Appendix B – Literature Review

During the Warm Fire Recovery project analysis, the interdisciplinary team considered literature items identified during public comment periods. Many articles were brought forth in the context of conflicting science; however, some of the literature documented study findings for moist forest ecosystems not found in the dry conifer forests of northern Arizona. The interdisciplinary team considered the articles identified and relevant literature was cited in the analysis.

The following presents the review completed by the interdisciplinary team of the above described literature. In addition to the literature listed here, the interdisciplinary team considered literature cited and listed in the EIS.

Abbott, Isabella A. Ph.D. a letter opposing post-fire logging sent to Congress on Aug. 1, 2006 the letter was also signed by 556 other scientists their names are all included in the link below.

http://www.nativeforest.org/pdf/Post-fire%20logging%20scientists%20letter.pdf

"When we, as scientists, see policies being developed that run counter to the lessons of science, we feel compelled to speak up."

"Although logging and replanting may seem like a reasonable way to clean up and restore forests after disturbances like wildland fires, such activity would actually slow the natural recovery of forests and of streams and creatures within them. Many scientist-reviewed studies and syntheses (please see the selected citations appended to this letter) have recently come to this conclusion."

"For example, no substantive evidence supports the idea that fire-adapted forests might be improved by logging after a fire. In fact, many carefully conducted studies have concluded just the opposite. Most plants and animals in these forests are adapted to periodic fires and other natural disturbances."

"Specifically, post-disturbance logging impedes regeneration of forest landscapes when it compacts soils, removes or destroys so-called biological legacies (such as soil organic material, seeds in the soil, large standing and downed trees), damages riparian corridors, introduces or spreads invasive species, causes erosion, delivers sediment to streams from logging roads and steep slopes, degrades water quality, and damages populations of many aquatic species."

"Rather than leaving plant material standing and providing perching, nesting, and feeding sites for wildlife, such logging abruptly moves the material to the ground. Most of this material would naturally fall to the ground, adding important supplies of nutrients and energy to the forest floor and structure in the form of woody debris to stream channels. But this naturally happens over decades, not in the relatively short time associated with a logging operation. Advocates of post-disturbance logging may argue that this slash can be disposed of with controlled burns and other treatments. Yet such treatments can severely damage underlying soils, imposing other taxes on natural recovery. One additional tax concerns us. Postfire logging taxes the public treasury. Recent analysis of postfire logging operations after Oregon's Biscuit fire of 2002 shows that costs of the logging operations exceeded revenue by about $14 million for logging that removed more than 53 million board feet of timber (DellaSala et al. 2006)."

"Science provides the best insight into the real consequences of our policies and actions. Ironically, this legislation is crafted to ignore the science by waiving environmental reviews, reviews that would make use of the scientific knowledge often available only because of expenditures of public funds. Failure to conduct full environmental reviews informed by that science will inevitably lead to ecological and economic harm from post-disturbance logging."

"In short, neither ecological benefits nor economic efficiency result from post-disturbance logging. We therefore urge you to defeat these legislative efforts because they will set back forest recovery."

"We urge you to work with your fellow lawmakers to craft legislation that will rely on the most up-to-date scientific knowledge to protect the natural resources of the nation's public lands."

Review:

- The Warm Fire Recovery (WFR) project environmental impact statement (EIS) documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and vegetation section in the EIS references multiple scientific studies in the discussion of "Vegetation" response to fire.

Albini, F. A. and E. D. Reinhardt. 1997. Improved calibration of a large fuel burnout model. International Journal of Wildland Fire 7(1):21-28.

Review:

- This document describes updates to large fuel burnout models for predicting fuel reduction during burning. It focuses on the interaction between individual fuel pieces during burning due to the exchange of radiation during burning. The concepts of this document are incorporated into the fuels analysis.

Allen, Craig; Savage, M.; Falk, D; et al. 2002. Ecological Restoration of Southwestern Ponderosa Pine Ecosystems: A Broad Perspective. Ecological Applications 12(5), p 1424-1425.

Review:

- The purpose of this paper is to promote a broad and flexible perspective on ecological restoration of Southwestern (U.S.) ponderosa pine forests.
- One of the concepts endorsed in this paper is the re-introduction of low intensity fire. This concept was considered in designing the WFR project as demonstrated by the following sentence within the desired condition statement for the WFR project: "The future forest can be sustained with fire functioning as a key ecological process."
- Another concept endorsed in this paper is that of natural variability and the need for treatments to be "flexible enough to recognize and accommodate: high levels of natural heterogeneity; dynamic ecosystems; wildlife and other biodiversity considerations;

scientific uncertainty; and the challenges of on-the-ground implementation." In the purpose and need for the WFR project, it is stated that the Kaibab NF is not willing to tolerate long regeneration periods in areas that have a low potential for natural regeneration and where there is a reasonable potential of planting success. It is recognized that there is going to be high levels of variation across the landscape after the Warm Fire due to aspen sprouting, variable and sometimes heavy natural regeneration adjacent to existing seed sources, variable planting densities and survival in areas identified for planting, and slow (in some cases 100+ years) recolonization of conifers in harsher areas with no seed sources. We have acknowledged the pros and cons of salvage logging within the WFR project and designed the project by considering biodiversity. The project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ would not be identified for removal.

Amaranthus, M. P., D. S. Parrish and D. A. Perry. 1989. Decaying logs as moisture reservoirs after drought and wildfire. Pp. 191-194 in: E.B. Alexander (ed.). Proceedings of Watershed '89: Conference on the Stewardship of Soil, Air, and Water Resources. USDA For. Serv. Reg. 10 RIO-MB-77.

Review:

- Paper not available.
- The WFR project addresses coarse woody debris (CWD) to meet CWD as discussed in Brown (2003) and Graham (1994).

Amaranthus, M.; Jubas, H.; and D. Arthur. 1988. Stream Shading, Summer Streamflow, and Maximum Water Temperature Following Intense Wildfire in Headwater Streams. Unpublished paper presented at the Symposium on Fire and Watershed Management. October 26-28. Sacramento, CA. 4p. (GTR-PSW-109a pp. 75-78).

Review:

- The authors monitored stream shade following wildfires which burned intensely in headwater streams. The streams measured had decreases of approximately 60 percent shading. On these streams they found that solar radiation of streams increased substantially, which correspondingly had variable increases in stream water temperature.
- The WFR project area has no perennial streams. The few intermittent and ephemeral streams which do occur in the project area generally flow in response to spring snowmelt runoff and high intensity, short duration precipitation storm events. The water temperature of runoff which results from these events under these stream channel flow regime types is not likely to be affected by the lack of stream shading.

Andrews, P. L. 1986. BEHAVE: Fire Behavior Prediction and Fuel Modeling System: BURN Subsystem, Part One. USDA For. Serv. Int. Mtn. Res. Sta. Gen. Tech. Rep. INT-GTR-194. Ogden, UT.

Review:

- This document is essentially the instruction manual for running the BURN submodel within BEHAVE. This serves as background information.

Andrews, P. L. and R. C. Rothermel. 1982. Charts for interpreting wildland fire behavior characteristics. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. INT-GTR-131. Ogden, UT.

Review:

- This publication consists of NFDR fire characteristics charts. These charts are sometimes referred to as the "Hauling" chart. This publication is used as general background information in the fuels report.

Audubon WatchList Online. 2002 An Early Warning System for Bird Conservation. Olive-sided Flycatcher (*Contopus cooperi*)

http://audubon2.org/webapp/watchlist/viewSpecies.jsp?id=152

"Although numerous studies report a positive response to some types of harvested forest in the United States and Canada, Olive-sided Flycatchers have experienced precipitous population declines in nearly every region of its breeding range. These declines may likely be due to major deforestation on its wintering grounds. Additionally, it has been speculated that Olive-sided Flycatchers historically depended on post-fire habitats, so it has been proposed that harvested forests may actually be an ecological trap: while they look similar to a post-burn forest, they may function quite differently."

Review:

- This species account summarizes distribution and population trends, ecology, threats, and conservation ideas for the olive-sided flycatcher. It identifies preferred habitat as middle to high elevation montane and coniferous forests, often associated with forest openings and edges. Presence in early successional forests appears to depend on the availability of snags or live trees. While the paper does say that it has been speculated that harvested forests may be an ecological trap, it states that more studies are needed.
- The Warm Fire wildlife analysis includes olive-sided flycatchers as they have been identified as a priority species by Arizona Partners in Flight (PIF). PIF also identified habitat management recommendations which are also addressed in the analysis.

Bailey, T. 1993. Silviculture Process Paper. Warner Fire Recovery Project Final Environmental Impact Statement. USDA-FS Willamette National Forest. p. C-10.

Review:

- This paper was not available.
- The WFR project EIS includes analysis considered relevant scientific information from local research, as well as relevant factors from offsite research papers. The FEIS includes discussions of analysis methods and models used for the various resource analyses.

Bate, L. J.; Garton, E. O.; and M. J. Wisdom. 1999. Estimating Snag and Tree Densities and Distributions on a Landscape for Wildlife Management. USDA-FS Pacific Northwest Research Station. Gen. Tech. Rep. PNW-GTR-425. 76 p.

Review:

- This report discusses methods for sampling snags and large trees at the subwatershed scale, in order to conduct monitoring that will determine compliance and effectiveness in relation to habitat standards and guidelines contained in forest plans.
- Snag retention direction for the WFR project was developed based on existing direction, and includes a focus on retention of clusters of larger diameter snags (to increase longevity and use by more species), and leaves more snags close to green forests that are more likely to be used by species such as hairy woodpecker.

Beschta, Robert L. Ph.D., Christopher A. Frissell Ph.D., Robert Gresswell Ph.D., Richard Hauer Ph.D., James R. Karr Ph.D, G. Wayne Minshall Ph.D., David A. Perry Ph.D. and Jonathan J. Rhodes. 1995. Wildfire and Salvage Logging: Recommendations for Ecologically Sound Post-fire Salvage Logging and other Post-fire Treatments on Federal Lands in the West. Unpublished Report. Oregon State University.

http://www.saveamericasforests.org/congress/Fire/Beschta-report.htm

Also available as:

Beschta, R. L., C. A Frissell, R. Gresswell, R. Hauer, J. R. Karr, G. W. Marshal, D. A. Perry, and J. J. Rhodes. 1995. Wildfire and salvage logging: recommendations for ecologically sound post-fire salvage logging and other post-fire treatments on federal lands in the west. Pacific Rivers Council. Accessed online January 22, 2007 from http://www.pacrivers.org.

"There is little reason to believe that post-fire salvage logging has any positive ecological benefits."

"Salvage logging results in significant resource damage while altering the natural plant and animal succession."

Review:

- This commentary was written by a group of scientists intending to help guide the policy debate concerning salvage logging in post-wildfire watersheds. The authors present several scientific principles and practices that are directed at promoting ecological recovery from wildfire events. The paper describes several areas and situations where the authors believe that salvage logging disrupts ecologic recovery in burned watersheds.
- Beschta et al. provide findings and recommendations for fire management and salvage logging. In general, they find that natural recovery is a better path to ecologic recovery than management intervention. They reason that species in fire-adapted ecosystems have the ability to recover from wildfires, and that historic and continued human intervention only retards the ecological recovery process. The authors list several recommendations on post-fire actions. The Warm Fire Recovery project attempts to address these recommendations through the application of project design features, best management practices, and mitigation measures. The authors' recommendations are listed along with the appropriate project design features developed for the Warm Fire Recovery project.
- Salvage logging should be prohibited in sensitive areas.
    - The project does not totally prohibit logging in sensitive areas (such as on severely burned areas or erosive soils), but soil and water project design features such as the following are included to prevent or minimize further impacts to soil and water resources.
        - All ephemeral and intermittent stream channels would receive at least a 100-foot no disturbance buffer from the edge of the channel (a stream channel is defined as: a drainage feature with a definable bed and bank with evidence of scour). All streams are ephemeral/intermittent: there are no perennial streams in the project area.
        - No new system roads or temporary roads would be constructed. Existing closed roads would be opened for project activities and closed upon completion of the project.
        - On treatment units where soils are categorized as severely erodible, ground-based yarding and fuels treatment equipment would be restricted to slopes less than 20 percent.
        - Maintain a minimum spacing of 100 feet between skid trails.
        - Skid trails will not exceed 20 percent slope for distances greater than 100 feet.
        - Skidders and other fuels treatment equipment will be restricted to designated skid trails during non-winter harvest and fuels reduction activities, and will use existing skid trails where available. All skid trails would be water barred following completion of mechanized equipment operations.
        - Lop and scatter residual slash to a depth of 18 inches or less to provide some ground cover to reduce the potential for soil movement.

    - The operation of equipment will be restricted when soil conditions are such that accelerated soil erosion, excessive soil surface displacement, or excessive compaction would occur.
    - Ground-based mechanical falling and yarding operations would be stopped on units where soil conditions are such that rutting is occurring to depths greater than 4 inches.
    - Rip and seed/plant all existing and project created landings after project activities are complete. Erosion control seeding would use native seed, or sterile nonnative seed, or a mix of both.
- On portions of the post-fire landscape determined to be suitable for salvage logging, limitations aimed at maintaining species and natural recovery processes should apply.
    - Planting will occur within high and mixed-high fire mortality areas where limited and poorly distributed seed sources currently exist and where there is a moderate to high potential for planting success. This includes salvage units and other areas where the soil inventory indicates a moderate to high potential for planting success.
    - Areas determined to have enough aspen present to restock the stand through sprouting will be managed for aspen restoration, and artificial regeneration of conifers will not occur.
- Because of the wide range of chronic ecological effects associated with road building, the building of new roads in the burned landscape should be prohibited.
    - No new roads would be constructed.
- Active reseeding and replanting should be conducted only under limited conditions.
    - All plant material (e.g., straw, mulch, seeds, etc.) used for erosion control and/or roadside maintenance must be certified weed-free. A Forest Service botanist, biologist, or range conservationist must approve seed mixes prior to application. Where available, local or onsite native plant seed sources are preferred. Weed-free native seed or sterile nonnative seed or a mix of both may be used in the absence of local plant seed sources.
    - Planting will occur within high and mixed-high fire mortality areas where limited and poorly distributed seed sources currently exist and where there is a moderate to high potential for planting success. This includes salvage units and other areas where the soil inventory indicates a moderate to high potential for planting success.
- Structural post-fire restoration is generally to be discouraged.
    - There are no structures planned for stream channels. Some culverts may be cleaned to improve road drainage following best management practices for road maintenance.
- Post-fire management will generally require re-assessment of existing management.
    - This is outside of the scope of the current project analysis.

- Continued research efforts are needed to help address ecological and operational issues.
  - Discussions are currently underway with the Rocky Mountain Research Station to develop research projects within the wildfire area.
- Additional information must be provided to the public regarding natural fires and post-burn landscapes to provide balance to the "Smokey Bear" perspective of fires and forests.
  - This is outside the scope of the current project analysis.
  - The concept that native species are adapted to natural patterns and processes of disturbance and recovery in the landscape of the Kaibab Plateau was considered in designing the WFR project. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

Beschta, R. L. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range. Water Resources Research 14:1011-1016.

Review:

- This paper was included in the reviews in General Technical Report PNW-GTR-486 (McIver and Starr 2000). This paper was noted as a commentary with the following summarized conclusions:
  - There is no ecological need for immediate intervention after fire; most fires should not be suppressed.
  - No management should be done that does not protect soil.
  - Where salvage is conducted, leave all large trees and all live trees.
  - Use helicopters, cable yarding, or horse logging.
  - Research is needed on effects of new equipment and techniques for their suitability.
  - Post-fire logging, reseeding and replanting should be conducted only under limited conditions.
  - Managers should aim to re-establish natural disturbance regimes.
- The majority of the areas identified for salvage logging are 20 percent slope. Helicopter logging was considered but determined not economically feasible. Project design features were incorporated to protect soil resources and leave all live trees. Adequate large trees would be left onsite to provide for snag associated species as per forest plan direction, and to provide future coarse woody debris. The forest has been in contact with the research community for inclusion of sites in research proposals. Conifer planting is proposed within high and mixed-high fire mortality areas where limited and poorly distributed seed sources currently exist and where there is a moderate to high potential for planting success. This includes salvage units and other areas where the soil inventory indicates a moderate to high potential for planting success. Proposed planting is

designed to move these areas toward desired forested conditions. Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands and successful conifer reforestation observed on the salvaged and planted areas (USDA Forest Service 2008).

Beschta, Robert L. Ph.D. and J. Boone Kauffman Ph.D. "Expect fire of words once flames die down." Op-Ed in the Portland Oregonian. August 15, 2002.

http://www.saveamericasforests.org/congress/Fire/Oregonian-beschtaoped.htm

"Another environmental issue of major importance is how to treat the burned areas after the fires are out. Salvage logging and the seeding of exotic grasses after fire used to be standard practice. Yet it is remarkable how often land-management activities such as this are based upon very little science. Many scientists and land managers have expressed concern that salvage logging and grass seeding have more negative consequences than positive merits."

Review:

- This commentary notes decades of fire suppression lead to unnaturally high accumulations of fuels resulting in unnaturally severe fires, along with the issue of how to treat burned areas after the fires are out. The article notes a group of university and government scientists prepared the Beschta Report in March 1995, which provided recommendations for ecologically sound post-fire salvage operations and was produced in an attempt to integrate and synthesize the scientific knowledge regarding the environmental effects of post-fire salvage logging and other fuels treatments. The article refers to statements made by Forest Service officials regarding the article. There is no new information provided in this newspaper article. The Warm Fire Recovery project attempts to address the recommendations from the Beschta Report through the application of project design features, best management practices, and mitigation measures. See review of Beschta et al. 1995, above.

Beschta, R. L., J. J. Rhodes, J. B. Kauffman, R. E. Gresswell, G. W. Minshall, J. R. Karr, D. A. Perry, F. R. Hauer, and C. A. Frissel. 2004. Postfire management on forested public lands of the western United States. Conservation Biology 18(4): 957-967.

http://www.fs.fed.us/r6/fish/conservation-biology/11-postfiremanagement-2004.pdf

"Human intervention on the post-fire landscape may substantially or completely delay recovery, remove the elements of recovery, or accentuate the damage. In this light there is little reason to believe that post-fire salvage logging has any positive ecological benefits, particularly for aquatic ecosystems. There is considerable evidence that persistent, significant adverse environmental impacts are likely to result from salvage logging."

"There is generally no need for urgency, nor is there a universal, ecologically based need to salvage at all."

Review:

- This is a followup paper to the Beshcta et al. written in 1994. The authors promote the need to evaluate the effects of post-fire treatments in an ecological context. In this paper the authors review the existing literature and clarify and update their original position paper. Through this latest literature review, the authors find that there are certain environmental situations or where there are promising post-fire rehabilitation treatments. These include the rehabilitation of fire lines and roads, retention of large trees, and in some cases the planting of native species. They also note several practices which they feel are inconsistent with efforts to restore ecosystems after a fire: seeding of exotic species, livestock grazing, placing of structures in and/or near stream channels, ground-based salvage logging, removal of large trees, and road construction.
- The portion of the wildfire area within the proposed Warm Fire Recovery project area has or is planning to implement most of the suggestions or recommendations made by the authors. All of the fire lines built for fire suppression have been rehabilitated. Further, road and trail drainages have been maintained and upgraded to deal with runoff from the burned watershed condition. The seeding of nonnative species has been minimized and livestock grazing has been deferred until the watershed condition has improved sufficiently to withstand grazing pressures. There are no plans to place structures in or near stream channels, and there are also no plans to build any new or temporary roads. Ground-based logging is planned, but it is mostly restricted to existing skid trails and slope 20 percent and less, so it is expected that the adverse effects of ground-based logging will be minimized.

Beyers, Jan L., "Postfire Seeding for Erosion Control: Effectiveness and Impacts on Native Plant Communities." Conservation Biology, Volume 18, Issue 4, Page 947, August 2004.

"In all vegetation types, successful growth of seeded grasses (enough to affect erosion) appears to displace native or naturalized species, including shrub and tree seedlings."

Review:

- This paper discusses the effectiveness and impacts of post-fire grass seeding for erosion control.
- The WFR project does not propose large-scale grass seeding. Natural post-fire grass, forb and shrub plant recovery has progressed adequately over the last 2 years. There is no indication that the burned area emergency rehabilitation grass seeding that was done directly after the fire is inhibiting natural shrub or tree seedling regeneration.

Blake, J. G. 1982. Influence of fire and logging on nonbreeding bird communities of ponderosa pine forests. J. Wildl. Manage. 46(2):404-415.

Review:

- This study looked at changes in bird communities during the non-breeding season. Blake's results suggest that the primary discriminating factor was the degree of openness of habitat. The extent of the habitat modification (whether from burning or logging) may be more influential than the type of alteration. These conclusions suggest

that the salvage proposed in the mixed-high and high mortality areas in this project would not affect non-breeding bird communities as the area already supports species using open habitats as a result of the fire mortality.

Boddy, L. 1983. Microclimate and Moisture Dynamics of Wood Decomposing in Terrestrial Ecosystems. Soil Biology and Biochemistry 15(2):149-157.

Review:

- The author studied the relationships of microclimate, temperature, and moisture as they relate to wood decomposition processes.
- The author's study was conducted under environmental conditions that are not relevant to the WRF project. Wood decay properties and rates are much different within the drier WFR project area than in the moist climate of Kent, England.

Brewer, David. 2008. Managing Coarse Woody Debris in Fire-adapted Southwestern Forests. Working Papers in Southwestern Ponderosa Pine Forest Restoration. Northern Arizona University Ecological Restoration Institute. 21[1].

http://www.eri.nau.edu/joomla/files/NewsEvents/Brewer.2008.WorkingPaper21.pdf

Review:

- The author summarizes the available literature concerning CWD in Southwestern ponderosa pine forests.
- The WRF project used CWD recommendations cited in the Brewer report (2008).

Brown, J. K.; and T. E. See. 1981. Downed and Dead Woody Fuel and Biomass in the Northern Rocky Mountains. USDA-FS Intermountain Research Station. Gen. Tech. Rep. INT-117.

Review:

- The authors summarized data from downed dead woody fuel biomass collected in northern Idaho and Montana. The forest types, climate, and soils are quite different from the dry conifer types and arid climate found within the WRF project area. Therefore, the summary of fine fuel and CWD data are not directly applicable to the WRF project area. The discussion of fuels accumulations, succession of fuels, and the proposal that quantities greater that 15 to 20 tons per acre of woody material greater than 6 inches would diminish fire protection efficiency was considered in preparing the fuels report for the WFRP.

