ADAPTIVE MANAGEMENT; ASSESSMENTS, MONITORING AND RESEARCH

A strong adaptive management process will be in the forests best interest to guide future management activities, to provide education and outreach on success stories, and to facilitate any future Planning and NEPA processes (e.g, Forest Plan Revision, Travel Management Plan, White Mountain Stewardship, Four-Forest Restoration Initiative (4-FRI), and Other Projects). This is an opportunity for the forest to invest funds that otherwise could not be allocated towards baseline data to guide and help support these ongoing initiatives. The possibility to get this amount of funding for fire restoration treatments potentially over $50 million dollars over 3 years, warrants spending a small percent on the adaptive management process. The importance of using some science, and evaluating management practices that will have a greater chance of success, to be more cost efficient, is in everyone's interest. Spending a portion of the BAER funding on these adaptive management activities is required by policy, and will demonstrate sound ecological and fiscal management. The baseline information which otherwise would not likely be collected, will also provide quantified resource data to inform management decisions over decades and thus should be considered a sound investment.

Although the Wallow Fire is not a typical fire event, very recent and relative research done in the Southwest Region regarding post-fire rehabilitation and restoration treatments and natural vegetation response, should be evaluated for lessons learned to inform future activities (Peppin et. al 2010; Peppin et al. 2011; Robichou et al. 2009). Additionally key contacts on nearby forests and from other agencies should be solicited for their lessons learned and advice on what worked and what did not in similar situations (e.g., Rodeo Chediski, Warm Springs,).

The opening up of certain recreational opportunities, grazing, hunting and forest thinning areas could potentially exacerbate hill slope soil erosion, debris flows, and potentially delay the natural regeneration of the burned area in particular areas. These would include priority high to extreme risk watersheds (see HUD-6 Watershed Risk Map 1), areas with moderate to high fire severity, T&E species habitats, sensitive habitats, culturally important sites, and areas with special resource values, etc. Any management activities in these areas that would further disturb vulnerable soil conditions, native seed crops and new regeneration would not be recommended for periods of greater than 1-3 years, depending upon assessment of resource conditions.

After stabilizing soil erosion threats and risk to lives and properties, the recovery of the watersheds, specifically riparian and wetland ecosystems should be the greatest priority. The soil stabilization and recovery of the upland watershed vegetation cover is implicit in this recovery. The recovery of the wetlands however will be the measure of success overall, which will be measured through water quality and riparian recovery assessments and monitoring. This is because of the important values of these riparian ecosystems for water storage and filtration, range, wildlife, recreation and biological diversity. These ecosystems are thought to be less-adapted or more-sensitive to fire. The recovery of stream and aquatic habitats is varied but can take more than 15 years in places (Elliot et al. 2010; Benda et. al., 2003; Miler et. al., 2003;

Scheidt 2006) and will likely require the most attention with regards to more intensive monitoring and restoration treatments. These priority watersheds and riparian ecosystems (ranked by watershed risk and listed below, See Map 2) are in essence the 'biggest bang for the buck' for focusing assessment and restoration efforts, because through them, the most valued resources on the forest are sustained, and as this is achieved for each priority watershed, this will also provide a strong indication of acceptable upland forest and range conditions.

Coarse-scale assessments (e.g., BARC Mapping, Soil Burn Severity Mapping) during the Emergency Stabilization and BAER planning and implementation phases have thus far guided treatments to stabilize hill slopes and soils primarily above communities, on the steepest slopes and associated with moderate to high burn severities. Given the size, magnitude of impacts to human life and safety, and urgency to complete treatments prior to the monsoon rains, these assessments and treatments have been acknowledged to likely have many uncertainties and high variability. Further assessments and monitoring are necessary to validate or refute some of these assumptions and BAER modeling (e.g., Post-fire response in moderate and high burn severity, and treated areas). The less-urgent situation in the future (e.g., $\leq$ 6 months of fire control) should enable a more responsible approach to spending, a more strategic selection and placement of treatments, informed by a more rigorous level of assessment, monitoring and research.

On a normal year, typical hill-slope stabilization treatments have a low to moderate potential for effectiveness, some much less than others (Robichou et al. 2000, 2009). Given the current drought and long-range forecast for increased warming their effectiveness may be even less certain. Seeding in particular, has been shown to be ineffective the first year, less effective than mulching (e.g., with various biomass materials), to inhibit native species regeneration, and to have the highest potential for exotic species introductions (Keeley et al. 2006; McMaster et al. 2010; Peppin et. al 2010; Peppin et al. 2011). Due to the number of forest fires with large moderate and high severity components in the Southwest, native seeding mixes have been quickly stripped from local distributors, and managers have been forced to buy seed from larger companies outside the region. This also calls into consideration the quality of the current and future seed sources. The high financial cost and low potential for effectiveness should caution the continued practice of seeding areas burned in high-severity wildfires (Stella et al. 2010). Stella et al. (2010) provides growing evidence that post-fire seeding is often ineffective in enhancing post-fire plant cover, reducing bare ground, or reducing invasive non-natives (Hunter et al. 2006; McMasters et al. 2010). **Mulching** should be considered over seeding in most cases; the risk of introduced persistent, exotic and noxious species is typically less usually with greater efficacy and lower cost. Nevertheless, rapid detection of exotic and noxious species should be a priority.

