristlecone pine trees in order to maintain white pine species in SJNF and TRFO forested environments.

2.2.86 Revegetation and reforestation plans or activities should consider the following strategies to maintain or improve resilience of forested and non-forested ecosystems:

- use a variety of species and phenotypes;
- emphasize use of native species, collected locally;
- use both commercial and non-commercial species for reforestation (non-commercial species include southwestern white, limber or bristlecone pine);
- use seed collected from across the range of climate zones.

Terrestrial Wildlife

Desired Conditions

2.3.11 Habitat continuity and travel corridors exist and persist to facilitate species movement and establishment into newly suitable areas as a result of changing habitats.

Riparian Area and Wetland Ecosystems

Desired Conditions

2.4.5 Riparian area and wetland ecosystems are resilient to change from disturbances (including from floods, fire, and drought) and offer resistance and resilience to changes in climate.

Objectives

2.4.18 Maintain or restore native riparian ecosystems and connected uplands that have been treated to control non-native species on a minimum of 50 miles on the Dolores River and its tributaries on TRFO lands over the next 20 years.

Aquatic Ecosystems and Fisheries

Desired Conditions

2.5.1 Long-term sustainability of aquatic ecosystems is maintained.

2.5.3 The quantity and quality of aquatic habitats are maintained or enhanced to provide for the long-term sustainability of biological diversity and population viability of all native and/or desired non-native vertebrate species.

2.5.4 Channel characteristics, water quality, flow regimens, and physical habitat features are diverse and appropriately reflect the climate, geology, and natural biota of the area.

Water

Desired Conditions

2.6.11 Administrative and permitted activities on the SJNF and TRFO do not contribute to the reduction of surface water or groundwater that supplies seasonal springs, seeps, small ponds, and small wetlands considered most vulnerable to a changing climate.

Objectives

2.6.28 Over the next 10 years, improve the efficiency of water and energy use at all administrative facilities on the SJNF by using the minimum consumption practicable.

Invasive Species

Desired Conditions

2.8.5 Management activities do not contribute to the spread of invasive annual plants or other invasive species.

Objectives

2.8.9 Over the life of the LRMP eradicate newly established invasive species, especially Colorado Class A noxious species on both SJNF and TRFO lands.

Timber Management and Special Forest Products

Desired Conditions

2.9.1 Forest vegetation management on SJNF and TRFO lands that results in, among other objectives, meeting needs or demands for forest product offerings (commercial, personal, or other use) would be done in a manner that:

- maintains or improves ecosystem function, resilience, and sustainability;
- supports, at least, the current level of economic activity in the local timber industry;
- provides economic or social support to local communities;
- ensures current and future needs for Native American tribal use, including that associated with special forest products (e.g., teepee poles);
- utilizes, to the fullest extent practicable, potential products including sawtimber, poles, topwood, or slash (like limbs, foliage);
- supports innovation in utilization, including conversion of cut-tree mass into biofuels, pellets, biochar, or other useful products;
- efficiently balances or reduces costs of implementation of treatment activities; and
- anticipates climate-related plant succession changes (such as favoring heat- or drought-resistant tree species as leave trees, or in reforestation)

2.9.4 Reforestation activities on SJNF and TRFO lands use native tree species germinated from locally collected seed stock to improve the resiliency of forest ecosystems.

Objectives

2.9.9 Every 3 years review silvicultural prescriptions for incorporation of strategies that anticipate potential plant succession changes relative to warmer and/or drier forested conditions.

2.9.11 Annually review seed inventories to ensure adequate seed from locally collected native tree species is available for planned reforestation activities on SJNF and TRFO lands.

Insects and Disease

Desired Conditions

2.10.4 Mortality of aspen trees in high value aspen forests due to sudden aspen decline is significantly reduced.

Fire and Fuels Management

Desired Conditions

2.11.7 Planned and unplanned fire ignitions are used to increase resiliency and diversity across all forest and rangeland vegetation types.

2.11.8 Fire is reintroduce to increase the resistance and resiliency of the warm dry mixed conifer and ponderosa pine forest types in landscape such as Hermosa and Piedra areas.

2.11.9 The occurrence of low-elevation fires burning upward into spruce-fir forest increases over time to promote the heterogeneity of spruce-fir forests.

Air Quality

Desired Conditions

2.12.6 Management activities on the SJNF and TRFO control dust in order to minimize impacts of dust-on-snow events.

Standards

2.12.15 Green completion technology for oil and natural gas well completions and for restimulation or refracture activities during workovers is required to prevent venting and most flaring of methane gas and other air pollutants into the atmosphere. Green completion practices include, but are not limited to 1) maximal capturing of fluids, well effluent, and flammable gases as soon as practicable during flowback and cleanout operations; 2) separation of sand, hydrocarbon and other liquids, and gas from saleable products of saleable quantity; 3) storage and delivery of saleable products to sales line; and 4) environmentally safe disposal of non-saleable waste products. Venting of flammable gas during the well completion process would not be allowed except for gas testing or safety and emergency situations. This standard is required for all non-wildcat oil and natural gas wells and would be implemented in all places where technically feasible. (Technically feasible would be determined by the USFS and BLM, with input from air quality regulatory agencies as needed).

2.12.16 For exploration, production, transport, and processing of oil and natural gas, storage vessels must not leak and tank thief hatches must be closed when not being serviced during liquid transport, repair, or measuring activities. Valves must be maintained in a leak-free condition (<10,000 ppm leakage). The venting of volatile organic compound and hazardous air pollutants emissions would achieve at least 95 % emission reduction from uncontrolled emissions through the use of vapor recovery units, combustion, or other practices allowed by air quality regulatory agencies.

2.12.18 No-bleed, low-bleed, or air-driven pneumatic devices are required for all new and retrofitted oil and natural gas production sites to reduce methane emissions. Exceptions may be made for safety and operational requirements.

Guidelines

2.12.22 Volatile organic compounds, hazardous air pollutants, and greenhouse gases should not be vented from existing wells and should achieve at least 95% emission reduction from uncontrolled emissions through capture and delivery to sales pipeline, vapor recovery units, combustion, or other practices allowed by air quality regulatory agencies. This would eliminate most venting from well blow-downs, during the well completion process, from oil wells freely venting casing gas, and from defective gas well bores. Exceptions may be allowed for Bradenhead testing or other well tests where venting occurs for time periods of less than 10 minutes.

2.12.23 For new lease or new development areas, new mineral development facilities should be collocated and/or centralized. Facilities include roads, well pads, utilities, pipelines, compressors, power sources, fluid storage tanks, and other associated equipment. Collocation of wells (more than one well per pad) should be required where feasible.

Alternative Energy

Desired Conditions

Biomass

2.20.6 Forest vegetation management includes evaluation opportunities for harvesting and removal of biomass to meet treatment objectives.

2.20.7 Potential partners are involved and collaborate with in exploring economically efficient means for biomass utilization.

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