Brown, J. K.; Reinhardt, E. D.; and K. A. Kramer. 2001. Coarse Woody Debris and Succession in the Recovering Forest. Unpublished manuscript. 21p.

Review:

- The authors define and describe CWD and its ecology in pre- and post-wildfire landscapes. They discuss the competing issues of soil productivity, post-fire fuel buildup and soil heating. They go on to suggest CWD levels for post-fire landscapes in various forest types.
- The WFR project used the recommendations promoted in this paper and in the following paper by Brown et al. (2003).

Brown J. K., Reinhardt E. D., Kramer K. A. 2003. Coarse woody debris: managing benefits and fire hazard in the recovering forest. Ogden (UT): USDA Forest Service. General Technical Report RMRS-GTR-1 05.

Review:

- This paper discusses the effects to potential fire effects and fire hazard, particularly in regard to fuel loading when combined with small woody fuels. The authors refine and further develop their previous (2001) definitions and recommendations of CWD for recovering forests following wildfire. The WFR project analysis used the recommendations provided in this document.

Brown, Rick. 1997. Post-fire salvage. Natural Resource News. La Grande, OR:Blue Mountains Natural Resources Institute; 7(3): 4.

Review:

- This commentary expresses views of salvage logging. Brown discusses salvage of dead trees, specifically burned trees and notes a thorough, careful weighing of economic values versus ecological risks must be conducted, and must be fully disclosed for deciding officials and the public. The author sums by noting he considers post-fire salvage logging to be a dubious proposition at best; an activity that entails substantial risk of degradation of ecological values of public lands, with little public benefit. Mr. Brown notes public resources used to pursue questionable post-fire salvage operations are, in most cases, better used investing in restoration activities such as prescribed fire, road obliteration, and thinning of small live trees.
- The Warm Fire Recovery project includes analysis of economic values and ecological conditions including effects to soils and wildlife.

Bull, E. L., C. G. Parks, and T. R. Torgersen. 1997. Trees and logs important to wildlife in the interior Columbia River basin. USDA For. Serv. Pac. Nor. Res. Sta. Gen. Tech. Rep. PNW-GTR-391. Portland, OR.

Review:

- This publication provides qualitative and quantitative information on five distinct structures: living trees with decayed parts, trees with hollow chambers, trees with

brooms, dead trees, and logs. Information is provided on the value of these structures to wildlife, the decay or infection processes involved in the formation of these structures, and the principles to consider for selecting the best structures to retain.

- Project design features for this project include retention of groups of snags targeting existing clusters of the largest diameter snags available. This publication was not used specifically in this analysis, but it has long been recognized that downed logs have values for wildlife. The forest plan includes direction for downed log retention and this is included in the project design features. Appendix C of the wildlife report is a discussion and analysis of snags and downed logs. Additionally, studies in the interior Columbia River Basin would not be directly relevant to conditions in the arid ponderosa pine forests of the Southwest.

Burgan, R. E. and R. C. Rothermel. 1984. BEHAVE: Fire Behavior Prediction and Fuel Modeling System: FUEL Subsystem. USDA For. Serv. Int. Mtn. Res. Sta. Gen. Tech. Rep. INT-GTR-167. Ogden, UT.

Review:

- This document is the instruction manual for the fuel submodel within the BEHAVE model. This document is useful for background information when selecting fuel model parameters.

Byrnes, Patricia. 1988. Fire sales. Wilderness. Spring: 30-32.

Review:

- This paper was reviewed in General Technical Report PNW-GTR-486, January 2000. This commentary included the following summarized conclusions:
  - Burned areas will recover naturally, and salvage logging interferes with that process, thereby causing long-term damage.
  - When roads are built, the areas containing them no longer are eligible for wilderness consideration.
  - The combination of fire, logging, and roads could severely stress species in the area.
- Conifer planting is proposed within high and mixed-high fire mortality areas where limited and poorly distributed seed sources currently exist and where there is a moderate to high potential for planting success. This includes salvage units and other areas where the soil inventory indicates a moderate to high potential for planting success. Proposed planting is designed to move these areas toward desired forested conditions. Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands and successful conifer reforestation on the salvage and planted areas (USDA Forest Service 2008).
- No new roads are proposed to be constructed.

Campbell, John L., Dan C. Donato, Joe B. Fontaine, J. Boone Kauffman, B. E. Law, and Doug Robinson. "Biscuit Fire Study." Oregon State University Department of Forest Science. Terrestrial Ecosystem Research and Regional Analysis. 2003.

http://zircote.forestry.oregonstate.edu/terra/biscuit.htm

"Recently burned areas represent an important type of habitat that many species of animals have evolved to utilize. Snags (standing dead trees) provide critical nesting and foraging habitat for birds and small mammals, and as they decay and fall, create additional habitat for small mammals and terrestrial amphibians as coarse woody debris. Removal of the largest wood from a site is likely to have large consequences for the species of wildlife that are able to persist there. Post-fire logging is thus likely to interact with several other management objectives on the landscape."

(this document in 3 parts, summary, methods, results)

Review:

- This is a summary of a study that was underway with statements supporting the need for the study. It mentions the value of recently burned forests and importance of dead trees (standing and dead).
- Post-fire habitats do provide habitat for a suite of species. One species, the hairy woodpecker which is benefited by the increase in beetles post-fire, is addressed in detail in the wildlife analysis. It has long been recognized that snags and downed logs have values for wildlife. The forest plan includes direction for snag and downed log retention. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest. The analysis for wildlife species that use snags and downed logs incorporate that into the analysis, and appendix C of the wildlife report is a discussion and analysis of snags and downed logs.

Caton, E. L. 1996. Effects of fire and salvage logging on the cavity-nesting bird community in northwestern Montana. Ph.D. dissertation, Univ. Montana: Missoula. 115 pp.

Review:

- Post-fire habitats provide habitat for a suite of species. It has long been recognized that snags have values for wildlife. The forest plan includes direction for snag and downed log retention. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest. The analysis for wildlife species that use snags incorporate that into the analysis, and appendix C of the wildlife report is a discussion and analysis of snags and downed logs.

[CWWR] Centers for Water and Wildland Resources. 1996. Status of the Sierra Nevada:

Summary of the Sierra Nevada Ecosystem Project Report. Davis (CA): CWWR, University of California. Wildland Resources Center Report no. 39.

Review:

- The summary of the Sierra Nevada Ecosystem Project Report is a status report provided by the Science Team. It lists the critical findings the Science Team has developed concerning the state of the Sierra Nevada Ecosystem. Most of the findings concern emerging trends in the socioeconomic and environmental health of the Sierra Nevada Ecosystem.

Chambers C. L. and J. N. Mast. 2005. Ponderosa pine snag dynamics and cavity excavation following wildfire in northern Arizona. Forest Ecology and Management 216 (2005) 227–240.

Review:

- This study looked at snag availability and use by cavity nesters post fire in ponderosa pine forests. Snags that were most likely to contain excavated cavities were large diameter snags with broken tops.
- This paper was used for the snag analysis found in appendix C of the wildlife report. Project design features for this project include retention of groups of snags targeting existing clusters of the largest diameter snags available.

Cline, S. P.; Berg, A. B.; and H. M. Wright. 1980. Snag Characteristics and Dynamics in Douglas-fir Forests, Western Oregon. Journal of Wildlife Management 44(4):773-786.

Review:

- This study looked at snags in managed and unmanaged stands of various ages of Douglas-fir in western Oregon. This study is not relevant to the ponderosa pine forests of the Southwest or this project.

Cobb, Tyler P. and John R. Spence Department of Renewable Resources, University of Alberta. "Pyrophilous Beetles and Postfire Salvage Logging: A Hot Issue for Sustainable Forest Management and Biodiversity Conservation." Arthropods of Canadian Forests, April 2006.

http://www.biology.ualberta.ca/bsc/pdf/forestarthropodsno2.pdf

"Fire-killed trees represent an important input of dead wood or coarse woody debris on the landscape, and this substrate is now widely recognized as critical for maintaining biodiversity in managed forests (Esseen et al. 1997; Ehnström 2001; Harmon 2001; Grove 2002). Species associated with dead wood are called 'saproxylic' (Speight 1989), and research in Australia (Grove 2002), Canada (Hammond et al. 2001, 2004; Saint-Germain et al. 2004), and Europe (Siitonen and Martikainen 1994; Økland et al. 1996; Martikainen 2001; Siitonen 2001; Kappes and Topp 2004; Martikainen and Kaila 2004) has suggested that saproxylic insects are

particularly sensitive to intensive forest management because of its effects on volume, exposure, and piece size of deadwood. Many saproxylic insects in Fennoscandian boreal forests either have been extirpated or are currently threatened by reductions in deadwood volume (Siitonen and Martikainen 1994; Martikainen 2001; Siitonen 2001; Grove 2002). In Sweden, for example, Ehnström (2001) reported that more than 1000 beetle species depend directly on dead trees for their survival and that many of those species are currently 'red-listed'." (pg 14)

"Salvage operations are generally conducted 1–3 years after a fire to reduce further economic losses due to degradation of timber by wood-boring beetles (Ross 1960; de Groot and Nott 2004). However, because this practice combines the effects of wildfire and forest harvesting on the same sites, it not only results in the reduction of deadwood on the landscape, but also contributes to multifactorial environmental stress." (pg 15)

Review:

- This paper discusses how meeting the simultaneous goals of continued ecological functioning of boreal ecosystems and sustainable forest management will depend on a better understanding of the ecological consequences of combining natural and anthropogenic disturbances.
- There are no boreal forests in Arizona. This paper is not applicable to the WFR project.

Congressional Research Service, The Library of Congress, Washington, D.C. 20540 Memorandum: U.S. Taxpayer Consequences of Salvage Timber Sales Under the Emergency Salvage Timber Sale Program. May 14, 1996.

Review:

- General discussion of wildfire effects.
- The WFR project EIS discloses the wildfire effects to forest plants and animals. The EIS also acknowledges that before effective fire suppression began early in the 20th century, the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity, and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement fire, and killed all or most of the large trees.

Congressional Research Service Report "Forest Fire/Wildfire Protection" February 14, 2005.

http://www.coloradofirecamp.com/congressional_research/forest-fire-wildfire-effects.htm

"Finally, as mentioned above, wildfires can also generate benefits. Many plants regrow quickly following wildfires, because fire converts organic matter to available mineral nutrients. Some plant species, such as aspen and especially many native perennial grasses, also regrow from root systems that are rarely damaged by wildfire. Other plant species, such as lodgepole pine and jack pine, have evolved to depend on stand replacement fires for their regeneration; fire is required to open their cones and spread their seeds. One author identified research reporting various significant ecosystems threatened by fire exclusion — including aspen, whitebark pine, and Ponderosa pine (western montane ecosystems), longleaf pine, pitch pine, and oak savannah

(southern and eastern ecosystems), and the tallgrass prairie. [57] Other researchers found that, of the 146 rare, threatened, or endangered plants in the coterminous 48 states for which there is conclusive information on fire effects, 135 species (92%) benefit from fire or are found in fire-adapted ecosystems." [58]

"Animals, as well as plants, can benefit from fire. Some individual animals may be killed, especially by catastrophic fires, but populations and communities are rarely threatened. Many species are attracted to burned areas following fires — some even during or immediately after the fire. Species can be attracted by the newly available minerals or the reduced vegetation allowing them to see and catch prey. Others are attracted in the weeks to months (even a few years) following, to the new plant growth (including fresh and available seeds and berries), for insects and other prey, or for habitat (e.g., snags for woodpeckers and other cavity nesters). A few may be highly dependent on fire; the endangered Kirtland's warbler, for example, only nests under young jack pine that was regenerated by fire, because only fire-regenerated jack pine stands are dense enough to protect the nestlings from predators."

Review:

- General discussion of wildfire effects.
- The WFR EIS discloses the wildfire effects to forest plants and animals. The EIS also acknowledges that before effective fire suppression began early in the 20th century the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity, and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement fire, and killed all or most of the large trees.

Countryman, C. M. 1955. Old-growth conversion also converts fire climate. Fire Control Notes 17(4):15-19.

Review:

- This publication details information about the changes in the fire environment when the large or dense overstory in mature stands is removed. It suggests that decreased shade can increase surface fuel temperature and the reduced canopy can allow more wind into the stand to dry fuels as well as have higher effective windspeeds during a fire. This document serves as background information for fire behavior modeling.

DellaSala, D. A., D. M. Olson, S. E. Barth, S. L. Crane and S. A. Primm. 1995. Forest health: moving beyond rhetoric to restore healthy landscapes in the inland northwest. Wildlife Society Bulletin 23:346-356.

Review:

- This paper discusses forest health restoration policy on federally owned lands and reviews a broad set of scientific considerations of forest health and forest health treatments.
- The authors of this paper recommend that the discussion of forest health be expanded beyond tree health to include inland forest ecosystems and their capacity to: (1)

maintain viable populations of native species across their geographic range, as mandated by the National Forest Management Act of 1976 (16 U.S.C. 1600); (2) sustain critical ecosystem processes such as nutrient cycling, epizootics, natural fires, and species interactions that support and maintain diverse communities of species and ecosystems; and (3) retain characteristic biodiversity and dynamic properties in the face of short- and long-term disturbance. The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

- Under the SALVAGE heading, the authors include a discussion of the benefits of large woody debris. We recognize the benefits of large woody debris to stabilize soils, create wildlife habitat, and enhance soil properties and considered these concepts in the development of the project design (e.g. salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas and leaving a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ within the salvage units). They also recommend design features to incorporate when implementing salvage logging. These include such things as limiting removal of dead trees to roaded areas; using low-impact logging techniques that minimize soil damage; maintaining sufficient densities and diameter classes of woody debris for species dependent on logs and snags; avoiding sensitive sites such as severely burned areas with litter destruction, sites with erosive or fragile soils, roadless and riparian areas, and steep slopes. All of these recommended designs were considered and incorporated into the WFR project. See project description and design features.

DellaSala, D. A. and E. Frost. 2001. An ecologically based strategy for fire and fuels management in national forest roadless areas. Fire Management Today 61(2):12-23.

Review:

- This paper compares the tradeoffs between mechanical and prescribed fire treatments in roadless areas; however, there is no discussion of fuel treatment in areas such as the WFR project that have already experienced wildfire. The roadless areas within the project area are steep and not proposed for salvage logging within the parameters of the WFR project. Some planting of conifers is proposed where seed sources are lacking to move the area toward desired conditions.

DellaSala, Dominick Ph.D., Mike Wood Ph.D., Christine Ambrose and Dale Thornburgh Ph.D. "Healthy Forests? Scientists See Salvage Logging (not Wildfire Protection) at Center of Healthy Forests Initiative." Tidepool. May 20, 2003.

http://www.tidepool.org/features/healthyF.cfm

"After a fire, there's usually a rush to harvest timber and 'salvage' its economic value before it decomposes. There are two major problems with this."

"First, burnt trees are part of the natural forest's ecosystem, and removing them deprives organisms of habitat and nutrients."

"Second, much of the timber 'salvaged' is in fact alive and thriving old-growth that survived the recent fire (and often several previous ones). They are the forest's heartiest survivors and a big source of biodiversity."

"The ecological rationale for salvage logging is very weak. We can't think of any ecological grounds for salvage logging."

Review:

- Newsletter article discussing President Bush's Healthy Forest Initiative. The quote that Mr. Artley references is under the heading Salvage logging.
- In reference to the quote "Second, much of the timber 'salvaged' is in fact alive and thriving old-growth that survived the recent fire (and often several previous ones). They are the forest's heartiest survivors and a big source of biodiversity." The WFR project does not remove any live trees. Only some of the mixed-high and high mortality areas are proposed for salvage (none of the low and mixed-low mortality areas would be salvaged).

Dellasala, Dominick A. Ph.D. Testimony to the Senate Subcommittee on Public Lands and Forests, Committee on Energy and Natural Resources, September 17, 2004.

http://www.worldwildlife.org/wildplaces/kla/pubs/klamathTestimony91704.pdf

"Recovery following large and intense fires was readily apparent within a few years and scientists cautioned about replanting burned areas, since this would inhibit natural recovery processes from restoring healthy landscapes following fires. Many scientists concerned about impacts to native plant communities and erosion control effectiveness also have questioned the need for aggressive post-fire seeding (e.g., with grasses)."

"While large, high-severity wildfires remove vegetation and expose mineral soils, less than half of 62 studies reviewed by fire scientists have shown reduced sediment movement after grass seeding. Due to competition of seeded grasses, seeding often inhibits native plant recovery."

"Nearly two-dozen scientific articles have been published on the impacts of salvage logging. These studies indicate that salvage logging is virtually always damaging to soils, streams, and plant and animal life, and must not be considered a 'restorative action' for post-fire landscapes."

Review:

- Testimony addressing Senate Bill 2709 – the National Reforestation Act. DellaSala noted four primary concerns with the bill: (1) proposed reforestation measures in moderate and high fire intensity landscapes will inhibit natural post-fire recovery processes vital to ecosystem health, fire resiliency, and biodiversity; (2) reliance on salvage logging will cause significant damage to post-fire recovery processes; (3) conversion of naturally recovering landscapes to tree plantations will come at the expense of biodiversity and fire resilient properties of the forest; and (4) funds directed to forestry schools will not address broader ecosystem recovery needs following natural

disturbances.

- The WFR project EIS documents an environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies.
- Short-term adverse effects to soils from salvage logging ground-disturbing activities are well documented. The WFR project includes project design features and best management practices to minimize adverse impacts to soil and vegetation resources. Using existing skid trails and road templates will reduce the potential ground disturbance area. Proposed planting is designed to move the areas that experienced high levels of mortality that are lacking seed sources toward desired forested conditions. Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands and successful conifer reforestation observed on the salvaged and planted areas (USDA Forest Service 2008).
- Breaking up the future large fuel component is one of the purposes for the WFR project. Future fires would expose the soils beneath and directly around coarse woody debris to high heat for extended periods of time, exposing roots to lethal temperatures (Monsanto and Agee 2008). Monsanto and Agee (2008) noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. Monsanto and Agee (2008) also note "most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period."
- The forest recognized the unique research opportunities and has been working with the research community to provide recovery study areas within the WFR project area.

References:

- Monsanto, Philip; James Agee. 2008. Long-term post wildfire dynamics of coarse woody debris after salvage logging. College of Forest Resources, University of Washington. Seattle, WA.
- USDA Forest Service. 2008. Higgins, B. 2008. A comparative analysis of forest recovery on the Summit, Willis, Bridger-Knoll and Hockderffer fires in ponderosa pine forest. USDA Forest Service, Kaibab National Forest unpublished report. Williams, AZ. 17 p.

DellaSala, Dominick A. Ph.D. and James Strittholt, Ph.D. "Biscuit fire salvage will harm forest." Eugene Register Guard, September 24, 2004.

http://www.consbio.org/cbi/media/newspaper_articles/ed.col.biscuit.0924.html

"The Biscuit fire burned through the Siskiyou Wild Rivers area of Southwest Oregon, home to an astonishing array of rare plants, wild salmon and the largest expanse of unprotected roadless areas along the Pacific Coast. For thousands of years, fire has shaped the region's unique ecology."

"Sen. Gordon Smith calls the post-fire landscape a 'moonscape,' and tells us that only logging and tree planting can transform burned areas to green forests."

"The wasteland image was broadly placed in Americans' minds another time - after the Yellowstone fires of 1988. Yellowstone was never salvaged, never planted and never treated with chemicals; the forest has recovered."

"The Biscuit is recovering rapidly, too, although the two forests are quite different. Such regional differences are what ecologists warn against in making the kind of apples-to-oranges comparisons Smith evokes when linking the Biscuit to another high-profile Oregon fire, the Tillamook forest."

"To suggest that environmental lawyers are impeding widespread scientific opinion also misstates the facts. Many scientists both inside and outside federal agencies have expressed legitimate concern about the scientific flaws in the Biscuit plan, but their comments have been largely ignored."

"Let's be clear: No scientific evidence supports the position that salvage logging benefits forest ecosystem health. In fact, existing studies show that such activities virtually always damage recovering soils, native plants and salmon. Salvage has everything to do with economics for a few, and little or nothing to do with forest health."

Review:

Guest viewpoint concerning the Biscuit Fire salvage project in the Siskiyou region of southwest Oregon.

- The WFR project is not in the Pacific Northwest or southern Oregon so many of the findings in the Biscuit Fire area are not relevant to the Warm Fire. The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

DellaSala, D. A. 2006. Post-disturbance logging summary of key studies and findings. Unpublished Report. National Center for Conservation Science & Policy, Ashland. OR.

Review:

- Short-term adverse effects to soils from salvage logging ground-disturbing activities are well documented. The WFR project includes project design features and best management practices to minimize adverse impacts to soil and vegetation resources. Using existing skid trails and road templates will reduce the potential ground disturbance area. Proposed planting is designed to move the areas that experienced high levels of mortality that are lacking seed sources toward desired forested conditions. Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands and successful conifer reforestation observed on the salvaged and planted areas (USDA Forest Service 2008).
- Breaking up the future large fuel component is one of the purposes for the WFR project. Future fires would expose the soils beneath and directly around coarse woody debris to high heat for extended periods of time, exposing roots to lethal temperatures (Monsanto and Agee 2008). Monsanto and Agee (2008) noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. Monsanto and Agee (2008) also note "most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period."

References:

- Monsanto, Philip; James Agee. 2008 Long-term post wildfire dynamics of coarse woody debris after salvage logging. College of Forest Resources, University of Washington. Seattle, WA.
- USDA Forest Service. 2008. Higgins, B. 2008. A comparative analysis of forest recovery on the Summit, Willis, Bridger-Knoll and Hockderffer fires in ponderosa pine forest. USDA Forest Service, Kaibab National Forest unpublished report. Williams, AZ. 17 p.