A change condition assessment using remote sensing technologies (e.g., satellite imagery, remote weather station flood early-warning systems, and in-stream sensors) with on the ground assessment would include an assessment of completed BAER treatments for efficacy and an evaluation of native vegetation response. Key variables would include effectiveness of

treatments, flood, sedimentation, natural vegetation response at ecosystem level, water quality and chemistry changes for important aquatic systems and fisheries.

The development of a relatively simple evaluation tool would include a catalog of repeatable photographs that would document the forest changes in context of burn severities, forest habitat types, burn severity, treatments, special sites and resource values (e.g., recreational sites, pastures, critical and sensitive habitats). This tool would be used to demonstrate success stories and best management practices, for reporting and assessment of resource change and condition, and internal and external education and outreach.

The large uncertainty with relative treatment effectiveness and huge cost associated with stabilization and rehabilitation treatments, warrant a more detailed and regular assessment to focus future actions on emerging critical needs for treatments in highest-valued-resource areas. Due to the rapidly changing conditions, the ongoing coarse-scale assessments and uncertainty with treatment effects, future treatments and activities should be regularly evaluated and re-evaluated through an interdisciplinary assessment process with key forest staff for measures to best protect and restore the future resource base.

ADAPTIVE MANAGEMENT;

ASSESSMENT, MONITORING, AND RESEARCH GOALS

Not everything needs monitoring; prioritize by risk to lives and properties, high resource values, relative risk of population declines, endangered, threatened, rare, and sensitive species and their habitats. The goal will be to invest a small percentage of overall funding in an adaptive management process to help guide future treatments and management actions to be more cost and ecologically effective. Additionally these activities will be designed to help complete and inform related ongoing forest planning and NEPA. Research level academic studies would be desirable for some of the complex topics below for example related to hydrological and riparian changes, and Threatened and Endangered Species.

The first critical assessment activity the forest will be involved with would be a coarse-scale resource-condition-change assessment using remote sensing technologies. This assessment is crucial to inform decisions on infrastructure, range allotments and pastures, dispersed recreational sites, salvaged timber, and to strategically place future rehabilitation treatments, etc... This would likely begin early in FY2012 and could be required multiple times over the next several years to assess longer-term post-fire vegetation and soil recovery. It is recommended this be conducted at the scale of the burned area and include adjacent lands for comparison and to assess down-stream effects. This could also help inform for example other Forest planning and NEPA needs for 4-FRI, Forest Plan Revisions, TMR, and WMS. This could be completed by an assembled team with special skills, or it could be contracted out to a

university (e.g., the Environmental Restoration Institute at NAU). Alternatively the regional office could potentially provide this support in collaboration with R-3 Regional Office, the USDA Remote Sensing Applications Center (RSAC) and the Monitoring Trends in Burn Severity (MTBS) program.

Additional assessment and monitoring needs can be achieved through the hiring of seasonal task forces and led by a forest ecologist or biologist, or other team leader. This position should be identified immediately in FY2012 as an assessment-monitoring leadership position and extended as needed over next 1-3 years. This person would act as team leader of assessment and monitoring duties for the burned area and as team leader for several monitoring task forces (see next paragraph). This position would also be responsible for the analysis, interpretation, reporting and dissemination of assessment and monitoring data for public outreach and education. This would include the incorporation of pre-fire monitoring and other resource data. This position would also integrate related assessment and monitoring needs of the current Forest planning and NEPA needs (e.g., 4-FRI, Forest Plan Revision, WMS, and Salvage).

To implement the numerous key resource area assessment and monitoring goals and objectives, it is recommended students seasonals be hired to strategically target priority areas as task forces. Seasonal student task forces (6 person teams) could be utilized in a very cost efficient manner to implement assessment and monitoring priorities. These teams could be hired in the spring of 2012 through 2015 as needed. There may be opportunities for seeking in-kind contributions for these teams from partners and support groups due to student nature. Teams could be hired for some of the following high priority resource areas; condition change assessments, soils-hydrological, aquatic-riparian-fisheries, exotic species.