DellaSala, Dominick A. Ph.D. James R. Karr, Ph.D. "Forest Service Losing Money on Biscuit Post-fire Logging." Sustainable Review. January 16, 2006.

http://www.sustainablereview.com/articles/article/2773752/41299.htm

"The public needs to know that post-fire logging is a lose-lose proposition; the taxpayer loses by footing the bill and the environment loses by damaged soils and degraded fish and wildlife habitat." Dr. DellaSala

"It's unfortunate but true that logging cast as 'restoration' is one of the most damaging

management activities humans can initiate after a fire. No amount of tree planting can make up for the damages caused by logging after large wild fires." Dr. Karr

Review:

- The quotes cited from this commentary pertain to the economic and environmental impacts of salvage logging.
- The restoration components of the WFR project include planting of conifers in areas where seed sources were consumed in the fire. Proposed planting is designed to move the areas that experienced high levels of mortality that are lacking seed sources toward desired forested conditions. Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands and successful conifer reforestation observed on the salvaged and planted areas (USDA Forest Service 2008).
- Breaking up the future large fuel component is one of the purposes for the WFR project. Future fires would expose the soils beneath and directly around coarse woody debris to high heat for extended periods of time, exposing roots to lethal temperatures (Monsanto and Agee 2008). Monsanto and Agee (2008) noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. Monsanto and Agee (2008) also note "most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period."
- The WFR project economic information was updated between the DEIS and FEIS to incorporate updated values and costs.
- See also review of DellaSala's September 17, 2004, Testimony to the Senate Subcommittee on Public Lands and Forest above.

DellaSala, Dominick, Ph.D. a forest ecologist for the World Wildlife Fund from an article written by Matthew Koehler "Scientists Warn Congress Against Fast-Track Logging in Forests Recovering from Fire." New West, March 15, 2006

http://www.newwest.net/citjo/article/scientists_warn_congress_against_fast_track_logging_in_forests_recovering_f/C13/L8/

"Proponents of expedited logging can't provide a significant body of evidence that a nationwide program of logging in forests recovering from disturbance is scientifically justified. Of the more than 30 scientific papers on post-fire logging published to date, not a single one indicates that logging provides benefits to ecosystems regenerating after disturbance."

Review:

- This article reports on a letter by a group of scientists sent to members of Congress concerning the Forest Emergency Recovery and Research Act.

- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

DellaSala, Dominick A. Ph.D, Greg Nagle Ph.D., James R. Karr Ph.D., Rich Fairbanks, Dennis C. Odion Ph.D., Jack E. Williams Ph.D, Chris Frissell Ph.D. and Timothy Ingalsbee Ph.D. 2006. "The Facts and Myths of Post-Fire Management: A Case Study of the Biscuit Fire, Southwest Oregon." Unpublished Report, World Wildlife Fund, Klamath–Siskiyou Program. 31 p.

http://www.worldwildlife.org/news/pubs/Biscuitwhitepaper.pdf

"We conducted a three-day workshop on the Biscuit logging project with researchers having extensive background in disturbance ecology and field studies within the Biscuit and other fire areas to examine key assertions related to post-fire landscapes in general and post-fire logging in particular. We used literature reviews, preliminary field work, and extensive photo documentation of Biscuit logging units to refute suppositions having little or no ecological basis but often used to justify post-fire logging and related management. In particular, we provide key findings related to post-disturbance landscapes and their management:

1. Post-fire logging is not a restorative action, rather it harms regenerative processes by degrading soils, causing excessive erosion, delaying natural plant and animal succession, and introducing or spreading invasive species.
2. Post-fire logging, rather than jump starting old-growth forests, inhibits the return of old-growth forest conditions by removing the very components (large dead, dying, and downed trees) crucial in their development.
3. Post-fire logging can elevate hazardous fuels by removing the least flammable portion of trees (trunks) and generating significant logging slash (in places where logging slash is treated with pile burning, damage to soils can have long-term consequences).
4. Naturally regenerating landscapes following fire are some of the richest habitats in the Pacific Northwest and need to be managed for their unique ecological values."

"The impacts of post-fire logging on the Biscuit were many, including impairment of natural vegetation, reduction in conifer seedling establishment, damage to soils and watersheds, and increases in fuel accumulations in the years after logging. These impacts were readily apparent for cable logging operations and are expected to persist for decades following the initial activities. In general, post-fire logging depletes forests of regenerating conifers and large dead trees, and replanting with conifers does not offset these effects. It also fails to treat the primary cause of human damage on the landscape, pre- and post-fire--the road system (Trombulak and Frissell 2000)."

"Legislation that seeks to expedite post-disturbance logging and increase the scale of such activities nation-wide should avoid this rush to log, as evidence from the Biscuit indicates that (1) resource values will inevitably be compromised in these biologically rich and unique landscapes, and (2) the timber sales that do move forward are a drain on the public treasury."

Review:

- This report debates the treatment of post-fire landscapes using the Biscuit Fire in southwestern Oregon as a case study. The objectives of the report were to: (1) examine assertions surrounding post-disturbance logging; (2) discuss post-fire regeneration within the Biscuit area in relation to logging activities; and (3) provide recommendations on restoration of post-fire landscapes that can guide decision makers.
- The WFR project is not in the Pacific Northwest or southwestern Oregon so many of the findings in the Biscuit Fire area are not relevant to the Warm Fire. Concepts concerning post-fire regenerative processes and regenerating landscapes on the Kaibab Plateau were considered in designing the WFR project. It is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see natural regeneration assumptions in the "Methodology" section of this report), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities, and using existing skid trails where available.

Dillaha, T. A. and S. P. Inamdar. 1996. Buffer zones as sediment traps or sources. Pp. 33-42 in N. E. Haycock, F. P. Burt, K. W. T. Goulding and G. Pinay (eds.). Buffer Zones: Their Processes and Potential in Water Protection. Proc. Intl. Conf. on Buffer Zones. Sept. 19-22: Hertfordshire, U.K. Quest Environmental, Inc.

Review:

- Paper not available.
- Although the WRP area does not contain perennial streams, the ephemeral drainages were identified and 100-foot buffers delineated to provide protection of watershed resources from salvage logging activities. In addition to these buffers, project design features (e.g. to leave adequate down woody material) and use of best management practices are incorporated to reduce impacts to soil and water resources (see the FEIS chapter 2 and appendix A for a full listing of measures and where they are identified to be used).

Dombeck, M., J. E. Williams, and C. A. Wood. 2004. Wildfire policy and public lands: integrating scientific understanding with social concerns across landscapes. Conservation Biology 18:883-889.

Review:

- This paper provides a historical overview of wildfire policy and challenges resulting from fire suppression activities and challenges and recommended principles for wildlife policies that meet ecological and social needs. The paper notes concerns with: spread of exotic species; overaccumulation of trees–denser forests; urban interface along wildland boundaries, issues of landowners taking responsibility for reducing vulnerability of their homes to wildfire and use of fire resistant materials; thinning smaller diameter material and use of fire to reduce densities of small diameter trees.
- The Kaibab National Forest currently is monitoring and treating invasive species and the WFR project includes mitigation to prevent spread of invasive species due to project activities. This analysis focused on addressing the areas that experienced moderate to high and high severity fire. The areas that experienced light to moderate fire severity resulted in a decrease of fuels on those sites. The WFR project area does not abut urban interface areas.
- Integrating policies for private and public lands is beyond the scope of this project.

Dombeck, Mike Ph.D., Chief, U.S. Forest Service Remarks at a Society of American Foresters breakfast on September 21, 1998

https://www.uwsp.edu/cnr/gem/Dombeck/MDSpeeches/CD%20COPY/SAF%20Breakfast.092198.htm

"Our answer is to develop land-based performance measures that evaluate the 'outcomes' rather than the 'outputs' of our management -- to focus less on what we take from the land and more on what leave behind. To focus less on the volume of wood fiber removed and more on the quality of the water, the diversity of the species, the productive capacity of the land, itself."

Review:

- Former Chief of the Forest Service remarks concerning how the natural resource agenda is being implemented in each of the deputy areas of the Forest Service.
- In reference to the quote by Chief Dombeck that Mr. Artley referenced, the WFR project EIS documents a desired condition (outcome) on the landscape and analyzes the resulting conditions of three action alternatives and one no action alternative in terms of progressing toward that desired condition.

Donato, D. C., J. B. Fontaine, J. L. Campbell, W. D. Robinson, J. B. Kauffman, and B. E. Law. 2006. Post-wildfire logging hinders regeneration and increases fire risk. Science 311: 352. Accessed online January 22, 2007 from Science Express.

www.scienceexpress.org

Review:

- It is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see natural regeneration assumptions in the "Methodology" section of the silviculture report), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities and using existing skid trails where available.
- This paper was considered in the vegetation analysis. Anticipated fuel loading is discussed in chapter 3. Anticipated regeneration is discussed under "Vegetation" in chapter 3.

Dudley, J. G. 2005. Home range size and foraging habitat of Black-backed Woodpeckers. M.S. thesis. Boise State University, Idaho. 76 p.

http://www.rmrs.nau.edu/publications/jdudley_thesis_final_web/jdudley_thesis_final_web.pdf

"Because the size of required habitats is unknown, Blackbacked Woodpeckers may be vulnerable to local extinction if, for example, post-fire salvage logging reduces or eliminates high-quality habitats (Murphy and Lehnhausen 1998). This relationship was observed in burned ponderosa pine (*Pinus ponderosa*)/Douglas-fir (*Pseudotsuga menziesii*) forests of southwestern Idaho, where nesting densities of Black-backed Woodpeckers were nearly six times lower in logged versus unlogged units during the first nine years following fire, and non-existent thereafter (Saab and Dudley, unpublished data). Similar results were reported in burned lodgepole pine (*Pinus contorta*) and Douglas-fir dominated forests of Montana (Harris 1982, Caton 1996)."

Review:

- This thesis is relative to black-backed woodpeckers; however, distribution does not include Arizona and, therefore, is not relevant to this project.

Duncan, Sally. "Postfire Logging: Is it Beneficial to a Forest?" USDA Forest Service. PNW Science Findings issue 47. October 2002.

http://www.fs.fed.us/pnw/sciencef/scifi47.pdf

"Post-fire logging can cause significant changes in the abundance and nest density of cavity-nesting birds, particularly those attracted to recently burned forests."

"Trees killed by wildfire and left standing take on roles that change the ecological services they previously provided as components of a green-tree system. They still offer some shade, which in a burned environment can slow the heating of surface waters and the soil surface. They may also provide more rapid recruitment of large wood into streams. Decomposing fallen trees provide nutrients, shelter, and early structure for a rejuvenating forest floor."

"Burned forests typically support significantly different bird communities, with many species dependent on stand-replacement fires to maintain their populations across the landscape. Usually there's an increase in cavity-nesting, insectivorous birds such as woodpeckers and certain species of flycatchers."

Review:

- It has long been recognized that snags and downed logs have values for wildlife. The forest plan includes direction for snag and downed log retention. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest. The analysis for wildlife species that use snags and downed logs incorporates this information. Appendix C of the wildlife report is a discussion and analysis of snags and downed logs.
- Black-backed woodpeckers (which do not occur in Arizona) and three-toed woodpeckers have been shown to select unsalvaged areas of a burn. Other species have been shown to select salvage logged areas of a burn (Lewis' woodpecker). Only some of the mixed-high and high mortality areas are proposed for salvage (none of the low and mixed-low mortality areas would be salvaged). The percent of the mixed-high and high mortality areas proposed for salvage varies by alternative, but ranges from 26 to 43 percent, as shown in the wildlife report.
- The WFR project recognizes the need for CWD in forest soil and stream function. Streams are buffered to preclude ground-based equipment activities, and CWD amounts will be left in accordance with recommendations described in Brown (2003), Graham (1994) and Brewer (2008).

Environment Canada – Canadian Wildlife Service. Excerpts from their review notes for the project plans for the Barney Lake and False Canyon Creek fires sent to Robin Sharples, Environmental Assessment Coordinator, Government of Yukon, Forest Management Branch. June 13, 2005

"Erosion can occur where soil disturbance accompanies fire (e.g., during fire fighting or timber salvage operations)."

"Lindenmayer et al. (2004), note that "To many ecologists, natural disturbances are key ecosystem processes rather than ecological disasters that require human repair." The authors also state that salvage harvesting activities undermine many of the ecosystem benefits of major disturbances. That removal of large quantities of biological legacies can have negative impacts on many taxa; and that salvage logging removes critical habitat for species, such as cavity nesting mammals, woodpeckers, invertebrates like highly specialized beetle taxa that depend on burned wood, and bryoflora closely associated with recently charred logs. The authors continue, noting that salvage logging can impair ecosystem recovery; and that some taxa may be maladapted to the interactive effects of two disturbance events in rapid succession."

"Black-backed and Three-toed Woodpeckers are the species most likely to benefit from unsalvaged burns. Salvage logging in burned forests can have pronounced effects on cavity-nesting species that use post-fire habitats. Salvage logging reduces the number of available snags which impacts populations of Black-backed and Three-toed Woodpeckers, which rarely use even partially-logged post-fire forests."

"Altman (2000) notes that preliminary indications of the importance of postfire habitat to nest success indicate the need to avoid or minimize the salvage of burned trees in forest burns and suggests that forest harvest practices that retain snags and live trees (potential nest trees) help provide suitable habitat."

"Koitlar et al. (2002) note that given our limited understanding of the cumulative effects of fire suppression and post-fire salvage logging, and their effects on post-fire habitat availability across the landscape, allowing succession to proceed naturally in unsalvaged burns may benefit the most species."

"Some taxa may be maladapted to the interactive effects of two disturbance events in rapid succession. Salvage logging is likely to have unanticipated consequences concerning micro-habitat for species that are associated with recovery."

Review:

- Black-backed woodpeckers (which do not occur in Arizona) and three-toed woodpeckers have been shown to select unsalvaged areas of a burn. Other species have been shown to select salvage logged areas of a burn (Lewis' woodpecker). These concerns were considered and impacts were analyzed and are documented in the wildlife report.

Everett, R. 1995. Review of Recommendations for Post-Fire Management (Memo to John Lowe, Regional Forester, R-6, dated August 17, 1995. 8p.

Review:

- Everett's review is one of several of the Beschta et al. 1995 paper, as requested by Deputy Chief Gray Reynolds.
- The reviewer notes the document identifies several important ecological principles that should be addressed in deciding if post-fire salvage logging is desired and, if so, accomplished to conserve terrestrial and aquatic resources. The reviewer agrees there is a need to return forests to more dynamic systems where landscape characteristics are in

synchrony with inherent disturbance regimes but argues for more flexibility in approach.

- The reviewer sums their comments by agreeing on the need to proceed with caution in post-fire management and suggests there is a need to reduce post-fire fuel loading in excess of historical amounts to reduce future fire intensity and fire effects.
- One objective of the Warm Fire Recovery project is to promote, over the longer term, fuel conditions with low surface fire intensity and fire severity, and low resistance to fire line construction to increase the likelihood of safe and successful fire management of both wildland and prescribed fire efforts in the future.

Fairbanks, Richard A. Science Forum on Post-Fire Logging and Forest Ecology Sponsored by Congressman Tom Udall U.S. House of Representatives March 10, 2006

http://www.wilderness.org/Library/Documents/upload/FairbanksFireScience.pdf

"I believe it is important to recognize the capacity of the forest to regenerate naturally after a fire. After most forest fires, some trees within the burned area survive. Silviculturists recognize that even if only a few of these trees survive for the long term, they are an important source of seedlings for renewing the forest. The offspring of these survivors often contain genes for high fire resistance and are usually much better adapted to a particular site than planted nursery stock."

"NEPA requires that agencies collect and interpret data about proposed projects and the impacts they may have both on the environment and on communities. The law also requires that federal bureaucrats disclose the effects of their actions. As such, NEPA is an important defense against any tendency for line officers to make decisions based on inappropriate considerations that are not in the best interests of the land or the public. It makes the process transparent enough that such behavior may be exposed, as is now happening with the Biscuit project."

Review:

Statement made to Congressman Tom Udall concerning post-fire logging and forest ecology in light of recently introduced legislation.

- In reference to comments concerning tree survival—The WFR project does not remove any live trees. Only some of the mixed-high and high mortality areas are proposed for salvage (none of the low and mixed-low mortality areas would be salvaged).
- The WFR EIS is a NEPA document and, therefore, discloses effects of three action alternatives and the no action alternative.

Finch, Deborah M. Ph.D., Joseph L. Ganey Ph.D., Wang Yong PH.D., Rebecca T. Kimball Ph.D. and Rex Sallabanks Ph.D. "Effects and Interactions of Fire, Logging, and Grazing." USDA Forest Service. Gen. Tech. Rep. RM-GTR-292, Chapter 6. 1997.

http://www.rmrs.nau.edu/publications/rm_gtr292_ch6/rm_gtr292_ch6.pdf

"The response of birds or bird communities to fire may also vary depending on whether salvage logging follows the fire. As mentioned, snags created by fire provide nest and foraging sites. Removal of some or all of these snags eliminates or reduces the benefits they provide (Moeur

and Guthrie 1984; Hutto 1995; Hitchcox 1996)."

"Regardless of the reason for a salvage operation, the result is the removal of dead and dying trees from a forest stand. Bird species that depend on dead and dying trees (snags) are most impacted by any type of salvage logging, whether it be selective harvest of individual trees or complete stand removal. Cavity nesters in ponderosa pine forests of the Southwest, such as the acorn woodpecker, hairy woodpecker, northern flicker, pygmy nuthatch, white-breasted nuthatch, western bluebird, mountain chickadee, house wren, Cordilleran flycatcher, and violet-green swallow (Szaro and Balda 1979a), will potentially be affected the most. Snags also provide important habitat features for other species (Glinslu et al. 1983; Hutto 1995; Sallabanks 1995)."

"Salvage prescriptions that tend to homogenize forest structure (selective removal of all trees of a certain size) are unlikely to maintain the necessary variety of microhabitats within a burned forest."

Review:

- This paper discusses post-fire salvage and effects on species densities and potential methods to reduce effects. Cavity nesters are affected the most. One suggestion to reduce the homogenization of forest structure by salvage logging was to take trees from part of the burn and leave other parts of the burn untouched, rather than selectively salvage the whole area. This paper then summarizes three ongoing studies (not occurring in ponderosa pine in the Southwest).
- Only some of the mixed-high and high mortality areas are proposed for salvage (none of the low and mixed-low mortality areas would be salvaged). The percent of the mixed-high and high mortality areas proposed for salvage varies by alternative, but ranges from 26 to 43 percent, as shown in the wildlife report.

Foster, D. R.; Knight, D. H.; and J. F. Franklin. 1998. Landscape Patterns and Legacies Resulting from Large, Infrequent Forest Disturbances. Ecosystems 1: 497-510.

Review:

- This paper studied five large, infrequent disturbances (LIDs)–fire, hurricanes, tornadoes, volcanic eruptions, and floods–in terms of the physical processes involved, the damage patterns they create in forested landscapes, and the potential impacts of those patterns on subsequent forest development. The resulting landscape patterns were strongly controlled by interactions between the specific disturbance, the abiotic environment, and the composition and structure of the vegetation at the time of disturbance. In all cases, the evidence suggests that these LIDs produce enduring legacies of physical and biological structure that influence ecosystem processes for decades or centuries.
- The Warm Fire's effects are long lasting. The WFR project is proposed as a step in the recovery process to move the area toward the desired forested conditions identified in the forest plan.
- Only fire-killed trees are proposed for removal, while leaving snags to provide habitat for snag related species. The remnant living trees would not be removed with proposed activities. Rather those trees would provide seed sources for the adjacent areas. The

reforestation planting is proposed for areas lacking adequate conifer seed sources outside of areas naturally regenerating to aspen.

Franklin, Jerry F. Ph.D. Testimony to the House Committee on Resources, Subcommittee on Forests and Forest Health. July 15, 2004.

http://www.wildfirecentral.org/facts/upload/CongrTestRestoringForests(071504).pdf

"Where recovery of natural ecological functions is a primary goal, removal of significant legacies of living trees, snags, and logs through timber salvage is not appropriate."

"Timber salvage will rarely achieve any positive ecological benefit as has been pointed out in a recent article in *Science* (Lindenmayer et al. 2004). Timber salvage should be viewed as a 'tax' or debit on the recovery process. Removal of large, decay resistant snags and logs is particularly negative, because of impacts on long-term recovery and stand development processes."

"It is sometimes argued that following a stand-replacement fire in an old-growth forest that snags and logs are present in 'excess' of the needs of the site, in terms of ecosystem recovery. In fact, the large pulse of dead wood created by the disturbance is the only significant input of woody debris that the site is going to get for the next 50 to 150 years. The ecosystem has to 'live' off of this woody debris until the forest matures to the point where it has again produced the large trees that can become the source for new snags and logs (Maser et al. 1988)."

Review:

- The amounts of CWD and fine woody debris were considered and the amounts prescribed to leave (where material is available) were determined based on recommendations by Brown (2003), Graham (1994), and Brewer (2008).

Franklin, Jerry F. Ph.D as quoted in: "Bush Plan to Aid Forests after Wildfires Draws Criticism." Washington Post, 15 October, 2004.

"Forests are more resistant to wildfire if they are not logged and replanted."

Review:

- This commentary discussed the Biscuit Fire and economics in context with the presidential race in Oregon.
- The WFR EIS included economic analysis of the alternatives. This information has been updated in the FEIS based upon updated estimates of defect values in use in Region 3 and the anticipated reduction in commercial timber products.

Franklin, Jerry Ph.D. Testimony before the House Subcommittee on Forests and Forest Health. Legislative Hearing on HR 4200. 10 November 2005.

http://resourcescommittee.house.gov/archives/109/testimony/2005/jerryfranklin111005.htm

"Salvage logging generally cannot be justified on the basis that it contributes to the recovery of forest ecosystems following catastrophic disturbances. There is essentially no scientific support

for the view that salvage logging can contribute direct positive benefits to ecological recovery; there is abundant scientific evidence that salvage logging can have diverse and significant negative impacts of salvage logging on ecological recovery (e.g., Lindenmayer et al. 2004)."

"Negative impacts of timber salvage on ecological recovery occur in many different ways, which cannot be comprehensively reviewed here. They include direct effects of removal of wood and indirect effects, such as the impacts of logging operations on water and soils."

"One of the largest sets of impacts from salvage logging relates to the role of dead wood (snags and logs) in both intact and disturbed forest ecosystems. There is now a very large body of scientific literature documenting the importance of large wood structures in forest ecosystems (see, e.g., Harmon et al. 2004 and Maser et al. 1988). Snags and logs play important roles in energy and nutrient cycling, nitrogen fixation, and hydrologic and geomorphic processes, such as sediment storage. Wood is immensely important to the animal life of forest ecosystems, both vertebrate and invertebrate; probably 1/2 to 2/3 of the forest dwelling animal species utilize large wood as habitat."

"The largest and most decay resistant snags and logs are the most important part of the legacy of dead wood created by disturbances, such as stand replacement fires. Large trees of decay resistant species, such as cedars and Douglas-fir will persist and play important functional roles in the forest for literally a century or more."

"From the standpoint of ecological impacts, cutting live trees from a green forest will often have a lower ecological cost than removing dead trees from a burn or blowdown. It is also why salvage logging has very long-term effects on recovery processes."

"In making decisions about where and how to salvage, how can we minimize negative impacts on ecological values? One part of the answer to this question is to avoid salvage on affected lands where management objectives are focused primarily on ecological objectives."

Review:

- This testimony includes some discussion about the role of dead wood (snags and logs) in ecosystems and highlights the importance of CWD in soil and stream function.
- It has long been recognized that snags and downed logs have values for wildlife. The forest plan includes direction for snag and downed log retention. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest. The analysis for wildlife species that use snags and downed logs incorporate that into the analysis, and appendix C of the wildlife report is a discussion and analysis of snags and downed logs.
- The WFR project recognizes the need for CWD in forest soil and stream function. Ephemeral drainages are buffered to preclude ground-based equipment activities, and CWD amounts will be left in accordance with recommendations described in Brown (2003), Graham (1994) and Brewer (2008), where material is available.

Franklin, Jerry Ph.D. Testimony before the House Subcommittee on Forests and Forest Health on scientific research and the knowledge-base concerning forest management following wildfires and other major disturbances at a Field Hearing in Medford, Oregon, February 24, 2006.

http://www.crag.org/documents/Franklin%20Testimony.pdf

"I personally believe that much of the controversy that has arisen over post-fire logging and other activities relates to stakeholders viewing the appropriateness of an activity through the prism of their own experience and values without adequately considering the defined management objectives for the area under consideration."

"There is a very large body of ecological science relevant to management of areas following large disturbances, much of which has not yet been fully assimilated by resource management agencies, policy makers, and the public."

Review:

- Testimony regarding scientific knowledge relevant to appropriate management activities following a major forest disturbance.
- At the beginning of his testimony, Mr. Franklin states "I view it as fundamental that the management objectives for a disturbed area under consideration are an essential consideration in identifying and applying science relevant to post-disturbance activities." This concept was considered in designing the WFR project through direction provided by the Kaibab forest plan and various other policies and laws as documented in the WFR EIS. The WFR project EIS documents a full environmental review informed by science based on the management objectives.

Franklin, Jerry. "Scorched forests best left alone, study finds." The Oregonian on the WEB. 6 January 2006.

<http://www.oregonlive.com/printer/printer.ssf?/base/news/113652150932390.xml&coll=7>

"It's usually far better ecologically to take a green tree from a live forest than a dead tree from a burned forest. Salvage almost never achieves any ecological goal. It almost always is a tax on the ecological process."

Review:

- Article not available, quote provided pertains to salvage logging.
- It is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see natural regeneration assumptions in the "Methodology" section of the silviculture report), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels

reduction activities and using existing skid trails where available.

- Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands and successful conifer reforestation observed on the salvaged and planted areas (USDA Forest Service 2008).

References:

- USDA Forest Service. 2008. Higgins, B. 2008. A comparative analysis of forest recovery on the Summit, Willis, Bridger-Knoll and Hockderffer fires in ponderosa pine forest. USDA Forest Service, Kaibab National Forest unpublished report. Williams, AZ. 17 p.

Franklin, J. F., and J. Agee. 2003. Scientific issues and national forest fire policy: forging a science-based national forest fire policy. Issues in Science and Technology 20:59-66

http://inr.oregonstate.edu/download/forging_a_science_based_national_forest_fire_policy.pdf

"Management of post-burn areas, including timber salvage, needs to incorporate the concept of biological legacies. Salvaging dead and damaged trees from burns involves the ecology of a place, not simply economics and fuels. In addition to effects on post-fire wildlife habitat, there are also effects of salvage logging on soils, sediments, water quality, and aquatic organisms. Significant scientific information exists on this topic as well as on biological legacies."

"Natural forest disturbances, including fire, kill trees but remove very little of the total organic matter. Combustion rarely consumes more than 10 to 15 percent of the organic matter, even in stand-replacement fires, and often much less. Consequently, much of the forest remains in the form of live trees, standing dead trees, and logs on the ground. Also, many plants and animals typically survive such disturbances. This includes living trees, individually and in patches."

"These surviving elements are biological legacies passed from the pre-disturbance ecosystem to the regenerating ecosystem that comes after. Biological legacies are crucial for ecological recovery. They may serve as lifeboats for many species, provide seed and other inocula, and enrich the structure of the regenerated forest. Large old trees, snags, and logs are critical wildlife habitat and, once removed, take a very long time to replace."

"Salvaging dead and damaged trees from burns involves the ecology of a place, not simply economics and fuels. In addition to effects on post-fire wildlife habitat, there are also effects of salvage logging on soils, sediments, water quality, and aquatic organisms. Significant scientific information exists on this topic as well as on biological legacies."

Review:

- This paper discusses the need for a comprehensive, science based, national forest fire policy and the various aspects that should be considered in developing this policy. One point in this paper is that remaining live trees, standing dead trees, and logs on the ground are biological legacies that will enrich the regenerated forest.
- This project does not propose removal of live trees. Only some of the mixed-high and high mortality areas are proposed for salvage (none of the low and mixed-low mortality

areas would be salvaged). Within the salvage units, snag and downed log retention is included in project design. These project design features have been developed to maximize longevity (focusing on patches of large diameter snags) and utility (inclusion of a no-salvage buffer adjacent to green forest).

- As discussed in appendix C of the wildlife report, it is unlikely that any of the snags will remain standing by the end of 3 decades. When they fall, they will contribute to increases in downed logs.
- The quote that Mr. Artley references comes from the after the fire section of the paper which discusses appropriate restoration treatment policies after a fire. After the discussion Mr. Artley references, the authors go on to say "Biological legacies differ by orders of magnitude in natural forests, a fact that should guide restoration programs." Followed by "uncharacteristic stand-replacement fires in dry forests can produce uncharacteristic levels of post-fire fuels, including standing dead and down trees. Removing portions of that particular biological legacy may be appropriate as part of an intelligent ecological restoration program, and not simply as salvage."
- The WFR project will not cut live trees. Those trees that will be cut were killed in the wildfire. Sufficient amounts of CWD will be left to sustain soil productivity. CWD volumes prescribed to be left are based on recommendations by Brown (2003), Graham (1994), and Brewer. Further, streams will be buffered with equipment exclusion zones to avoid soil disturbance and sediment delivery to stream channels.
- This concept was considered as illustrated by the desired condition statements for vegetation and fuels in the WFR project area and in the comparison of the current condition to the desired condition.

Franklin, J. F.; and T. A. Spies. 1991. Composition, Structure, and Function of Old-Growth Douglas-fir Forests. In: L. F. Ruggierio; K. B. Aubry; A. B. Carey; and M. H. Huff (eds.) Wildlife and Vegetation of Unmanaged Douglas-fir Forests. Gen. Tech. Rep. PNW-GTR-285. USDA-FS. P.71-80.

Review:

- Ecological characteristics of old-growth (Pacific Northwest) Douglas-fir forests are examined in terms of compositional, functional, and structural features.
- The ecological characteristics of old-growth Douglas-fir forests in the Pacific Northwest are not relevant to the ponderosa pine and dry mixed conifer forests of the Kaibab Plateau.

Franklin, J. F.; and C. Maser. 1988. Looking Ahead: Some Options for Public Lands. In: Maser, C.; Tarrant, R. F.; Trappe, James, M.; and J. F. Franklin (eds.). From the Forest to the Sea: A Story of Fallen Trees. USDA-FS and USDI-BLM Gen. Tech. Rep. PNW-GTR-229. p.113-122.

Review:

- The authors discuss CWD as an example indicator for the health of ecosystems. They describe aspects of forest management and their impacts to forest structure and complexity. The paper then discusses the need for maintaining options for forest management to maintain variability within forest structures. The need to protect wetland and riparian habitats is also noted. CWD pathways and maintenance of CWD within ecosystems are discussed at length. The need for more research concerning the relationships between CWD and long-term site productivity and habitat are also identified. This paper compares intensive and diversified forest management in the Douglas-fir region of the Pacific Northwest and uses coarse woody debris as an example of biological diversity.
- Although the ecological characteristics of old-growth Douglas-fir forests in the Pacific Northwest are not relevant to the ponderosa pine and mixed conifer forests of the Kaibab Plateau, the concept that coarse woody debris contributes to biological diversity and serves as a biological legacy was considered in the development of the WFR project design. We recognize the benefits of large woody debris to stabilize soils, create wildlife habitat, and enhance soil properties and considered these concepts in the development of the project design (e.g. salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas and leaving a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ within the salvage units).
- The WFR project recognizes the importance of CWD in recovering ecosystems and has provided standards for maintaining sufficient amounts of CWD to meet recommendations of material as described in Brown (2003), Graham (1994), and Brewer (2008).

Furniss, M. J., T. D. Roelofs and C. S. Yee. 1991. Road construction and maintenance. Pp. 297-323 in: W. R. Meehan (ed.). Influences of forest and rangeland management on salmonid fishes and their habitats. Am. Fish. Soc. Spec. Publ. 19. Bethesda, MD.

Review:

- This paper discusses roads and their impacts on watersheds and fisheries. Road location and design to lessen impacts to streams is described as well as promoting culvert design for fish passage.
- The WFR project does not propose to construct new roads and there are no perennial streams or fisheries in or immediately adjacent to the project area. The discussion of road locations, road design, and erosion from roads is relevant to the project and is considered through the application of Forest Service soil and water conservation measures (BMPs).

Gibbons, D. R. and E. O. Salo. 1973. An annotated bibliography of the effects of logging on fish of the western United States and Canada. USDA For. Serv. Gen. Tech. Rep. PNW-GTR-10. Portland, OR.

Review:

- There are no perennial streams within or immediately adjacent to the project area (see the aquatics report for analysis of effects to fish).

Gilliam, J. W. 1994. Riparian wetlands and water quality. Journal of Environmental Quality 23:896-900.

Review:

- The author notes the importance of riparian buffers to water quality and riparian areas.
- The WFR project will implement stream buffers on all intermittent stream channels. This is consistent with Gilliam's view on implementing riparian buffers.

Gorte, R. W. 1995. Forest Fires and Forest Health. Congressional Research Service Report for Congress 95-51-ENR. Washington, D.C.: Environment and Natural Resources Policy Division. 6 p.

Review:

- This report to Congress discusses fuel management and notes that the roles and responsibilities of the Federal and State governments in fire protection may be subject to further debate. The report notes salvage timber operations may be used to reduce fuels, however, salvage sales can be costly and often cost more than the revenues they generate.
- The WFR project considered the economic costs of proposed actions and this information is included in chapter 3 of the FEIS. The values were updated based on regional updated estimates of defect.

Gorte, Ross W. Ph.D. from a CRS report for Congress, January 18, 2006

http://www.ncseonline.org/nle/crsreports/06Feb/RL30755.pdf

"Research had documented that, in some situations, wildfires brought ecological benefits to the burned areas — aiding regeneration of native flora, improving the habitat of native fauna, and reducing infestations of pests and of exotic and invasive species." (pg 2)

Review:

- Report to Congress concerning forestry practices, funding levels, and the Federal role in wildland fire protection.
- In reference to the above quote, the WFR EIS discloses the wildfire effects to forest plants and animals. The EIS also acknowledges that before effective fire suppression began early in the 20th century, the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity,

and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement fire, and killed all or most of the large trees.

Graham, R. T.; Harvey, A. E.; Jain, T. B.; and J. R. Tonn. 1999. The Effects of Thinning and Similar Stand Treatments on Fire Behavior in Western Forests. USDA-FS Pacific Northwest Research Station. Gen. Tech. Rep. PNW-GTR-463. 27 p.

Review:

- This paper discusses the effects of green tree thinning and partial cuttings on potential fire behavior in Western forests.
- The WFR project does not propose to implement any green tree thinning or partial cuts.

Greenberg, C. H., D. G. Neary, L. D. Harris, and S. P. Linda. 1994. Vegetation recovery following high-intensity wildfire and silvicultural treatments in sand pine scrub. Am. Midi. Natur. 133(1):149-163.

Review:

- This Florida study hypothesized that clear-cutting mimics natural high-intensity disturbance by wildfire followed by salvage logging in sand pine scrub (Florida), and tested whether vegetation adapted to recovery from fire would respond similarly to another type of biomass removal. Plant community composition and structural characteristics were measured in three replicated areas. Non-woody plant species richness and diversity were significantly lower in mature sand pine forests than in disturbance treatments. The study suggests that plant resiliency traits, which evolved in response to the selective pressures of high-intensity disturbance and harsh environmental conditions, confer resiliency to human-caused disturbance as well. Mechanical biomass removal may be a suitable ecosystem management practice where burning is impractical.
- This study is not directly applicable to the ponderosa pine and mixed conifer forests of the Kaibab Plateau.
- This publication was cited following a notation that “Salvage logging has generally been shown to prevent or slow ecosystem recovery by: … Spreading nonnative invasive species as a result of logging and road construction.”
- The Kaibab National Forest currently is monitoring and treating invasive species and the WFR project includes mitigation to prevent spread of invasive species due to project activities. In addition to the forest-wide efforts, the WFR project incorporates project design features to reduce the potential of spreading nonnative invasive species.

Gregory, Lisa Dale Ph.D. "Wildland Fire Use: An Essential Fire Management Tool" A Wilderness Society Policy and Science Brief December 2004

http://wilderness.org/Library/Documents/upload/ScienceBrief-WildlandFireUseEssentialTool.pdf

"Ecologists and fire experts unanimously agree that fire has served an essential role in certain ecosystems for millennia. The ecological benefits of fire include: the creation of critical wildlife habitat in standing dead trees, increased nutrients and productivity in soil systems when burned material decomposes, improved conditions for surviving old growth trees when a surface fire moves through a system, and the regeneration of some fire dependent trees like lodgepole pine (Pinus contorta). Fire also increases availability of other fundamental building blocks of ecosystems such as moisture and sunshine by opening up the canopy and returning nutrients to the soil. Natural fire cycles maintain the diversity of habitats available to all the species in the ecosystem, from wildlife to wildflowers to fungi."

Review:

- This paper discusses wildland fire use policy and the benefits of wildland fire use.
- The WFR EIS discloses the wildfire effects to forest plants and animals. The EIS also acknowledges that before effective fire suppression began early in the 20th century, the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity, and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement fire, and killed all or most of the large trees.

Grifantini, M. C., J. D. Stuart, and L. Fox III. 1992. Deer habitat changes following wildfire, salvage logging and reforestation, Klamath Mountains, California. P. 163-167 in Proceedings of the Symposium on Biodiversity of Northwestern California, Report #29, Univ. Calif, Wildland Resour. Cent., Berkeley, CA.

Review:

- Document not available for review.
- While studies of habitat changes in the Klamath Mountains of California may not be directly relevant to the dry mixed conifer and ponderosa pine forests of the Southwest, mule deer are a management indicator species selected for this project as an indicator for early-seral aspen habitat. The effects to deer are discussed in the FEIS. Aspen that is regenerating within the Warm Fire area would not be targeted for planting efforts.
- Although mule deer populations appear to be decreasing on the forest (Bratland et al. 2007), aspen habitats in the project area will increase and provide a significant portion of the forest-wide habitat. As habitat quality of aspen in other parts of the forest continues to decline due to competition with and shading from conifer, aspen habitats in the project area will become increasingly important. Aspen habitat will continue to increase across the project area and will contribute to maintaining mule deer habitat and populations distributed across the Kaibab National Forest.

Gucinski, H., M. J. Furniss, R. R. Ziemer and M. H. Brookes (eds.). 2001. Forest Roads: A Synthesis of Scientific Information. USDA For. Serv. Gen. Tech. Rep. PNW-GTR-509. Portland, OR.

Review:

- PNW-GTR-509 describes the effects roads have on ecosystems. It is a companion paper to "Roads Analysis: Informing Decisions About Managing the National Forest Transportation System" (USDA FS 1999). The report details the known issues related to road impacts on physical and biological resources, road impacts at various scales, and the socioeconomics of roads. The report then describes the known science surrounding these issues. The focus of the report is to help the reader understand how roads function in the landscape.
- The WFR project recognizes the impacts that roads have on the landscape. No new roads would be constructed with this project; however, some older, existing spur roads would need to be re-opened for salvage activities, then closed following use. None of these re-opening of existing spur roads are within stream buffer areas. All roads, existing and temporary, will be managed and maintained in accordance with Forest Service soil and water conservation practices (BMPs).

Haggstrom, Dale A. and Thomas F. Paragi "Fire Ecology FAQs"

http://wildlife.alaska.gov/index.cfm?adfg=fire.fire5

"Fire is a natural process in the boreal forest. The plants and the animals rely on fire to maintain a natural balance of vegetation and wildlife abundance. Without habitat mosaics created by fire throughout the boreal forest, many species would not exist."

Review:

- This document is a discussion of boreal forest fire ecology presented by the Alaska Fish and Game Division of Wildlife Conservation. There are no boreal forests in Arizona. Although this paper is not applicable to the WFR project, effects to wildlife were discussed in the EIS.

Haney, Alan Ph.D. Introduction to the keynote presentation of the 8th annual Wisconsin Association of Lifelong Learning conference University of Wisconsin Stevens Point, October 25, 2007.

http://www.uwsp.edu/conted/wall/conference.aspx

"In 2007, we are witnessing one of the 'worst' wildfire years in recent history, as measured in acres burned, suppression costs, and loss of property. We tend to view loss of property or timber value, and aesthetics. This perspective was greatly promoted by the U.S. Forest Service and the highly successful Smokey the Bear campaign that continues, albeit much reduced. When examined from a more objective, ecological perspective, the benefits of wildfire greatly exceed the negatives. This illustrated presentation examines the ecology of wildfire and presents the case that our anthropocentric perspective often clouds a more balanced understanding of nature

where even bears are benefactors of fire."

Review:

- This document is not available from the link listed. This paragraph is the only part of the presentation available.
- The WFR EIS discloses the wildfire effects to forest plants and animals. The EIS also acknowledges that before effective fire suppression began early in the 20th century the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity, and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement fire, and killed all or most of the large trees.

Hann, W. J., J. L. Jones, M. G. Karl, and others. 1997. Landscape dynamics of the basin. Ch. 3 in: T.M. Quigley and S. J. Arbelbide (tech. eds.). An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins: Vol. II. USDA For. Serv. Pac. Nor. Res. Sta. Gen. Tech. Rep. PNW-GTR-405. Portland, OR.

Review:

- Commenter cited this report while noting research in forest science and landscape ecology notes that the number and distribution of even-aged plantations has altered fire behavior and effects at both stand and landscape scales.
- The desired condition for the WFR project area, within Ecosystem Management Area 13, is a forested condition with predominately ponderosa pine in most of the area with mixed conifers and spruce-fir vegetative cover.
- Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands and successful conifer reforestation observed on the salvaged and planted areas (USDA Forest Service 2008).
- In a paper reviewing the conditions of the Rodeo-Chediski Fire, Storm and Fule 2007 noted while tree planting is costly and often fails in the Southwest, it should be considered because of sparse ponderosa pine regeneration and the likelihood of shrub species dominance, especially in untreated areas.
- The areas identified for planting in the WFR project are currently lacking conifer seed sources and are proposed for planting at densities aimed to move the area toward conditions similar to those present pre-forest management (e.g. before fire suppression).

Hanson, Chad. GETTING BURNED BY LOGGING: Forest Service Abuse of the National Fire Plan in the Sierra Nevada. San Francisco Chronicle. June 19, 2001.

http://www.ourforests.org/fact/getting_burned.pdf

"In addition, post-fire salvage logging - particularly tractor logging and logging road construction, which the Forest Service favors as methods for its salvage logging projects - causes erosion and serious damage to soil. Ironically, these are the exact things the National Fire Plan Rehabilitation funds were designed to prevent. See Beschta et al. (1995), Wildfire and Salvage Logging, Oregon State University; see also McIver and Starr (2000), pp. 11-12, 19-20; Swank et al. (1989), Effects of timber management practices on soil and water, U.S. Forest Service (erosion rates from logging are seven times higher than undisturbed sites, and erosion rates on landings and logging roads are 100 times those of undisturbed sites); Potts et al (1985), Watershed modeling for fire management planning in northern Rocky Mountains, Res. Pap. Berkeley, CA, Pacific Southwest Forest and Range Experiment Station (sedimentation increases after large fires, but increases significantly more after post-fire logging)."

"This increased sedimentation caused by post-fire logging is particularly severe where high-intensity fires occurred. See Megahan and Molitor (1975), Erosional Effects of Wildfire and Logging in Idaho, American Society of Civil Engineers. Erosion and resulting sedimentation is most severe with ground-based skidding systems. See Klock (1975), Impact of Five Postfire Salvage Logging Systems on Soils and Vegetation, Journal of Soil and Water Conservation, 30(2):78-81. Most of the post-fire salvage logging proposed on Sierra Nevada national forests plan to primarily use ground-based skidding systems."

Review:

- The article by Hanson is a position paper that presents broad arguments against various points of Forest Service land management policies and ecosystem treatments. The author gives a short background of the development and rational for the National Fire Plan, and then goes on to provide rational why the National Fire Plan is not necessary. He utilizes scientific articles to argue that some of the larger scale fuels reduction projects promoted under the National Fire Plan are not needed to protect homes from wildfire. The author goes on further to review hazardous fuels projects and cites Forest Service projects where he believes that acreages of severely burned forests were overstated. The author continues with a review of forest restoration projects and discusses the literature concerning tree mortality after wildfires. The article ends with a literature review of the impacts of post-fire logging on soil and water resources.
- Much of the author's discussion concerning the National Fire Plan is not relevant to the Warm Fire Recovery project. Most of the points the commenter (Artley) cites are more appropriately found in the original scientific articles—many of which are cited and listed above. Other literature reviews which are critical of post-fire salvage logging, Beschta et al. for example, covers the post-fire salvage logging assessment with more scientific credibility and with less bias.

Hanson, Chad. 2005. Post-fire salvage logging: a misguided policy for California's forests. Unpublished fact sheet. May 2005.