It is recommended that a research coordinator is hired immediately in the fall of 2012 as needed for a year or more. This position would coordinate forest fire research priorities and reduce the workload of forest staff who would otherwise be dealing directly with these requests. This position should develop a short research plan that outlines existing research, principal investigators, and priority research needs within burned area. Additionally this position would solicit competent research scientists to help obtain funding and to conduct priority research. They would also look for partners and other agencies to help contribute research and monitoring financial support. They would also help draft special-use permits for research activities. This could be done economically for example through the funding of a Graduate Assistantship Student, at one of the university, natural resource programs. Alternatively, this could be delegated to a team position with similar interest and experience. See list of possible Research Opportunities below.

OBJECTIVES (not necessarily in order of priority)

1. Human Health and Safety; Assess hydrological, debris flows, rolling debris and hazardous tree threats to roads, recreational areas, and infrastructure that could potentially jeopardize human health and safety (see hydrological, engineering infrastructure and human health and safety sections for details).
2. Resource Condition Change Assessment; Geographic information science and remote sensing technologies should be used in combination with on-the-ground assessments (e.g., due to lower cost, ease and rapid repeatability). This process could be used to assess changes to a variety of key resource conditions (e.g., soils, watershed, range, timber, riparian, etc…). Assess resource change in condition and post-fire vegetation response in Low, Moderate and High Burn Severity and areas with special resource values (e.g., to inform appropriate timing for opening grazing pastures, recreation areas, hunting units), and to strategically guide future restoration treatments.

    a. Assess range condition/ vegetation response using accepted methods to determine when individual allotments and pastures are re-opened (See Range section for more detailed methods for range condition analysis).
        i. Assessment needs to include standing seed crop (annuals and perennials) and grazing effects.
        ii. Prioritization should be in order of low, moderate, and high severity burn areas
        iii. Low severity completed in spring 2012
        iv. Assess seed crop productivity.
    b. Monitor and evaluate natural ecosystem regeneration in high to moderate burn severity areas for sufficient vegetation soil cover to help strategically locate any additional rehabilitation/revegetation treatments for example mulching, seeding, or planting.

3. Critical and sensitive species and habitats
        i. T&E species
            1. Mexican Spotted Owl
            2. New Mexican Jumping Mouse
            3. Mexican Wolf
        ii. Sensitive Species
            1. Locate populations of rare and sensitive plant species, monitor for post-fire response.
            2. Set up repeat photo points in areas with sensitive plant species to document fire effects and species response to fire.
            3. Aspen not impacted by sudden death syndrome and where prone to heavy herbivory.

b. Sensitive Plant Species; Set up repeat photo points in areas with sensitive plant species to document fire effects and species response to fire.

4. Assess and monitor high to extreme risk watersheds, streams/ riparian systems for change conditions including stream flow, habitat structures, stream sediment, course woody debris, general recovery progress and need for additional treatments to rebuild connectivity to stream bank and watershed (see more detailed monitoring design and technologies under Hydrology, Soils and Wildlife sections).

    a. Assess and Monitor Priority High to Extreme Risk Watersheds and Priority Stream Systems below (See Hydrological and Fish and Aquatics sections; Map 1)
        i. East Fork Black River
        ii. Campbell Blue
        iii. Southfork Lower Colorado River
        iv. Rudd Creek
        v. Lower West Fork of Black River
        vi. Boneyard Creek
        vii. Coyote Tributary of Black River
        viii. Fish Creek
        ix. Conklin Creek
        x. Bear Wallow Creek

    b. Monitoring and control elements
        i. Aquatic exotic species early detection and control
        ii. Water quantity, quality, turbidity, woody debris, pool max depth, pebble counts, photo points, etc.
        iii. Pre-existing and proposed Channel Cross-Sections
        iv. Fish Barrier Function/Maintenance
        v. Riparian Vegetation Recovery
        vi. Micro- and macro- invertebrates

    c. Aquatic T&E Species in watersheds with high to very-high risk (see Map ? and BAER Plan assessment)
        i. Three Forks Spring Snail and Anodonta
        ii. Loach Minnow
        iii. Apache Trout
        iv. LCR Spinedace
        v. Spike Dace
        vi. Gila Trout

vii. Roundtail Chub
viii. Chiricahua Leopard Frog
ix. Southwestern Willow Flycatcher
x. Narrow Headed Garter Snake

5. Rapid detection and control treatment of upland exotic and noxious species in areas of high risk and vectors for dispersal (See ABAER Plan section on noxious weeds, and Range Section).
    a. Suppression and Rehabilitation resource roads, dozer lines, staging areas, camps, helispots, etc…
    b. Roads, trail, recreational areas, Range corrals and staging areas
    c. BAER treatment areas with seeding and mulching treatments
    d. Known populations of exotics that may be exacerbated by burn severity
        - Mullein
        - Musk thistle
        - Dalmatian toadflax
        - Saltcedar
        - Siberian elm
        - Bull thistle
        - Canada thistle
        - Whitetop
        - Leafy spurge
        - Jointed goatgrass
        - Cheatgrass
        - Oxeye daisy