Review:

- This commentary pertains to salvage logging on national forests in California. The article recommends opposing legislation proposing to restrict or suspend environmental laws for the purpose of expediting post-fire salvage logging on national forests, and considering supporting legislation to restrict salvage logging.
- The issues and facts noted 10 to 15 percent of affected acreage burned at high severity; numerous avian species have a positive association with recently burned forests; lack of journal articles in recent published, peer-reviewed scientific literature favor post-fire salvage logging; areas proposed for salvage logging in the Sierra have been mainly live, mildly-burned old growth trees; logs over 10 inches in diameter contribute very little to fire behavior and effects; and logging slash at the level of 30 to 40 tons per acre is considered to represent high to extreme fire hazard.
- The WFR project analysis focused on treating the moderately to high and high severity burned areas where only dead trees are proposed for removal. Snags are recognized as an important component for wildlife habitat and project design features are incorporated to maintain snags on the salvaged areas, as well as the untreated areas, across the project area.
- Breaking up the future large fuel component is one of the purposes for the WFR project. Future fires would expose the soils beneath and directly around coarse woody debris to high heat for extended periods of time, exposing roots to lethal temperatures (Monsanto and Agee 2008). Monsanto and Agee (2008) noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. Monsanto and Agee (2008) also note "most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period."

Reference:

- Monsanto, Philip; James Agee. 2008 Long-term post wildfire dynamics of coarse woody debris after salvage logging. College of Forest Resources, University of Washington. Seattle, WA.

Harden, Blaine, staff writer. "Bush Plan to Aid Forests after Wildfires Draws Criticism" Washington Post. October 15, 2004.

<http://72.14.203.104/search?q=cache:uHv25JHb5TQJ:www.crag.org/content/news/wp20041015.pdf+logging+after+wildfire&hl=en&gl=us&ct=clnk&cd=171&lr=lang_en>

"Seven of the world's leading forest ecologists say that salvage logging is the wrong prescription for fire-damaged forests such as the Siskiyou. Writing this year in the journal *Science*, they said research findings from around the world show that 'salvage logging can

impair ecosystem recovery.' They also wrote that fire has long-term benefits that increase biological diversity, and that salvage logging 'undermines' these benefits."

"Jerry F. Franklin, professor of ecosystem science at the University of Washington and a co-author of the *Science* article, said forests are more resistant to wildfire if they are not logged and replanted."

Review:

- A 2004 newspaper article that discusses national policy on post-wildfire forest treatments. Specific reference to the Lindenmayer et al. 2004 paper in Science. See Lindenmayer et al. 2004 for discussion of that paper.

Harmon, M.; Franklin, J. F.; Swanson, F.; Sollins, P.; Gregory, S. V.; Lattin, J. D.; Anderson, N. H.; Cline, S. P.; Aumen, N. G.; Sedell, J. R.; Linekaemper, G. W.; Cromack, K.; and Cummins, K. W. 1986. Ecology of Coarse Woody Debris in Temperate Ecosystems. In: MacFayden, A. and E. D. Ford (eds.) Advances in Ecological Research. Academic Press 15:133-302.

Review:

- Coarse woody debris was considered in the WFR project. It has long been recognized that downed logs have values for wildlife. The forest plan includes direction for downed log retention and this is included in the project design features. The wildlife report discusses and analyzed snags and downed logs.
- The WFR project considered coarse woody debris. Project design features to maintain adequate amounts of dead and down woody material levels within treated stands are noted below:
  - Leave a minimum of 15 to 20 tons per acre of coarse woody debris (CWD) (material >3″) on all activity units, where available.
- These are volumes of dead and down woody debris that meet or exceed recommendations by Graham (1994), Brown (2003), and Brewer (2008).

Harrod, R. J., W. L. Gaines, W. E. Hartl and A. Camp. 1998. Estimating Historical Snag Density in Dry Forests East of the Cascade Range. USDA For. Serv. Pac. Nor. Res. Sta. Gen. Tech. Rep. PNW-GTR-428. Portland, OR.

Review:

- This paper looked at snag densities in pre-European landscapes in dry forests east of the Cascade Range in Washington.
- The method for determining snag density in this study was based on growth potential and stand dynamics typical of dry forests east of the Cascade Range in Oregon and Washington. The authors conclude that snag density in historical landscapes ranged from 14.5 to 34.6 snags per hectare (5.9 to 14.1 snags per acre).
- The growth potential and disturbance regimes typical of the dry forests of the Kaibab Plateau are not the same as those found in the dry forests east of the Cascade Range in Washington. Therefore, a direct correlation is not warranted. Project design for salvage

units within the WFR project area includes snag requirements that meet forest plan guidelines. Within the untreated stands and corridors/drainages snag density will far exceed the maximum of 14 per acre estimated by this study.

Hebblewhite, Mark Ph.D., Robin Munro and Evelyn Merrill Ph.D. April 2005. Post-fire harvest in the Dogrib Burn and Elk Habitat.

http://ursus.biology.ualberta.ca/yhtelkwolfproject/Dogrib_ElkFire_Final_Report_small.pdf

"Despite minimal differences in forage between burned and salvaged sites, elk (and deer and moose) selected un-logged burns and avoided post-fire logged sites. Based on other studies of elk and forestry across western North America, we infer that elk avoided salvaged cutblocks because: 1) post-fire logging would reduce habitat effectiveness through removal of dead standing tree cover, and/or 2) elk avoided salvaged areas due to predation risk by humans and wolves associated with logging roads built for salvage logging."

"Numerous studies have documented the disruptive effects of post-fire logging on natural processes such as fuel accumulation, hydrology, sediment transport, and on select wildlife species (Lindenmayer et al. 2004; Smith 2000; McIver & Starr 2000; Beschta et al. 2004; Nappi et al. 2004)."

"Post-fire harvesting removes critical habitat for species, such as cavity-nesting mammals, birds, and insects that depend on burned wood (Lindenmayer et al. 2004)."

"Removal of large woody structure has caused declines in the abundance of several cavity-nesting bird species, including mountain bluebird (*Sialia currucoides*), and black-backed (*Picoides arcticus*), hairy (*P. villosus*), and three-toed woodpeckers (*P. tridactylis*) (Hutto 1995; Hoyt & Hannon 2002; Morissette et al. 2002; Hobson & Schieck 1999)."

"Post-fire logging reduced herbaceous groundcover in Arizona Ponderosa Pine (*Pinus ponderosa*) stands (Blake 1982). In Idaho, also in Ponderosa pine, post-fire logging reduced herbaceous biomass and plant species diversity during the first two-years post burn (Sexton 1998). In California Douglas Fir (*Psuedotsuga menziesii*) stands subjected to post-fire logging, the effects of reduced shrub and forb biomass persisted from the first year post burn to 11-years post post-fire (Stuart et al. 1993). Although we found no published studies on post-fire logging in lodgepole pine, these previous studies support our findings of at least short-term negative effects of post-fire logging on herbaceous forage."

Page not found

Review:

- The document is not available but the quotes pulled out by Artley discuss loss of cover and decreased use by big game after salvage logging; loss of habitat provided by dead wood and decreases in abundance of cavity-nesting species; and decreases in ground cover as a result of salvage logging.
- These effects were discussed in the wildlife analysis, in the appropriate sections.

Heede, B. H. 1980. Stream Dynamics: An Overview for Land Managers. USDA For. Serv. Gen. Tech. Rep. RM-72. Ft. Collins, CO.

Review:

- The WRP area does not contain any perennial streams. Ephemeral drainages were identified and buffered to reduce potential impacts to water resources.

Helvey, J. D. 1980. Effects of a north central Washington wildfire on runoff and sediment production. Water Resources Bulletin 16(4):627-634.

Review:

- The author measured runoff from a burned mixed conifer forest on Entiat Experimental Forest in the State of Washington. The study found that runoff increased substantially after the fires and that sediment production had similar increases.
- The WFR project recognizes the potential for decreased infiltration and increased runoff and sediment production resulting from the burned landscape. Stream buffers and hillslope restrictions for ground-based equipment were in order to avoid further impacts to the landscape from the proposed action.

Henly, R. K. 1988. Conflicts Over Fire-Killed Timber Salvage Continue. Journal of Forestry. October. pp. 5-9.

Review:

- This commentary pertains to conflicts over fire-killed timber salvage on the Silver Fire on the Siskiyou National Forest in Oregon. The paper relays the progression of analysis and responses from affected groups, congressional involvement and court involvement.
- It is well understood there are conflicts regarding salvage logging of fire-killed trees on National Forest System lands.
- The WFR project EIS documents an environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies.

Hillis, M., Jacobs, A. and V. Wright, 2002. Region One Black-backed woodpecker Assessment September 6, 2002.

Review:

- Black-backed woodpeckers are not found in the ponderosa pine forests of the Southwest. This assessment is not relevant to this project.

Hitchcox, S. M. 1996. Abundance and nesting success of cavity-nesting birds in unlogged and salvage-logged burned forests in northwestern Montana. M.S. Thesis, Univ. Montana: Missoula. 89 pp.

Review:

- Although this paper was not available, it has long been recognized that snags and downed logs have values for wildlife. The forest plan includes direction for snag and downed log retention. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest. The analysis for wildlife species that use snags and downed logs incorporate that into the analysis, and appendix C of the wildlife report is a discussion and analysis of snags and downed logs.
- Black-backed woodpeckers (which do not occur in Arizona) and three-toed woodpeckers have been shown to select unsalvaged areas of a burn. Other species have been shown to select salvage logged areas of a burn (Lewis' woodpecker). Only some of the mixed-high and high mortality areas are proposed for salvage (none of the low and mixed-low mortality areas would be salvaged). The percent of the mixed-high and high mortality areas proposed for salvage varies by alternative, but ranges from 26 to 43 percent, as shown in the wildlife report.

Huff, M. H., R. D. Ottmar, E. Alvarado, R. E. Vihnanek, J. F. Lehmkuhl, P. F. Hessburg and R. L. Everett. 1995. Historical and current landscapes in eastern Oregon and Washington. Part II: Linking vegetation characteristics to potential fire behavior and related smoke production. USDA For. Serv. Pac. Nor. For. and Ran. Exp. Sta. Gen. Tech. Rep. PNW-GTR-335. Portland, OR.

Review:

- This document discusses the link between several factors having an effect on departure from historic fire regimes and fire behavior. Fire exclusion, overly dense plantations, and heavy fuel loads associated with untreated activity fuels are some of the items discussed. This document does not specifically address the issue of restoration or fuels treatment in areas with previous uncharacteristically severe fire and for that reason has a limited application to the WFRP. The relevant topics from this document have been incorporated into the fuels report.

Hutto, R. L. 1995. Composition of bird communities following stand-replacing fires in northern Rocky Mountain (USA) conifer forests. Conservation Biology 9:1041-1058

Review:

- This study looked at post-fire bird communities in several forest types in western Montana. He found that bird communities are different in composition to other cover types, because members of three feeding guilds are especially abundant – woodpeckers, flycatchers and seed-eaters. Nearly all of the broken-topped snags that were used were present before the fire, so forest conditions prior to the fire may be important in determining the suitability of a site for cavity-nesting birds after a fire. He suggests that

stand-replacing fire may be necessary for long-term maintenance of some species that use the post-fire communities (i.e. black-backed woodpecker).

- The Warm Fire project area is in ponderosa pine forests in Arizona that are not characterized by a stand-replacement fire regime.

Hutto, Richard Ph.D., "One year after fire, Black Mountain is springing back to life." The Missoulian. August 1, 2004

http://www.missoulian.com/articles/2004/08/01/news/top/news01.txt

"Public land is the only hope for these burned ecosystems. These are the only places left where we can let fire play its natural role."

Review:

- This is not peer-reviewed scientific literature, rather a popular newspaper article written about how a fire area in Montana is responding a year after the fire. There is no argument that a burned area will recover naturally after a fire. This project proposes to salvage harvest about 9,000 acres of an approximately 40,000-acre burn, and plant conifer seedlings on approximately 10,000 acres. This would leave about 30,000 acres to recover naturally "let fire play its natural role," while still meeting the need and forest plan multiple-use objective to salvage some timber in fire areas to recover economic value of the wood.

Hutto, Richard L. Ph.D. "Birds in the black: Through following avian wildlife, a UM scientist has discovered that burned forests play a critical role in the health and diversity of the Western landscape". The Missoulian. August 11, 2005.

<http://www.missoulian.com/articles/2005/08/11/outdoors/od01.txt>

"Personally, I've come to think we need to change our thinking on salvage logging. There are other values in the forest. In fact, a burned area is probably the most sensitive place you could be working in. The public really hasn't caught on to this yet. People still want to get the cut, get the trees they see as wasting away. They want the economic value. We talk about forest restoration after a fire, but it just got restored. That's what fire does. We know that, but we can't seem to get the message out. Until you start thinking like a black-backed woodpecker, you just ain't going to get it."

Review:

- This newspaper article discusses the importance of fire severity on bird species use, i.e. some use low severity fires, while some like severely burned forests. It also discusses the importance of fire for some tree species, beetles and the potential value for other species such as western toad.
- The effects of fire severity on vegetation mortality are discussed in the DEIS. Each mortality class was identified based on overstory and understory effects, and results in shifts in use by some species of wildlife. Fire has also been identified as effective in regenerating aspen, as is happening in the project area and as analyzed in the DEIS.

Hutto. Richard L. Ph.D., "Post-Fire Logging is bad for Forests and Wildlife." The Seattle Times Special. 8 December 2005.

http://seattletimes.nwsource.com/html/opinion/2002670756_burnedforests08.html

"Burned forests have great ecological significance and importance. With Congress now debating controversial legislation that encourages logging after fires, it is important for the public and policymakers to recognize the role of burned forests in maintaining wildlife populations and healthy forests."

"The species whose habitat distribution is more restricted than any other to burned-forest conditions is the black-backed woodpecker. Everything about it, including its jet-black coloration, undoubtedly reflects a long evolutionary history with burned forests. There are many additional bird species, including the mountain bluebird, three-toed woodpecker and olive-sided flycatcher, that also reach their greatest abundance in burned forests."

"This is important because if we value and want to maintain the full variety of organisms with which we share this Earth, we must begin to recognize the healthy nature of burned forests. We must also begin to recognize that post-fire logging removes the very element (the standing dead trees) upon which each of those bird species depends for nest sites and food resources."

"We need to change our thinking when it comes to logging after forest fires. There is potential economic value in the timber, yes, but there are numerous other values in a burned forest. And the prospect of losing those values must be weighed against the potential gain that may accompany post-fire timber harvest. The scientific facts also reveal that burned areas are probably the most ecologically sensitive places from which we might extract trees."

"Nature doesn't waste anything. Burned forests, even severely burned forests, are forests that have been 'restored' in the eyes of numerous plant and animal species and in the eyes of an informed public. The burned trees are essential for maintaining an important part of the biological diversity we value today, and are the foundation for the forests of the future."

"So, while it may seem counterintuitive, trying to make a quick buck off the burned forests today is more like borrowing from the forests of tomorrow. Our forests and the biological legacy we leave to future generations will be diminished if we fail to listen to the birds."

Review:

- This newspaper article discusses some of the values of burned forests for bird habitat.
- The concepts discussed in this article were incorporated into the analysis, for both hairy woodpecker and species using burned stands (i.e. olive-sided flycatcher). The analysis in the EIS identifies how much of the burned forest habitat would not be salvaged and would remain as habitat (until the trees fall), as well as incorporation of snag design features in the areas that are salvaged.

Hutto, R. L. 2006. Toward meaningful snag management guidelines for postfire salvage logging in North American conifer forests. Conservation Biology 20:984-993.

Review:

- This paper includes a discussion about fire regimes in western forest types. He found support showing low elevation ponderosa pine forests are typified by an unspecified amount of mixed-severity fire and at least some crown-fire events are entirely natural. From there, he develops the case the current snag guidelines for green forests are not suitable for salvage in stand-replacing fires.
- Analysis for this project was based on studies in the ponderosa pine forest of the North Rim of the Grand Canyon, adjacent to the project area. While frequencies varied, all studies found frequent, low intensity fire occurrence in the ponderosa pine type. The mixed conifer forest types are characterized as a mixed fire regime. Stand-replacing fire regimes are not found in the project area, although that does not preclude some stand-replacing fire. Snag retention direction for this project was developed based on existing direction. But it also includes a focus on retention of clusters of larger diameter snags (to increase longevity and use by more species), and leaves more snags close to green forests that are more likely to be used by species such as hairy woodpecker.

Hutto, Richard L. Ph.D., Kerry R. Foresman Ph.D. and Paul Alaback Ph.D. "Patterns of Plant, Bird, Amphibian, and Small Mammal Occurrence in Salvage-Logged and Unsalvaged Burned Conifer Forests in the Bitterroot Valley, Montana." A Proposal Submitted to USFS Northern Region.

http://www.fs.fed.us/r1/nfp/research/project12.shtml

"Though fire is a major disturbance to forest systems, salvage logging represents an added disturbance."

"Critical issues will be the extent to which salvage logging may enhance invasions by exotic plants, in particular noxious species. Some studies have also suggested that salvage logging can lead to significant losses in natural tree regeneration, all depending on the extent of on-the-ground disturbance and the initial extent of tree regeneration. Previous studies suggest that salvage logging may set back ecosystem recovery in general."

"With respect to post-fire fuels-reduction logging or salvage logging, the bird species most restricted to post-fire conditions appear to be affected most negatively. Burned forests that are completely logged decrease the suitability of post-fire forests for most bird species (Caton 1996, Hitchcox 1996, Saab and Dudley 1998), but the effects of partial logging are equivocal."

Review:

- The statements quoted by Artley are part of a research proposal to study the effects of salvage in burned conifer habitats.
- It is recognized that salvaging reduces habitat for some species, as is shown in the hairy woodpecker analysis in the wildlife report.

Ingalsbee, Timothy Ph.D. "Fighting Forests with Fire: A Soldier's Story." Wildfire!: an endangered ecosystem process. Vol. 1 1994.

http://www.fire-ecology.org/research/soldiers_story.htm

"As a matter of policy, every fire in the agency's designated 'general forest' zone is salvage logged--and the bigger the fire, the bigger the salvage sale! It has saddened and angered me to learn how many wild places me and my crewmembers worked our butts off to save (like the North Kalmiopsis Roadless Area, like Yellowstone National Park!) were salvage logged. The public should quickly dispel themselves of the myth that firefighting saves trees … they are 'saved' only for the salvage saws. Perhaps we should ask the agency why it needs to spend millions of tax dollars 'fighting' forest fires if it intends to log off the trees anyway."

Review:

- This commentary discusses past forest and fire management policies and practices along with personal firefighting experiences.
- The WFR project area lies within a managed area of the Kaibab National Forest. Areas proposed for salvage are located within EMA 13, which includes salvage logging of burned areas as an appropriate action.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies.

Ingalsbee, Timothy Ph.D. "The War on Wildfire: Firefighting and the Militarization of Forestry." Wildfire!: an endangered ecosystem process. Vol. 2 1997.

http://www.fire-ecology.org/research/war_on_wildfire.htm

"Firefighting and fire salvage logging represent a militarization of forest management that portends dangerous consequences for both native ecosystems and democratic society. The 'collatoral damage' inflicted upon ecosystems in the wake of firefighting and fire salvage logging operations is truly astounding."

"The damage to ecology and democracy does not end when the fire is out, however. The Forest Service allegedly 'recovers' burned stands by 'salvaging' the commercially valuable timber in order to 'protect' the forest from future fires. Again, it must destroy it to save it."

Review:

- This commentary discusses firefighting and salvage logging as representing a militarization of forest management and notes Cascadia's native and ancient forests contain floral and faunal populations and ecological processes which are naturally adapted to, if not vitally dependent on, recurring fires.
- This commentary does not contain new information relevant to the WFR project area. The analysis includes the no action alternative in which no salvage logging would occur.

- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies.

Ingalsbee, Timothy Ph.D. "Fanning the Flames! The U.S. Forest Service: A Fire-Dependent Bureaucracy." Missoula Independent Vol. 14 No. 24. June 2003.

http://www.fire-ecology.org/research/USFS_fire_dependent.html

"Wildfires provide the Forest Service with new and greater opportunities for commercially logging the remnants of native forests. One means is through post-fire salvage logging."

"The agency routinely offers up fire-scorched trees for 'salvage' timber sales, often claiming the need for streamlined environmental analyses, or special exemptions from official standards and guidelines, or abandonment of conservation strategies in order to get the salvage timber cut out as quickly as possible before the trees decay and the timber is 'wasted.' In some cases, salvage timber sales have been proposed in areas that for environmental reasons were supposed to be prohibited from any commercial logging."

Review:

- This commentary discusses past forest and fire management policies of the U.S. Forest Service.
- The WFR project area lies within a managed area of the Kaibab National Forest. Areas proposed for salvage are located within EMA 13, which includes salvage logging of burned areas as an appropriate action.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies.

Ingalsbee, Timothy Ph.D. 2004. Salvaging Timber; Scuttling Forests: The Ecological Effects of Post-Fire Salvage Logging. Western Fire Ecology Center.

http://www.klamathforestalliance.org/Documents/scuttlingforests.html

"Far from being a 'wasted resource,' large-diameter snags and logs play critical structural and functional roles in maintaining healthy, diverse wildlife populations. Indeed, an ecologist could argue that a dead tree sustains more wildlife than a live tree."

"In the short-term, the adverse effects of high-severity fires … decreased infiltration, increased overland flow, and excess sedimentation in streams, can be greatly exacerbated by the soil disturbance caused by salvage logging. In the long-term, extracting snags that would have become downed logs eliminates their ability to intercept precipitation and retard erosion."

Review:

- Ingalsbee presents a review of the potential adverse aspects of post-wildfire salvage logging to soils, streams, wildlife, vegetation, and increased fire risk and fuels hazard. The review is consistent with the arguments presented by Beschta et al. (1994), but does not present any new science. His discussions on the utility of downed woody material for soil enhancement and protection and for wildlife use are well covered on the Warm Fire Recovery project with the project design features and best management practices for soil protection and coarse woody debris maintenance (See "Project Design Features Common to All Alternatives, DEIS, chapter 2, pgs. 28-32.)
- It has long been recognized that snags and downed logs have values for wildlife. The forest plan includes direction for snag and downed log retention. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest. The analysis for wildlife species that use snags and downed logs incorporate that into the analysis, and appendix C of the wildlife report is a discussion and analysis of snags and downed logs.

Jenny H. 1980. The Soil Resource: Origin and Behavior.New York: Springer-Verlag.

Review:

- "The Soil Resource" is a text describing the nature and properties of soils. It presents the concepts concerning the development and formation of soils.
- The terrestrial ecosystems survey (TES) of the Kaibab National Forest was utilized for the analysis of the WFR project. The TES was developed utilizing concepts and principals outlined in the Soil Resource.

Johnson, D. W., J. F. Murphy, R. B. Susfalk, T. G. Caldwell W. W. Miller Ph.D, R. F. Walker, and R. F. Powers. 2005. "The effects of wildfire, salvage logging, and post-fire N-fixation on the nutrient budgets of a Sierran forest. Forest Ecology and Management 220:155-165.

http://www.cababstractsplus.org/google/abstract.asp?AcNo=20053224517

"The effects of fire, post-fire salvage logging and revegetation on nutrient budgets were estimated for a site in the eastern Sierra Nevada Mountains, California, USA, that burned in a wildfire in 1981."

"Approximately two decades after the fire, the shrub (former fire) ecosystem contained less C and more N than the adjacent forest ecosystem. Reconstruction of pre-fire nutrient budgets suggested that most C was exported in biomass during salvage logging and will not be recovered until forest vegetation occupies the site again. Salvage logging may have resulted in longer-term C sequestration in wood products than would have occurred had the logs been left in the field to decay, however."

Review:

- The WFR project recognizes the value of nitrogen fixing plants and has developed project design features intended to minimize the disturbance to plant regrowth and the regeneration of duff and litter layers. Specifically, ground-based equipment will be restricted to designated skid trails and gentle slopes.

Karr, James R. Ph. D. "Forest Service Losing Money on Biscuit Post-fire Logging." Sustainable Review. January 16, 2006.

http://www.sustainablereview.com/articles/article/2773752/41299.htm

"It's unfortunate but true that logging cast as 'restoration' is one of the most damaging management activities humans can initiate after a fire. No amount of tree planting can make up for the damages caused by logging after large wild fires."

Review:

- This document is not available from the link listed. This paragraph is the only part of the document available.
- The WFR EIS discloses the wildfire effects to forest plants and animals. It also discloses the effects of logging for three action alternatives.

Karr, James R. Ph. D. Professor of Aquatics Sciences and Biology, University of Washington from an article written by Matthew Koehler "Scientists Warn Congress Against Fast-Track Logging in Forests Recovering from Fire." New West, March 15, 2006

http://www.newwest.net/citjo/article/scientists_warn_congress_against_fast_track_logging_in_forests_recovering_f/C13/L8/

"Proposed post-disturbance legislation (specifically the Forest Emergency Recovery and Research Act [HR 4200], crafted as a response to recent fires and other disturbances, is misguided because it distorts or ignores recent scientific advances."

Review:

- This article reports on a letter by a group of scientists sent to members of Congress concerning the Forest Emergency Recovery and Research Act.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

Karr, James R. Ph. D. "When Government Ignores Science, Scientists Should Speak Up" BioScience Vol. 56 No. 4, April 2006.

"First, science is central to policy decisions with immense societal impact. Whether US policymakers are setting NASA's budget, determining how to dispose of nuclear waste, or protecting the nation's soil, water, and living resources, science is central to the decisions they make, and scientists are uniquely qualified to apply that science to the decisionmaking process. Scientists do more than collect data. Their training, and the day-to-day practice of their profession, centers on gathering evidence for and against hypotheses, weighing that evidence, and drawing conclusions based on the evidence."

"… the training that scientists receive—to question the assumptions and conventions of science—also equips them to challenge the assumptions of public policy, the law, and implementation of the law, especially when that implementation violates both science and common sense."

"When scientists do not speak up, the message seems to be that science is irrelevant and that scientists do not matter. Yet science has never been more relevant or more essential."

Review:

- This commentary discusses the need for scientists to voice their concerns pertaining to management actions.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies.

Karr, James R. Ph.D., Christopher Frissell Ph.D., Jonathan J. Rhodes, Robert L. Beschta Ph.D., David L. Perry Ph.D. and G. Wayne Minshall Ph.D. Excerpts from a Letter to U.S. House of Representatives, Subcommittee on Forests & Forest Health. July 3, 2002.

http://www.plantsocieties.org/PDFs/Beschta%20response.pdf

"Several years ago, we contributed to a report titled Wildfire and Salvage Logging, Recommendations for Ecologically Sound Post-Fire Salvage Management and Other Post-Fire Treatments (Beschta et al., 1995), commonly referred to as the 'Beschta Report.'"

"Oddly, recent testimony by the current Chief of the USFS before the Subcommittee on Forests & Forest Health on June 12, 2002 and a June 2002 USFS report titled The Process Predicament: How Statutory, Regulatory, and Administrative Factors Affect National Forest Management indicts the Beschta Report as 'questionable.'"

"Contrary to the Chief's wholly unsubstantiated statement that our report is 'questionable,' our work is supported by a rich history of scholarly work by scientists inside and outside the USFS. We cited more than a dozen such publications in our report. We are not aware of any papers published in the peer-reviewed scientific literature, before or after the 1995 publication of the

report that negate or substantially contradict our conclusions and recommendations."

"Chief Bosworth should be aware that the USFS itself has repeatedly conceded that our March 1995 report had, and still has, scientific merit. In August 1995, Dr. Richard Everett of the USFS Pacific Northwest Research Station prepared a response to the Beschta Report titled Review of Recommendations for Post-Fire Management (Everett Report) in a letter to the Regional Forester of Region 6 (Oregon and Washington). The Everett Report concurred with key aspects of our report, including our conclusion that there were no data to indicate that post-fire salvage logging reduced the risk of reburn."

"The Chief's assertion that EISs must address work of 'questionable' scientific merit that has not been peer-reviewed is amusing, and self-contradictory. USFS EISs are not normally subjected to peer-review by scientists outside of the agency. Further, USFS EISs often come to conclusions, or are used to support decisions, that directly contradict the vast body of scientific evidence and information."

"The agency often strives to ignore or deny the vast body of knowledge that has accumulated in recent decades in favor of antiquated policies. For example, extensive and detailed studies (mostly conducted by the agency's own scientists) demonstrate that the smallest diameter fuels present the highest risk for fire while the largest diameter trees are critically important to retain crucial ecological functions in forested landscapes. Yet, the USFS continues to attempt to implement post-fire salvage logging that focuses on the removal of the largest diameter fuels."

"Humans, too, suffer when these resources are degraded, as will often happen if the forest practices advocated by the Chief and The Process Predicament report are continued. Continued denial of the extensive body of technical and scientific evidence that formed the foundation of our report will guarantee continuation of the downward spiral of forest-associated resources."

Review:

- The Karr letter the U.S. House of Representatives, Subcommittee on Forests and Forest Health, July 3, 2002, is a rebuttal to statements made by former Chief of the Forest Service, Dale Bosworth, who commented to the subcommittee regarding the "Process Predicament Report" where the Chief questioned the usefulness of addressing certain types of scientific literature in environmental documents. The authors argue that the literature review and assessment provided by Beschta et al. in 1995 was scientifically based and has merit as a scientific article that should be included in discussions concerning treatment of burned ecosystems.
- As noted above, the Warm Fire Recovery project is striving to address the environmental concerns raised by the Beschta Report. The soil and water project design features and best management practices in particular were developed in response to issues previously raised in the Beschta Report. However, the Karr letter itself is directed to the U.S. House of Representatives, Subcommittee on Forests and Forest Health as a rebuttal and is not a scientific article that merits discussion in an environmental document.

Karr, J. R., J. J. Rhodes, G. W. Minshall, F. R. Hauer, R. L. Beschta, C. A. Frissel, and D. A. Perry. 2004. The effects of postfire salvage logging on aquatic ecosystems of the American west. Bioscience 54(11): 1029-1035.

"Land managers' focus on commodity extraction—sharpened by recent changes in forest policy, regulations, and laws that encourage salvage logging after fires—perpetuates this trend and its harmful impacts."

"Although often done in the name of postfire restoration, salvage logging typically delays or prevents natural recovery in several important ways (Beschta et al. 1995, 2004, Lindenmayer et al. 2004). These impacts tend to have a multiplier effect, because fire-affected ecosystems are sensitive to further disturbances."

"Postfire salvage logging generally damages soils by compacting them, by removing vital organic material, and by increasing the amount and duration of topsoil erosion and runoff (Kattleman 1996), which in turn harms aquatic ecosystems. The potential for damage to soil and water resources is especially severe when ground-based machinery is used."

"Postfire salvage logging has numerous ecological ramifications. The removal of burned trees that provide shade may hamper tree regeneration, especially on high-elevation or dry sites (Perry et al. 1989). The loss of future soil organic matter is likely to translate into soils that are less able to hold moisture (Jenny 1980), with implications for soil biota, plant growth (Rose et al. 2001, Brown et al. 2003), and stream flow (Waring and Schlesinger 1985). Logging and associated roads carry a high risk of spreading nonindigenous, weedy species (CWWR 1996, Beschta et al. 2004)."

"Increased runoff and erosion alter river hydrology by increasing the frequency and magnitude of erosive high flows and raising sediment loads. These changes alter the character of river channels and harm aquatic species ranging from invertebrates to fishes (Waters 1995)."

"Postfire salvage logging undermines the effectiveness of other costly postfire rehabilitation efforts, most of which are aimed at reducing soil erosion and runoff (Robichaud et al. 2000)."

"In short, by adding another stressor to burned watersheds, postfire salvage logging worsens degraded aquatic conditions accumulated from a century of human activity (CWWR 1996,NRC 1996, 2002,McIntosh et al. 2000). The additional damage impedes the recovery and restoration of aquatic systems, lowers water quality, shrinks the distribution and abundance of native aquatic species, and compromises the flow of economic benefits to human communities that depend on aquatic resources (Beschta et al. 2004)."

Review:

- The WRP project has recognized the known potential impacts of salvage logging on the post-fire watershed condition. The concepts presented by the Beschta et al. report (1994) and the Karr et al. (2004) report have been considered and incorporated into the design of the project. Many of the project design features (as described in chapter 2 of the DEIS) are directly related to recommendations stemming from the aforementioned documents.

Karr, James R. Ph.D., "Nature doesn't Benefit from Logging Fire-Damaged Lands." Op-Ed Tacoma News Tribune. December 8, 2005.

http://www.thenewstribune.com/opinion/othervoices/story/5379671p-4864728c.ht

"… we should look to science to understand how forests behave (and how we should behave) after forest fires."

"More than 10 years ago, and again two years ago, I joined eight other scientists to explore whether forests might be restored by logging soon after a fire. We had among us a wealth of knowledge across a wide range of fields. We pored over several decades of research but found nothing to show that fire-adapted forests might be improved by logging in the wake of a fire."

"In fact, we found just the opposite: Most plants and animals in these forests are adapted to periodic fires; they have a remarkable way of recovering … literally rising from the ashes."

"Trees in a burned landscape, both dead and alive, continue to provide homes for wildlife after a fire and form the building blocks of new forests."

"We need a more complete view of what a forest is."

"This more complete view of forests will acknowledge, rather than ignore or distort, the science that tells us forests best serve many human needs when they are viewed as vast, complex systems where uninformed actions inevitably have unintended consequences. And the science shows very clearly that post-fire salvage logging is not the way to restore forests."

Review:

- This article was not available. The cited excerpts provided above were reviewed regarding salvage after forest fires and the consideration of science.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. Salvage logging is identified in the forest plan as an appropriate action to take place in EMA 13 following fires. Project design features and best management practices have been incorporated to reduce potential adverse effects to soil resources and maintain adequate amounts of snags and coarse woody debris to provide for wildlife habitat.

Jim Karr, Ph.D. Testimony about the Forest Emergency Recovery and Research Act To the House Rural Revitalization, Conservation, Forestry and Credit Subcommittee August 2, 2006.

http://agriculture.senate.gov/Hearings/hearings.cfm?hearingid=2037&witnessId=5628

"What you may not know, however, is that certain forms of disturbance play a vital role in sustaining our forests. Although people see wildland fires, wind and ice storms, and insect outbreaks as 'catastrophes' affecting federal and nonfederal lands, over time, such events have

in fact both created and helped sustain the character of many regional ecosystems."

"My remarks today are based on my ecological research over four decades, particularly on research over the past 12 years with a dozen scientists and others, examining what happens when areas affected by natural disturbances are left to regenerate on their own or when humans intervene."

"The first point I wish to make is that logging after natural disturbances is not an ecosystem restoration tool. Such logging damages forest landscapes by limiting populations of species crucial to the maintenance of these landscapes and by impeding the natural processes that have long sustained these ecosystems. A substantial body of evidence (some dating from the early twentieth century) demonstrates that postdisturbance logging impairs the ability of forest ecosystems to recover from natural disturbances (Frothingham 1924; Isaac and Meagher 1938; Beschta et al. 1995, 2004; McIver and Starr 2001; Karr et al. 2004; Lindenmayer et al. 2004; DellaSala et al. 2006; Donato et al. 2006; Foster and Orwig 2006; Hutto 2006; Lindenmayer and Noss 2006; Lindemayeer and Ough 2006; Reeves et al. 2006; Schmiegelow et al. 2006)."

"Specifically, postdisturbance logging prevents or slows natural recovery by slowing the establishment of plant and animal populations and degrading streams. Logging after natural disturbances damages terrestrial and aquatic systems, plant and animal communities, sensitive areas, and crucial regional resources such as soils."

"Postdisturbance logging also threatens species listed under the Endangered Species Act and places more species at risk, making future listings a near certainty."

"Damage from postdisturbance logging may consist of direct effects from logging, such as increased mortality of tree and other seedlings, damage to soils, or destruction of key biological legacies (that is, intact understory vegetation, snags and logs, patches of undisturbed or partially disturbed forest; Lindenmayer and Noss 2006). Equally important are the indirect effects of activities associated with logging, such as more traffic on existing roads, development of new roads, spread of invasive species, further loss of biological legacies, and damaged soils as a result of burning of slash (the leaves, twigs, branches, and other organic material left after logging)."

Review:

- Congressional subcommittee testimony concerning the Forest Emergency Recovery and Research Act.
- The WFR EIS acknowledges that before effective fire suppression began early in the 20th century, the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity, and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement fire, and killed all or most of the large trees.
- The WFR EIS discloses the effects of logging for three action alternatives. It is recognized that salvage logging after a fire can have a negative affect on natural regeneration and soils. The WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration and soils by limiting the salvage to fire-killed

trees without green needles, designing the units to 20 percent or less slope with some short runs up to 30 percent slope, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities and using existing skid trails where available.

- In terms of biodiversity considerations, we have acknowledged the pros and cons of salvage logging within the WFR project and designed the project by considering biodiversity. The project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ will be left standing.

Kattleman R. 1996. Hydrology Sierra Nevada Ecosystem Project Final Report to Congress: Status of the Sierra Nevada, vol. 2. Davis: Centers for Water and Wildland Resources, University of California. Wildiand Resources Center Report No 39.

Review:

- The summary of the Sierra Nevada Ecosystem Project Report is a status report provided by the Science Team. It lists the critical findings the Science Team has developed concerning the state of the Sierra Nevada Ecosystem. Most of the findings concern emerging trends in the socioeconomic and environmental health of the Sierra Nevada Ecosystem.

Klock, G. O. 1975. Impact of five postfire salvage logging systems on soils and vegetation. J. Soil Water Conserv. 30: 78—8 1.

Review:

- Klock measured the effects of traditional and advanced logging systems on burned areas of the Entiat Experimental Forest in Washington. The author found that the traditional logging methods created more severe erosion than was created from more advanced (circa 1975) logging methods.
- Klock's paper (1975) is somewhat outdated in terms of the equipment and logging practices currently employed.
- The FEIS discloses the anticipated impacts from proposed salvage logging on vegetation and soil resources in chapter 3.

KoIb, P. F. 2002. Tree and forest restoration following wildfire. Section 4 in Knight, James E. (ed.) After Wildfire: Information for Landowners Coping with the Aftermath of Wildfire. Montana Extension Agriculture and Natural Resources Program, Montana State University, Bozeman, Montana.

http://www.montana.edu/wwwpb/pubs/445504tree.pdf

"Cons to salvage logging:

1) Logging increases surface erosion by further disturbing soils. The more a soil's structure is

disrupted, the greater the potential for surface erosion.

2) Logging vectors noxious weed seeds. Severely burned soils are very susceptible to noxious and exotic plant invasion. Existing data indicates that noxious weed abundance can increase threefold following fires.

3) Logging removes standing trees that provide shade for microsites.

4) Logging removes biomass needed for soil nutrient recycling.

5) Removal of standing dead trees reduces habitat for cavity nesting birds and their potential food source (beetle larvae that feed on dead trees)."

Review:

- This is a section from a booklet that contains information to help landowners cope with the aftermath of wildfires in Montana and in other states.
- The quote that Mr. Artley references comes from the salvage logging: "When and where is it appropriate?" part of the paper. The author concludes the discussion on the appropriateness of salvage logging by saying "Removal of all trees killed by fire will have a potentially negative impact on wildlife and may reduce soil productivity in the long term. Removal of some of the trees coupled with sound slash management has the potential of decreasing soil surface erosion, decreasing future risk of severe wildfire effects and increasing recovery rates of desirable vegetation. No manipulation of severely burned areas will result in soil erosion risk, future severe wildfire risks, and conversely, a large pool of organic matter for wildlife use and future soil amendments. The larger the area affected by fire, the greater the possibility of creating a mosaic of salvage and no-salvage logged areas that could enhance the benefits from both." We have acknowledged the pros and cons of salvage logging within the WFR project and designed the project by considering these factors. The project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas.

Kotliar, N. B, S. J. Heil, R. L. Hutto, V. A. Saab, C. P. Melcher, and M. E. McFadzen. 2002. Effects of fire and post-fire salvage logging on avian communities in conifer-dominated stands of the western United States. Studies in Avian Biology 25: 49-64.

http://avianscience.dbs.umt.edu/research_pub/pdf/2002SAB-fire.pdf

"Overall, salvage logging in burned forests can have pronounced effects on cavity-nesting species that use post-fire habitats."

"Salvage logging has resulted in dramatic reductions in the availability of snags in these ephemeral habitats. The effects of such reductions have serious implications for the viability of Black-backed and Three-toed woodpeckers, which rarely use even partially-logged post-fire forests."

Review:

- This paper looks at previous studies to compare the effects of fire and post-salvage logging on birds in conifer-dominated forests in the West. Information on hairy woodpecker use of burned areas was incorporated into the hairy woodpecker analysis (densities increased post-fire).
- This paper also identifies several alternatives to severe logging, based on knowledge of nesting requirements. Two of these strategies are included in this proposal: (1) salvage the burn after a delay of several years (it burned in 2006 and at the earliest salvage would begin in 2008); and (2) salvage part of the burn severely and leave the remainder unsalvaged.

Kurulok, Stephanie and Ellen Macdonald. "Impacts of post-fire salvage logging on tree regeneration and plant communities in the mixed-wood boreal forest of Alberta." A Paper submitted to the Sustainable Forest Management Network. February 6, 2004.

http://sfm-1.biology.ualberta.ca/english/pubs/PDF/PR_200304macdonaldeimpa7.pdf

"We examined the impacts of post-fire salvage logging on the forest structure, tree regeneration and understory plant communities of burned, aspen-dominated mixed-wood forest stands of Northeastern Alberta, Canada."

"Overall, our results showed that salvage logging significantly alters forest structure, tree regeneration, and understory plant community composition and diversity as compared to unsalvaged post-wildfire stands. Some of these effects were still evident 34 years after salvage logging."

"Salvaged stands also do not host the same understory communities that are found in unsalvaged wildfire stands in the early post-disturbance period. This creates some concern that in the long term, extensive post-fire salvage logging could lead to substantial declines in abundance of plant species which are specialists for early post-fire conditions of mesic stands. Additionally, over time, salvage logging could result in increased populations of introduced and weedy species. The longer-term impacts of salvage logging on understory composition of a stand will depend upon how the salvaging has affected the important drivers of understory community development (light, microenvironment, and regeneration microsites)."

Review:

- This paper discusses impacts of salvage logging in boreal forests. There are no boreal forests in Arizona and this paper is not directly relevant. However, forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. Monitoring noted a lack of conifer reforestation in the non-salvaged stands, and successful conifer reforestation on the salvaged and planted areas (USDA Forest Service 2008). Proposed planting is designed to move the areas that experienced high levels of mortality that are lacking seed sources toward desired forested conditions.

Lindenmayer, D. B., and H. P. Possingham. 1996. Ranking conservation and timber management options for Leadbeater's possum in southeastern Australia using population viability analysis. Conserv. Biol. 10(1):235—251.

Review:

- Commenter noted Lindenmayer and Possingham (1996) assert that salvage logging traditionally removes a high percentage of the largest dead woody structure on a given site and can thus significantly change post-fire habitat for wildlife.
- Project design features include leaving a number of large snags that would provide for large woody material when they fall. The salvaged stands are interspersed with unsalvaged areas that would also provide for large dead woody structure throughout the project area.

Lindenmayer, D. B., D. R. Foster. J. F. Franklin, M. L. Hunter, R. F. Noss, F. A. Schmiegelow, and D. Perry. 2004. Salvage harvest policies after natural disturbance. Science 303:1303.

http://inr.oregonstate.edu/download/salvage_harvesting_policies_after_natural_disturbance.pdf

"Removal of large quantities of biological legacies can have negative impacts on many taxa. For example, salvage harvesting removes critical habitat for species, such as cavity-nesting mammals, [and] woodpeckers."

"Large-scale salvage harvesting is often begun soon after a wildfire, when resource managers make decisions rapidly, with long-lasting ecological consequences."

"Natural disturbances are key ecosystem processes rather than ecological disasters that require human repair. Recent ecological paradigms emphasize the dynamic, non-equilibrial nature of ecological systems in which disturbance is a normal feature and how natural disturbance regimes and the maintenance of biodiversity and productivity are interrelated."

"Salvage harvesting activities undermine many of the ecosystem benefits of major disturbances."