6. Research Opportunity Possibilities (not prioritized; See other specialist reports by resource area for more research possibilities).
    - Fire history reconstructions using fire-scarred tree-ring samples for forest ecosystems where there is little documentation or this information is relatively unknown.
    - MSO post fire habitat selection and vegetation changes in relation to fire severity and burned area rehabilitation treatments.
    - Fire effects by severity classes on T&E species populations and related habitat changes or response.
    - Provide support for the Rock Mountain Research Station as described in the Hydrology BAER report as this will give valuable treatment analysis concerning BAER efforts. POC for this research is Pete Robichaud and Dan Neary of the RMRS. This effort will result in GTR with findings and recommendations addressing BAER treatment effectiveness.

- Examine effectiveness and longevity of fuels treatments implemented for hazard reduction within and adjacent to Wildland Urban Interface.
- Quantify the effectiveness of seeding/mulching in enhancing plant cover and reducing non-native invasive plants.
- Effects of a wildfire on large trees and fuel beds.
- Will forest composition along lower and upper ecotones change following a wildfire?
- High and moderate fire severity effects on aspen stands prone to heavy elk herbivory and sudden aspen decline syndrome.
- Quantify burn severity effects on large soil loss events?
- What factors contributed to fire spreading through some aspen stands under different burn severities and not in others?
- Quantify fire effects on current and proposed Research Natural Areas.
- SW White Pine blister rust interactions with *Ribes spp.* and fire effects.
- Fire and flood effects on AZ willow.
- Fire effects and severity interactions regarding forest stands infected by dwarf mistletoe.
- Assess effectiveness of Douglas-fir bark beetle pheromone treatments.
- Fuel treatment effectiveness and longevity
- Validation of Fire Behavior Models
- Fire effects and interactions with forest insects and disease

Literature Cited

Benda L., D. Miller, P. Bigelow, and K. Andras. 2003. Effects of Post-Wildfire Erosion on Channel Environments, Boise River, Idaho. Forest Ecology and Management;.

Elliot, William J.; Miller, Ina Sue; Audin, Lisa. Eds. 2010. Cumulative watershed effects of fuel management in the western United States. Gen. Tech. Rep. RMRS-GTR-231. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 299 p.

Hunter, M.E., P.N. Omi, E.J. Martinson, G.W. Chong. 2006. Establishment of non-native plant species after wildfires: Effects of fuel treatments, abiotic and biotic factors, and post-fire grass seeding treatment. International Journal of Wildland Fire 15:271-281.

Keeley, J.E., C.D. Allen, J. Betancourt, G.W. Chong, C.J. Fotheringham, and H.D. Safford. 2006. A 21st Century Perspective on Postfire Seeding. Journal of Forestry. Perspective; 1; 1-2.

McMaster M.A., A. Thode, B.Brost, M. Williamson, E. Aumack, D. Mertz. 2010. Changes in vegetation and fuels due to the Warm Fire on the Kaibab National Forest. Final Report to the Joint Fire Sciences Program, Project Number 07-1-2-18.

Miller D., C. Luce, and L. Benda. 2003. Time, space, and episodicity of physical disturbance in streams. Forest Ecology and Management;.

Peppin D., P.Z. Fulé, C.H. Sieg, J.L. Beyers, and M.E. Hunter. 2010. Post-wildfire seeding in forests of the western United States: An evidence-based review. Forest Ecology and Management 260 (2010) 573–586.

Peppin D., P.Z. Fulé, J.C. Lynn, A.L. Mottek-Lucas, and C.H. Sieg. 2011. Market Perceptions and Opportunities for Native Plant Production on the Southern Colorado Plateau. Restoration Ecology: 1-12.

Robichaud, P.R., J.L. Beyers, and D.G. Neary, 2000. Evaluating the Effectiveness of Postfire RehabilitationTreatments. Rocky Mountain Research Station, General Technical, Report RMRS-GTR-63.

Robichaud, P.R., S.A. Lewis, R.E. Brown, and L.E. Ashmun. 2009. Emergency post-fire rehabilitation treatment effects on burned area ecology and long-term restoration. Fire Ecology 5(1): 115-128.

Scheidt, N. E. 2006. Stream succession: channel changes after wildfire disturbance. Thesis in the College of Graduate Studies, University of Idaho. 69 pp.

Stella K.A., C.H. Sieg, and P.Z. Fule´. 2010. Minimal effectiveness of native and non-native seeding following three high-severity wildfires. International Journal of Wildland Fire: 19; 746–758.