Review:

- This paper gives a summary of the importance of natural disturbances, the habitat they provide and the effects of large-scale salvage harvesting.
- Concepts discussed in this paper were incorporated into the wildlife analysis. As discussed in the "Hairy Woodpecker" analysis in the DEIS, wildfires create ephemeral habitat for beetles that move into fire-killed trees. The beetles and larvae then provide an ephemeral foraging habitat for hairy woodpeckers. Salvage affects the quantity of this foraging habitat and this was considered in the analysis.
- The concept that natural disturbances are key ecosystem processes and good planning that consider this concept should guide the timing and intensity of salvage harvesting was used in designing the WFR project. We have acknowledged the pros and cons of salvage logging within the WFR project and designed the project by considering these factors. The project design includes a series of salvage units adjacent to untreated

corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ will be left standing.

- This paper was cited in Monsanto and Agee (2008) suggest that returning dry forests to a more historical fire regime should consider the effects of soil heating by the increased levels of coarse woody debris (large diameter fuels). They noted that although "concern has been raised about damage to ecological values (Beschta et al. 2004; Lindemayer et al. 2004), and a review of the available literature on salvage logging (McIver and Starr 2000) found almost all studies dealt with short-term effects." The WFR proposes salvage activities to reduce some of the long-term future large diameter fuels on portions of the project area.

Lindenmayer, D. B. and R. F. Noss. (2006) Salvage Logging, Ecosystem Processes, and Biodiversity Conservation. Conservation Biology 20(4): 949-958.

http://lib.bioinfo.pl/pmid:16922212

"We summarize the documented and potential impacts of salvage logging--a form of logging that removes trees and other biological material from sites after natural disturbance. Such operations may reduce or eliminate biological legacies, modify rare post disturbance habitats, influence populations, alter community composition, impair natural vegetation recovery, facilitate the colonization of invasive species, alter soil properties and nutrient levels, increase erosion, modify hydrological regimes and aquatic ecosystems, and alter patterns of landscape heterogeneity. These impacts can be assigned to three broad and interrelated effects: (1) altered stand structural complexity; (2) altered ecosystem processes and functions; and (3) altered populations of species and community composition."

"The potential impacts of salvage logging often have been overlooked, partly because the processes of ecosystem recovery after natural disturbance are still poorly understood and partly because potential cumulative effects of natural and human disturbance have not been well documented. Ecologically informed policies regarding salvage logging are needed prior to major natural disturbances so that when they occur ad hoc and crisis-mode decision making can be avoided. These policies should lead to salvage-exemption zones and limits on the amounts of disturbance-derived biological legacies (e.g., burned trees, logs) that are removed where salvage logging takes place. Finally, we believe new terminology is needed. The word salvage implies that something is being saved or recovered, whereas from an ecological perspective this is rarely the case."

Review:

- This paper was reviewed during the analysis and was used to identify the broad categories of impacts of salvage logging (see wildlife analysis in DEIS). This paper summarizes the documented and potential impacts of salvage logging and discusses the need for ecologically informed policies regarding salvage logging.
- The authors recommend that salvage logging policies should include salvage-exemption zones and limits on the amounts of disturbance-derived biological legacies (e.g., burned trees, logs) that are removed where salvage logging takes place. We have acknowledged the pros and cons of salvage logging within the WFR project and designed the project

by considering the environmental effects of logging activity. The project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ will be left standing.

Lowell, E. C., S. A. Willis and R. L. Krahmer. 1992. Deterioration of fire-killed and fire-damaged timber in the western United States. USDA For. Serv. Pac. Nor. Res. Sta. Gen. Tech. Rep. PNW-GTR-292. Portland, OR.

Review:

- This report reviews the literature on rate of deterioration for tree species found in the Western United States, the factors that influence rate of deterioration, and the agents primarily responsible for volume and value loss.
- This paper also includes a review on estimating rate of survival of fire-damaged trees. This review is not relevant to the WFR project. Salvage within the WFR project will occur within high and mixed-high fire mortality areas of the project area, and salvage is limited to fire-killed trees without green needles.

Marks, Raissa. Wildlife Habitat Council Fish and Wildlife Habitat Management Leaflet number 37 Published by the Natural Resources Conservation Service, USDA, April 2006.

ftp://ftp-fc.sc.egov.usda.gov/NHQ/ecs/Wild/ImportofDisturbInHabMgt.pdf

"Fire releases nutrients and uncovers bare soil. The blackened, bare soil warms quickly, which stimulates soil microbial activity, nutrient cycling, and plant growth. In forests, fire opens up part of the canopy to sunlight, which allows sun-loving plant species to recolonize the site. In prairies, fire can remove dead vegetation that hinders new growth, reduce invasive plants, encourage native species, and create wildlife habitat."

"Following fires, plant communities go through successional changes. Many native wildlife species and popular game species, such as bobwhite quail, white-tailed deer, and wild turkey, are dependent on periodic fire to create and maintain suitable habitat. Surface fires can stimulate the growth of herbaceous foods for deer, elk, moose, and hares, and can enhance berry production for black bears and other wildlife. Small mammal populations generally increase in response to new vegetation growth, providing a food source for carnivores. Fire can also reduce internal and external parasites on wildlife." (pg. 2)

"Natural disturbance such as fires, floods, and herbivory are critical in maintaining valuable ecosystem functions and creating and restoring wildlife habitat." (pg. 7)

Review:

- This leaflet explains the importance of disturbance in habitat management. This is well known among wildlife professionals. Impacts of fire and of the proposed action on game species are analyzed and documented in the wildlife report.

Maser, Chris Ph.D. 1996. "Salvage Logging: the Loss of Ecological Reason and Moral Restraint." International Journal of Ecoforestry. Vol. 12, pages 176-178.

http://www.uidaho.edu/e-journal/ecoforestry/ijev12n1maser.html

"Salvage logging, one of the most ecologically dangerous practices in modern forestry, employs an overriding short-term economic rational as an excuse to summarily ignore all current ecological knowledge about the long-term biological sustainability of forests. The sole objective of salvage logging is to convert trees into money, thus replacing the art of forestry with the technology and economics of cutting trees."

"Salvage logging epitomizes traditional, outmoded forestry, which is the myopic economic exploitation of trees at the supreme cost of the biological health of the forest as a living system."

Review:

- Editorial discussion concerning the ecological consequences of salvage logging.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

Maser, Chris Ph.D., Ralph G. Anderson, Kermit Cromack Ph.D., Jerry T. Williams and Robert E. Martin Ph.D. "Dead and Down Woody Material." Taken from Wildlife Habitats in Managed Forests the Blue Mountains of Oregon and Washington. October 1991.

http://www.fs.fed.us/r6/nr/wildlife/animalinn/hab_6ddwm.htm

"Logs and other woody debris, such as stumps, root wads, bark, and piles of limbs, occur on the floor of most forest ecosystems. These features provide diversity in the environment and are of varying significance as habitat for terrestrial wildlife (Winn 1976). In the Blue Mountains 179 species of vertebrates (5 amphibians, 9 reptiles, 116 birds, and 49 mammals) make some use of logs. Elton (1966, p. 279)."

"The large amount of slowly decomposing woody debris in western forests has important ecological implications in terms of mineral cycling, nutrient immobilization (Fogel and Cromack 1977 and MacMillan et al. 1977), nitrogen fixation (Cornaby and Waide 1973), and wildlife habitat."

"Vertebrates use logs for a variety of reasons and in a variety of ways, the most obvious of which are for hiding cover and as sites for feeding and reproduction. A variety of animals use logs as feeding sites (Deyrup 1975). Food is carried to a log where it is eaten or stored, or it can be obtained from the log itself. Some reptiles, birds, and mammals reproduce alongside, under, or within logs."

Review:

- Dead and Down Woody Material by Maser et al., describes the value that dead and down coarse woody material plays in the environment. The paper is information which helps promote a wider understanding of the ecological role that dead and down woody material play for soils and animal species. This chapter in this publication goes into detail on the values of downed logs for wildlife. It discusses decay classes, logging debris, use of logs by wildlife and management of logs as wildlife habitat.
- Although this publication was not used specifically in this analysis, it has long been recognized that downed logs have values for wildlife. The forest plan includes direction for downed log retention and this is included in the project design features. Appendix C of the wildlife report is a discussion and analysis of snags and downed logs.
- The Warm Fire Recovery project would promote dead and down woody material levels through project design features:
    - Leave a minimum of 15 to 20 tons per acre of coarse woody debris (CWD) (material >3″) on ponderosa pine forest type units where available.
    - Leave a minimum of 10 to 30 tons per acre of CWD (material >3″) on mixed conifer type units where available.
    - Leave 5 to 10 tons per acre of CWD (material >3″) on all other vegetation types within treatment unit areas.
    - Where available, leave sufficient CWD to approach the upper range of the above CWD requirements when activity units are located on high or moderate burn severity, or on highly erosive soils.
- These are volumes of dead and down woody debris that meet or exceed recommendations by Graham (1994), Brown (2003), and Brewer (2008).

Maser, C.; Tarrant, R. F.; Trappe, J. M.; and J. F. Franklin (eds.). 1988a. From the Forest to the Sea: A Story of Fallen Trees. USDA-FS and USDI-BLM Gen. Tech. Rep. PNW-GTR-229. 153p. Maser, C.; Cline, S. P.; Cromack, K.; Trappe, J. M.; and E. Hansen. 1988b. What We Know About Large Trees That Fall to the Forest Floor. In: Maser, C.; Tarrant, R. F.; Trappe, James, M.; and J. F. Franklin (eds.). 1988. From the Forest to the Sea: A Story of Fallen Trees. USDA-FS and USDI-BLM Gen. Tech. Rep. PNW-GTR-229. p.25-44 (chpt2)

Review:

- The authors describe the studies they have conducted and the current state of knowledge about the fall and decay of trees on forest floors of the Pacific Northwest.
- The environmental conditions which affect tree fall down and decay rates (tree species, climate, topography, local fauna, for example) are quite different in the Pacific Northwest from what is found within the WFR project. The rates of fall and decay presented in these documents do not mach what is found within the North Kaibab Ranger District.

Maser, C.; and J. M. Trappe. 1984. The Seen and Unseen World of a Fallen Tree. Gen. Tech. Rep. PNW-164. USDA-FS. 56 p.

Review:

- This report relays that large, fallen trees in various stages of decay contribute much needed diversity to terrestrial and aquatic habitats in Western forests.
- It has long been recognized that snags and downed logs have values for wildlife, as well as soil resources. The forest plan includes direction for snag and downed log retention.
- The Warm Fire Recovery project addresses dead wood through project design feature requirements to leave volumes of coarse woody debris (CWD) that are appropriate for the ecosystem and the burned landscape condition. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest.
- The analysis for wildlife species that use snags and downed logs incorporate that into the analysis, and appendix C of the wildlife report is a discussion and analysis of snags and downed logs.
- The Warm Fire Recovery interdisciplinary team has worked to incorporate the latest information on the volumes of CWD that are needed to help maintain forested ecosystems in northern Arizona. All project design features considered information provided by Graham (1994), Brown (2003), and Brewer (2008).

Massey C. L. and D. L. Parker. 1981. Arizona five-spined ips. Forest insect and disease leaflet 116. USDA Forest Service.

Review:

- This leaflet describes the life cycle of the Arizona five-spined ips and identifies concerns with green ponderosa pine slash.
- The WFR project proposes salvage harvest of fire-killed trees only. No green tree harvest is proposed. Therefore, green slash would not be created to provide the host habitat for this species.

McCashion, J. D. and R. M. Rice. 1983. Erosion on logging roads in northwestern California: how much is avoidable? Journal of Forestry 81:23-26.

Review:

- The authors studied 344 miles of forest roads in northwestern California. They classified roads and looked at various road segments that had erosion that was attributed to naturally derived erosion, unavoidable road related erosion, and road related erosion. They found that over 70 percent of erosion from roads was derived from local site conditions and choices in road alignment.

- The effects of roads on the WFR project area have been considered in the "Hydrology" and "Soils" analysis. Most of the roads within the project area are located on gentle rolling slopes or on ridges and do not produce the erosion the authors found on roads in the Pacific Northwest.

McIver, Jim and Roger Ottmar Ph.D. "Postfire Logging: Is it Beneficial to a Forest?" USDA Forest Service. Pacific Northwest Research Station. Science Findings, issue 47 October 2002.

http://www.fs.fed.us/pnw/sciencef/scifi47.pdf

"Supporters of post-fire logging argue that it is part of a suite of restoration techniques, and that removal of timber means reduction of fuels for future fires (the 'reburn' effect). Opponents argue that it causes damage to burned sites, particularly to soils, that it increases sediment transport, and that it removes large dead trees that have important ecological functions."

"Post-fire logging can cause significant changes in the abundance and nest density of cavity-nesting birds, particularly those attracted to recently burned forests."

"Just like in green forests, road building is likely to cause the greatest increase in sediment transport off-site."

"When you run machines over a burned site, you're more likely to get increased compaction and displacement."

"Removal of dead trees, of course, has its impacts on wildlife."

Review:

- This paper summarizes the processes post-fire (increases in beetles, cavity nesters and insectivores), soil and water effects, and a discussion about the tradeoffs between salvage harvesting or preserving the dead trees.
- This paper discusses the main considerations in the debate over post-fire salvage logging. Supporters of post-fire logging argue that it is part of a suite of restoration techniques, and that removal of timber means reduction of fuels for future fires (the "reburn" effect). Opponents argue that it causes damage to burned sites, particularly to soils, that it increases sediment transport, and that it removes large dead trees that have important ecological functions.
- This citation is a PNW research note intended to inform land managers of the discussion surrounding post-wildfire salvage logging. The paper generally describes the current political and research situation (or lack of research) surrounding the post-wildfire salvage logging debate. The article ends with a short discussion on the potential effects of salvage logging of burned landscapes.
- The particular quotes (wildlife) used by Artley are addressing changes in cavity nester abundance and effects of removal of dead trees. The concepts discussed in this article were incorporated into the analysis for both hairy woodpecker and species using burned stands (i.e. olive-sided flycatcher). The analysis in the EIS identifies how much of the burned forest habitat would not be salvaged and would remain as habitat (until the trees

fall), as well as incorporation of snag design features in the areas that are salvaged.

- We have acknowledged the pros and cons of salvage logging within the WFR project and designed the project by considering the environmental effects of logging activity. For example, the project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ will be left standing. The project design also includes limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities, and using existing skid trails where available.
- The Warm Fire Recovery project would implement project design features, best management practices, and mitigation measures designed to protect or minimize impacts to soils, streams, and wildlife.

McIver, James D., and Lynn Starr, eds. 2000. "Environmental Effects of Postfire Logging: Literature Review and Annotated Bibliography." USDA, Forest Service. Gen. Tech. Rep. PNW-GTR-486. 72 p.

http://72.14.203.104/search?q=cache:qcD1vQ0Okc4J:www.fs.fed.us/pnw/pubs/gtr486.pdf+%22gtr+486%22&hl=en&gl=us&ct=clnk&cd=1&lr=lang_en

"Only 21 major studies have examined the wide range of potential effects of post-fire logging, and yet this practice is likely to increase in relative importance, at least in federally managed forests. From these 21 major studies, and the available information on the effects of wildfire itself, we can list the following environmental effects likely to occur when intensely burned sites are logged:"

"Postfire logging associated with road building, conducted with ground-based log retrieval systems, or undertaken in stands having steep slopes and sensitive soils likely will have the greatest potential for exacerbating the erosional problems typically observed in burned watersheds."

"In general, ground-based skidding causes the greatest immediate soil effect, followed by skidding over snow, skyline, and helicopter retrieval (Klock 1975)."

"Skid trails formed in post-fire stands can influence productivity of trees growing directly on them (Smith and Wass 1980)."

"Post-fire logging normally removes a great percentage of large dead woody structure and thus has the potential for significantly changing post-fire habitat for wildlife (Lindenmayer and Possingham 1995, 1996). These changes include 'structural' effects, such as removal of existing and future snags and large woody material, and 'functional' effects, such as reduction in insect populations that serve as food for various wildlife species (Blake 1982, Saab and Dudley 1998, Sallabanks and McIver 1998)."

"In four recent independent studies conducted in the intermountain West, post-fire logging caused significant changes in abundance and nest density of cavity-nesting birds, although the effect differed somewhat by location (Caton 1996, Hejl and McFadzen 1998, Hitchcox 1996,

Saab and Dudley 1998)."

Review:

- This publication summarized research on post-fire logging literature as of 2000 with a focus on environmental effects of logging and removal of large woody structure. The authors reviewed 21 papers, some supporting and some opposing the appropriateness of salvage logging after wildfires. The authors distilled the review into 16 conclusions—most of which are based on a handful of studies. Results of this review are summarized in 16 major conclusions at the end of the text, most of which are based on results of a small group of studies. From a wildlife standpoint, effects were identified based on changes in abundance of cavity-nesting birds, and that post-fire habitats create attractive habitat for a distinct array of species.
- These concepts have been incorporated into the wildlife analysis in the DEIS.
- These concepts identified in the conclusions at the end of the review were considered in designing the WFR project. Conclusions 6 (If post-fire logging is undertaken after establishment of new seedlings, significant mortality of these seedlings can occur); 9 (Skid trails formed in post-fire stands can influence productivity of trees growing directly on them) and 10 (Post-fire logging can reduce vegetation biomass, increase exotic plant species, increase graminoid cover, reduce overall plant species richness and increase conifer growth in the first years after logging) are relevant to the vegetation resource.
- It is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see natural regeneration assumptions in the "Methodology" section of this report), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities and using existing skid trails where available.
- The concerns listed in the quotes from McIver and Starr, provided by the commenter, would be substantially lessened through the implementation of the project design features. The concerns for impact to soils and accelerated erosion should be ameliorated by the slope restrictions for ground-based logging. The restrictions on skid trail use, design, and rehabilitation will further deter erosion problems. The concerns over maintenance of woody material for soil productivity and wildlife will largely be mitigated through the project design features which specify the volumes of coarse woody material to be left onsite. The volumes of coarse woody debris specified by the project design features meet or exceed recommendations by several researchers for these ecosystems.

Mclver, J. D. and L. Starr. 2001. A literature review on the environmental effects of postfire logging. Western Journal of Applied Forestry 16(4): 159-168.

Review:

- This paper reviews literature on logging after wildfire with a focus on environmental effects of logging activity and the removal of large woody structure.
- The authors state "Overall, studies on the environmental effects of post-fire logging are limited, arguing for the use of adaptive management to monitor effects of logging and to adjust practices accordingly."
- We have acknowledged the pros and cons of salvage logging within the WFR project and designed the project by considering the environmental effects of logging activity. For example, the project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ will be left standing. The project design also includes limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities, and using existing skid trails where available.
- The WFR project analysis and project design have noted and incorporated most of the recommendations resulting from the McIver and Star literature review. Most of the project design features (see chapter 2 of the DEIS) incorporate suggestions made by the Beschta report (1994), the Karr report (2004) and the McIver and Star Report (2001).

Meehan, W. R. (ed.). 1991. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. Am. Fish. Soc. Spec. Publ. 19. Bethesda, MD.

Review:

- The author describes impacts of forest and rangeland management activities on streams and fish habitat. The WFR project does not have any perennial streams within the project boundaries. This paper is not relevant to the WFR project.

Meissner, J. K. 1995. Observations on the Emergency Salvage Sale Program. Testimony of General Accounting Office before the Subcommittee on Forests and Public Lands Management, Committee on Energy and Natural Resources, U.S. Senate, and the Timber Salvage Task Force, Resources Committee, House of Representatives. November 29.

Review:

- Although this paper was not available, the economic considerations of this project were analyzed. The WFR project considered the economic costs of proposed actions and this information is included in chapter 3 of the FEIS. The values were updated based on regional updated estimates of defect.

Minshall, G. Wayne Ph.D, Judy L. Meyer Ph.D, Jack A. Stanford Ph.D, James R. Karr Ph.D and Christopher A. Frissell Ph.D. Excerpts from an open letter to President Clinton. September 19, 1994.

http://www.metla.fi/archive/forest/1994/09/msg00047.html

"There is considerable scientific reason to believe that salvage logging and the accompanying road building is one of the most damaging management practices that could be proposed for burned areas."

"Most importantly, fires can sometimes radically accelerate the delivery of sediment to stream channels which (if compounded by management) can produce chronic and substantial loss of in-channel habitat, and seriously delay the biological recovery of the stream."

"The natural recovery of streams after fires can result in improved fish habitat if we do not interfere with the natural recovery processes that initiate themselves soon after the fires are gone."

"We know of no scientific reason to engage in salvage logging or roadbuilding in burned areas and we know of many sound reasons not to. Logging produces no known benefits to the streams, and entails very serious risks. We therefore strongly oppose a general public program of salvage logging in burned areas, simply because they have burned."

"We must not allow the appearance of crisis to be used to promote ecologically inappropriate logging that may seriously retard natural recovery."

Review:

- This is a letter sent to former President Clinton from a group of scientists regarding post-wildfire salvage logging and road building. The letter was written in response to several post-wildfire salvage sales which were proposed in 1994. The letter describes the risks of salvage logging and road building to stream channels and aquatic habitats. The authors maintain that it is not necessary to employ salvage logging where watersheds have burned and that the biological recovery of affected streams may be delayed if salvage logging is implemented.
- The Warm Springs Recovery project contains very few stream channels and most of these are ephemeral or intermittent in streamflow regime. To protect these channels, the project has developed design features that would apply a 100-foot buffer on all stream channels from treatment activities. There is no new road building planned for this project. There is the potential for some incidental sediment delivery on road segments that are immediately adjacent to stream channels, but it is expected that the implementation of Forest Service soil and water conservation practices (BMPs) would reduce and minimize any potential sediment delivery.

Monsanto, Philip, and James Agee. 2008. Long-term post-wildfire dynamics of coarse woody debris after salvage logging and implications for soil heating in dry forests of the eastern Cascades, Washington. Forest Ecology and Management 255 (2008) 3952-3961.

Review:

- This paper evaluated the long-term effects of salvage logging on coarse woody debris on four stand-replacing wildfires in Washington. Units that had been salvaged had lower log biomass than unsalvaged units, except for the most recently burned site where salvaged stands had higher log biomass. Experimentally burned logs produced lethal surface temperatures extending up to 10 cm laterally beyond the logs. This study noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. This study also noted most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period.
- This recent paper was considered and incorporated into the WFR project analysis.

Montana Field Guide for Black-backed Woodpeckers Current version

http://fieldguide.mt.gov/detail_ABNYF07090.aspx

"The habitat of Black-backed Woodpeckers in Montana is early successional, burned forest of mixed conifer, lodgepole pine, Douglas-fir, and spruce-fir (Hutto 1995a). They appear to concentrate in recently burned forests and remain for several years (3 to 5) before leaving due to prey source decline (Harris 1982)."

"Black-backed Woodpeckers may be attracted by the clearly audible chewings of wood-boring insects in recent burns (Taylor and Barmore 1980)."

"No known active management is ongoing for Black-backed Woodpeckers in the state. However, studies from the western United States on the logging of post-fire trees indicated the negative impacts of this activity on Black-backed Woodpeckers (Kotliar et al. 2002). The conclusion reached was that this species rarely used even partially logged post-fire forests. Therefore, when salvage logging is planned, a delay of work for at least five years after the disturbance event is very important (Hutto 1995, Dixon and Saab 2000). This time delay is essential to provide habitat as the woodpecker's main prey items (wood-boring beetles) become less abundant after this period (Caton 1996). Salvage operations should retain more than 104 to 123 snags per hectare (more than 42 to 50 snags per acre) that are more than 23 cm diameter at breast height (d.b.h), more than 9 inches d.b.h (Dixon and Saab 2000, Wisdom et al. 2000)."

Review:

- Black-backed woodpeckers do not occur in Arizona. This is not relevant to the Warm Fire Recovery project. Hairy woodpeckers, which are found on the forest, are discussed in the analysis.

Montana Partners in Flight. January 2000. Bird Conservation Plan - Montana. Version 1.0.

http://avianscience.dbs.umt.edu/documents/pl_mt_10.pdf

"Even if the recent increase in fire acreage were to result in stand-replacement post-fire habitats approaching historical levels, there is still a major concern from the strong pressure for salvage logging."

"When fires do occur, there is a high likelihood that the trees will be quickly 'salvaged,' because of the perception that the forest has been destroyed and the dead wood will go to waste. Salvage logging removes the very element that makes this habitat a uniquely productive resource for many bird species. Post-fire salvage logging may make some patches unsuitable by reducing nest sites and food resources (Raphael and White 1982, Caton 1996, Hitchcox 1996, Hejl unpublished data). Data on reproductive success of Mountain Bluebirds in unlogged and salvage-logged post-fire forests (Hitchcox 1996) suggest that both abundance and nest success may be lower in salvage-logged areas. Nesting success of Northern Flickers was also significantly lower in salvage-logged areas. House Wrens were three times less abundant in salvage-logged plots, but their nest success was no different (Hitchcox 1996)."

"Salvage logging may have a negative effect on species that are either relatively restricted to, or are most abundant in, early post-fire conditions because those bird species depend to a great extent on standing dead trees in burned forests for feeding and/or nesting purposes (Hutto 1995, Caton 1996, Hitchcox 1996, Saab and Dudley 1998). The presence of such narrowly distributed habitat specialists leaves little doubt that the clearcutting style associated with a large portion of post-fire salvage logging is in direct conflict with the needs of some of these bird species."

"To achieve targets we should be creating more habitat, so it would be counter-productive to also be salvage logging."

Review:

- This paper includes a discussion about fire regimes in forest types in Montana. Analysis for this project was based on studies in the ponderosa pine forest of the North Rim of the Grand Canyon, adjacent to the project area. While frequencies varied, all studies found frequent, low intensity fire occurrence in the ponderosa pine type. The mixed conifer forest types are characterized as a mixed fire regime. Stand-replacing fire regimes are not found in the project area, although that does not preclude some stand-replacing fire.

Morey, Sandra C. and Kevin E. Shaffer "Exotic Plant Considerations in the Wake of a Wildland Fire." California Exotic Pest Plant Council Symposium Proceedings 1995

http://www.cal-ipc.org/symposia/archive/pdf/1995_symposium_proceedings1793.pdf

"Evidence exists to suggest that reseeding should not be a routine or automatic erosion-control treatment (Keeler-Wolf 1995; Keeley 1995). Seeded grasses, especially nonnative, have been found to:

1) negatively influence diversity of native flora (Zedler et al. 1983; Florence 1986; Taskey et al. 1989; Stone 1993; Barro and Conard 1987; Keeler-Wolf 1995; Keeley 1995),

2) be ineffective in erosion control (Beyers et al. 1995; Booker et al. 1995; Conard et al. 1995; Spittler 1995), and

3) exacerbate erosion due to community type conversion (Keeley and Keeley 1986)."

"Seeding has been shown to reduce growth and survival of native species following a fire, and can increase susceptibility of a plant community to invasion by weedy plants (Keeley and Keeley 1986; Barro and Conard 1987; Stone 1993). In addition, some nonnative grasses may persist for several years after seeding, and where there is a short duration between fires or other disturbance, nonnative plants can replace native shrubs (Zedler et al. 1983; Keeler-Wolf 1995)."

"Additional evidence suggests that, in some cases, seeding may actually increase erosion (Taskey et al. 1989). Because of their leaf structure, grasses, as opposed to other herbs or shrubs, can actually channel water into the substrate, supersaturating the soil, leading to slope instability and even shallow slope failures in some areas."

Review:

- Although most (nonnative) species planted for erosion reasons can compete with natives not only for available resources (light, water, nutrients)—with many also allelopathic—that is they exude compounds to inhibit the growth of other species than themselves, seeding is appropriate when there is other overriding concerns than competing with any native seed supply. Those are the following:
    a. The risk of noxious weed invasion is high—and you would rather have the plants that have a short-term persistence and allow the natives to creep in. In the absence of other plants, noxious weeds are more likely to become established.
    b. The risk of erosion and soil loss is very high. The point is to keep the soil in place long enough for the natives to fill in. Without holding the soil in place, native plant species would have a more difficult time becoming established than with a short-term persistent species.
    c. And finally, if no native seed source is present to provide vegetation to hold the soil in place.

Morrison, M. L.; and M. G. Raphael. 1993. Modeling the Dynamics of Snags. Ecological Applications 3:322-330.

Review:

- This paper looks at modeling dynamics of snags over time, using data from a 10-year study on the rates of decay, falling, and recruitment of snags on burned and unburned plots in the Sierra Nevada, California.
- The snag dynamics for the WFR project were modeled using the Central Rockies variant of the Forest Vegetation Simulator (FVS) and the Fire and Fuels Extension (FFE). The models are calibrated specific to conditions and tree species in the Southwestern U.S. and are based on local scientific studies and experience.

- In the Warm Fire, the fire created the snags. Salvage would only occur in part of the stands with high and mixed-high mortality. In these areas, there are no residual live trees that would become snags in the future. Future snag recruitment would be based on regeneration of salvaged stands. Snag analysis is shown in appendix C of the wildlife report.

Nappi, Antoine, Pierre Drapeau Ph.D., Jean-François Giroux Ph.D., and Jean-Pierre Savard Ph.D. "Snag use by foraging black-backed woodpeckers (Picoides articus) in a recently burned eastern boreal forest." The Auk 120(2): 505-511. 2003.

http://www.borealcanada.ca/research_arc_hot_e.cfm

"Contrary to what you may think, a forest fire does not reduce everything to a lifeless ash. Instead, it leaves behind a landscape of blackened trees interspersed with remnants of green, intact forest. Post-fire specialists such as wood-boring insects quickly colonize the dead trees (snags), attracting an array of woodpeckers."

"Identifying the ecological value of a post-fire structure and the characteristics that make it attractive to wildlife is important. In the boreal, salvage logging operations, which recover merchantable timber from a recently burned area, are increasingly common and have the potential to greatly reduce the availability of snags, as well as other habitat structures, created by fire. In the case of the black-backed woodpecker, Nappi and colleagues recommend that within recently burned areas, unsalvaged tracts characterized by large, less severely burned trees should be retained in northeastern North America."

Review:

- This is not applicable as the distribution of black-backed woodpeckers does not include Arizona.

Nappi, Antoine, Pierre Drapeau, Ph.D. and Jean-Pierre Savard Ph.D. "Salvage Logging after Wildfire in the Boreal Forest: Is it becoming a Hot Issue for Wildlife?" The Forestry Chronicle, January/February 2004.

http://pubs.nrc-cnrc.gc.ca/tfc/tfc80067-1.html

"Pioneer studies have shown that these post-fire forests may represent important habitats for several wildlife species and that intensive salvage logging, by removing standing snags, has several impacts on wildlife."

"We conclude that snag retention at multiple spatial and temporal scales in recent burns, which will be salvage-logged, is a prescription that must be implemented to meet the principles of sustainable forest management and the maintenance of biodiversity in the boreal forest."

Review:

- This paper discusses impacts of salvage logging in boreal forests. The discussions pertaining to boreal forests is not relevant to the WFR project area. However, snag retention is discussed in the analysis. Design features include leaving clumps of snags within treated areas and treatments were designed to leave snags in the ephemeral

drainage buffer zones as well as other untreated areas to provide snag habitat for associated species.

Neary, Daniel G.; Ryan, Kevin C.; DeBano, Leonard F., eds. 2005. "Wildland fire in ecosystems:effects of fire on soils and water." Gen. Tech. Rep. RMRS-GTR-42-vol.4. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 250 p.

http://www.fs.fed.us/rm/pubs/rmrs_gtr042_4.pdf

"However, if the landscapes are denuded by disturbance (for example, fire, grazing, timber harvesting, and so forth), then the rate of erosion continues to increase with increasing precipitation." (pg 41)

"Watershed disturbances have occurred on the landscapes of National Forests for the past century. Roads to support timber harvest, timber harvest itself, and grazing of watersheds have cumulatively disturbed and altered watersheds." (pg. 138)

Review:

- General Technical Report RMRS-GTR-42-Vol 4 is a state of knowledge review about the effects of fire on soil and water. It is intended to help land managers conduct ecosystem analyses where the impacts of wildland fire need to be described. The chapters include discussions on the soil resource, physical soil properties and fire, soil chemistry effects, soil biology responses, the hydrologic cycle and water resources, water quality, aquatic biology, fire effects on wetland and riparian systems, fire effects models, and watershed rehabilitation.
- The Warm Fire Recovery project soils and watershed analyses utilized data and information gathered from the Warm Fire Burned Area Report and Warm Fire Assessment. All three of these analyses have considered and incorporated the basic scientific principles of post-wildfire soil and water resource condition described in RMRS-GTR-42-vol 4. Direct and indirect effects analyses and cumulative effects analyses in the "Soils and Watershed" section considered background post-wildfire erosion rates for past and current activities for each of the action alternatives (DEIS, chapter 3). Project design features, best management practices, and mitigation measures were also developed or included to prevent or minimize further impact to watershed condition from the proposed project.

Noss, R. F., P. Beier, W. W. Covington, R. E. Grumbine, D. B. Lindenmayer, J. W. Prather, F. Schmiegelow, T. D. Sisk, and D. J. Vosick. 2006. Recommendations for integrating restoration ecology and conservation biology in ponderosa pine forests of the southwestern United States. Restoration Ecology 14(1): 4-10.

Review:

- This study presents recommendations from a workshop for integrating the principles and practices of restoration ecology and conservation biology, toward the objective of restoring the composition, structure, and function of dry ponderosa pine forests.

- Specific to the practice of salvage logging, the authors state that salvage logging is not restoration and they define restoration as "guiding an ecosystem along a trajectory of recovery of natural structure, function, and composition, that is, toward ecological health and integrity." They go on to say "the careful removal of woody material to reduce intense reburn potential and improve restoration potential in forests that have experienced uncharacteristic stand-replacement fires may be justified." The purpose and need statement and the desired condition for the WFR project do not use the term restoration. These statements do, however, imply restoration concepts. For example, the desired condition for the vegetation and fuels in the Warm Fire area include "surface fuel levels are such that effects from future fires are acceptable and the benefits to soil productivity and wildlife habitat can be realized and the future forest can be sustained with fire functioning as a key ecological process. And for the long term, the desired conditions statement includes the statement "surface fuel levels are such that the historic fire regime (relatively frequent and low to mixed fire intensity) and the associated ecological processes can be maintained."

Noss, Reed F. Ph.D., Jerry F. Franklin and , Ph.D., William Baker, Ph.D., Tania Schoennagel, Ph.D., and Peter B. Moyle, Ph.D. "Ecological Science Relevant to Management Policies for Fire-prone Forests of the Western United States" Written for the Society for Conservation Biology, February 24, 2006

http://www.nifc.gov/fuels/downloads/planning/EcologicalScience.pdf

"Post-fire logging in naturally-disturbed forest landscapes generally has no direct ecological benefits and many potential negative impacts from an ecological standpoint. Trees that survive the fire for even a short period of time are critical as seed sources and as habitat that will sustain many elements of biodiversity both above and below ground. The dead wood, including large snags and logs, is second only to live trees in overall ecological importance. Removal of these structural legacies—living and dead—is inconsistent with our scientific understanding of natural disturbance regimes and short- and long-term recovery processes."

"Post-fire logging destroys much of whatever natural tree regeneration is occurring on a burned site. This is a fundamental concern since these tree seedlings are derived from local seed sources, which are most likely the best adapted to the site."

"Evidence from empirical studies is that post-fire logging typically generates significant short- to mid-term increases in fine and medium fuels. In some cases this may result in increased reburn potential rather than a decreased reburn potential, as is often claimed."

Review:

- A review that addresses the ecological science relevant to developing and implementing forest restoration and fuel management policies, including activities conducted before, during, and after forest wildfires.
- The WFR EIS acknowledges that before effective fire suppression began early in the 20th century, the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity, and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to

accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement ("uncharacteristic") fire, and killed all or most of the large trees.

- The WFR EIS discloses the effects of logging for three action alternatives. It is recognized that salvage logging after a fire can have a negative affect on natural regeneration and soils. The WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration and soils by limiting the salvage to fire-killed trees without green needles, designing the units to 20 percent or less slope with some short runs up to 30 percent slope, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities and using existing skid trails where available.
- In terms of biodiversity considerations, we have acknowledged the pros and cons of salvage logging within the WFR project and designed the project by considering biodiversity. The project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ will be left standing.

Noss, Reed Ph.D. and Bruce Lindenmayer Ph.D. "Communicating the Science of 'Salvage' Logging to the Public." Conservation Value Notes. August 29, 2006.

http://conservationvalue.blogspot.com/2006/08/communicating-science-of-salvage.html

"… in modern industrial societies, waste and messiness, such as that perceived to be caused by forest fires, are seen as bad and in need of 'cleaning up' (i.e., logging). They continue that the fundamental justification for postdisturbance ('salvage') logging is that 'if by cleaning up dead and dying trees after a disturbance, some money can be made from the timber, so much the better.'"

"… in many cases, forest ecosystems are more strongly affected by postdisturbance logging than by the initial disturbance... Ecologically informed policies for postdisturbance management of forests need to be in place before major disturbances inevitably take place in order to avoid the ad hoc decisionmaking that often leads to poorly planned and ecologically damaging salvage operations."

"… available evidence points to often severe long-lasting negative effects of postdisturbance logging on a wide variety of ecosystems and their biota. To log what is often the most biologically diverse and threatened forest condition in the landscape is fundamentally irrational."

"we believe new terminology is needed. The word salvage implies that something is being saved or recovered, whereas from an ecological perspective this is rarely the case."

Review:

- Article discussing the need for ecologically informed policies for post-disturbance management of forests to be in place before major disturbances take place in order to avoid the ad hoc decisionmaking that often leads to poorly planned and ecologically damaging salvage operations.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project EIS documents a desired condition on the landscape and analyzes the resulting conditions of three action alternatives and one no action alternative in terms of progressing toward that desired condition. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

Odion D. C., E. Frost, J. R. Strittholt. H. Jiang, D. A. DellaSala, and M. A. Moritz. 2004. Patterns of fire severity and forest conditions in the western Klamath Mountains, California. Conservation Biology 18: 927-936.

Review:

- This paper documents a study in the western Klamath Mountains of California that tested for modern human impacts on fire regimes by analyzing temporal patterns in fire extent and spatial patterns of fire severity in relation to vegetation structure, past fire occurrence, roads and timber management in a 244,000-acre area burned in 1987.
- This document is not applicable to the dry, more open stands of Southwestern forests. Specifically, the fuel loading buildup associated with the study would be substantially different than that of the WFRP.
- This paper discusses the mixed severity fire regime that has shaped the composition and structure of Klamath-Siskiyou vegetation. This study is irrelevant to the dry ponderosa pine and mixed conifer forests of the Kaibab Plateau and the WFR project.

Parks, C. G.; Conklin, D. A.; Bednar, L.; and H. Maffei. 1999. Woodpecker Use and Fall Rates of Snags Created by Killing Ponderosa Pine Infected with Dwarf Mistletoe. USDA-FS Pacific Northwest Research Station. Research Paper PNW-RP-515. 11p.

Review:

- Maintaining snags within salvaged areas, as well as the untreated areas, to provide this habitat element for wildlife associated species was incorporated into the project design features. Woodpeckers are specifically addressed in the analysis. An additional design feature for maintaining snags within a buffer around islands of live trees has been incorporated to provide for woodpecker habitat.

Passavoy, M. D. and P. Z. Fulé. 2006. Snag and woody debris dynamics following severe wildfires in northern Arizona ponderosa pine forests. Forest Ecology and Management 223: 237-246.

Review:

- This study describes post-fire conditions (snags, CWD, and fine woody debris and forest floor depth) on 7 fires in a chronosequence from 3 to 27 years old in northern Arizona. This study determined that although we can predict fuel loading, it is a complex matter to draw conclusions about future fire behavior and effects.
- Within the management implications of this paper, recommendations for optimal ranges of CWD in ponderosa pine forests are discussed. The desired condition statement for the vegetation and fuels in the Warm Fire area includes a description of fuels conditions as referenced from the same source as this study.
- The importance of snag and woody debris retention was considered in the project design.
- This literature was considered in the wildlife analysis and is cited in the wildlife report, and was considered when determining the appropriate fuel models for modeling future fire behavior for all the alternatives as well as the recommendation that active management may be appropriate when CWD may exceed thresholds.

Pedersen, Larry. "Expedited timber supply review for the Lakes, Prince George and Quesnel timber supply areas A Public Discussion Paper." B.C. Ministry of Forests, June 2004.

http://www.for.gov.bc.ca/hts/tsa/PDP_TSAs_14-24-26.pdf

"Conducting salvage operations based on the premise of reducing fire risk is not recommended except in the wildland-urban interface."

Review:

- This discussion paper makes recommendations for timber supply in British Columbia. It is specific to Mountain pine beetle epidemic treatment and makes only the above reference to fuel treatment without any supporting data as to why the author made the recommendation. Because of this, it is not directly applicable to the WFRP.
- Breaking up the future large fuel component is one of the purposes for the WFR project. Future fires would expose the soils beneath and directly around coarse woody debris to high heat for extended periods of time, exposing roots to lethal temperatures (Monsanto and Agee 2008). Monsanto and Agee (2008) noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. Monsanto and Agee (2008) also note "most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period."

Reference:

- Monsanto, Philip; James Agee. 2008 Long-term post wildfire dynamics of coarse woody debris after salvage logging. College of Forest Resources, University of Washington. Seattle, WA.

Perry, D. A. 1995. Self-organizing systems across scales. Trends in Ecology and Evolution 10:241-244.

Review:

- A paper that discusses the concept of self-organizing systems.
- The author discusses the roll biological legacies play in the reorganization of a system after natural disturbance. The concept of biological legacies was considered in the design of the WFR project. For example, the project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ will be left standing.

Potts, D. F., D. I. Peterson, H. R. Zuuring.1985. Watershed modeling for fire management planning in the northern Rocky Mountains. USDA Forest Service Research Paper PSW-177.

Review:

- The author describes a method for modeling both burned and unburned watersheds using a computerized version of the WRENSS model. The authors were able to model increases on water yield and sediment yield as they related to post-fire management activities.
- The hydrologic analysis in the WFR project analyzed erosion and sediment delivery to streams using the WEPP model as it is better adapted to analyze site-specific impacts due to logging and roading. The WRENSS model gives broad level planning information concerning water yield and sediment delivery, but was not as useful a tool as WEPP in describing impacts due to logging activities.

Powell, Mark Ph.D. "Science scores a victory over the big lie of salvage logging." Blogfish. July 18, 2007.

http://blogfishx.blogspot.com/2007/07/science-scores-victory-over-big-lie-of.html

"Five years after the notorious 'Biscuit' forest fire in southern Oregon, one lesson is clear. Logging a burned forest doesn't help forest recovery, it's all about making money."

"Simply stated, logging burned trees is not defended anymore as being good for the forest. US Forest Service spokesperson Rob Schull said:

"...people will be careful about their language in the future, that ecological recovery does not need salvage logging by any means. We achieve other objectives through salvage logging than any ecological recovery."

"In other words, the logging is to make some money from some dead, damaged, and nearby trees, not to help the forest."

Review:

- This commentary blog discusses the Biscuit Fire in southern Oregon.
- The economic analysis was updated for the FEIS to incorporate updated defect estimates. The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies.
- Breaking up the future large fuel component is one of the purposes for the WFR project. Future fires would expose the soils beneath and directly around coarse woody debris to high heat for extended periods of time, exposing roots to lethal temperatures (Monsanto and Agee 2008). Monsanto and Agee (2008) noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. Monsanto and Agee (2008) also note "most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period."

References:

- Monsanto, Philip; James Agee. 2008 Long-term post wildfire dynamics of coarse woody debris after salvage logging. College of Forest Resources, University of Washington. Seattle, WA.
- USDA Forest Service. 2008. Higgins, B. 2008. A comparative analysis of forest recovery on the Summit, Willis, Bridger-Knoll and Hockderffer fires in ponderosa pine forest. USDA Forest Service, Kaibab National Forest unpublished report. Williams, AZ. 17 p.

Power, Thomas Ph.D. Commentary on the Biscuit post-fire logging. Montana Public Radio. January 23, 2006.

http://www.mtpr.net/commentaries/155

"In short, the logging of the burned-over forest retarded reforestation and increased the volume of hazardous fuels, just the opposite of what the Forest Service had promised."

"The American taxpayer had to subsidize logging that appears to have damaged the forest and increased the danger of additional wildfires. The logging was both economically and environmentally irrational."

"This study, of course, was for a particular large fire area in southwest Oregon and the particular approach to logging taken there. Only further analysis in other areas will tell us if those results are more generally applicable. But these particular results do raise an important question about U. S. Forest Service activities that has been with us for a long time: Why does the Forest Service regularly under-estimate the costs of its activities, financial and environmental, and over-estimate the expected benefits."

"The U.S. Forest Service loses money on almost all of its commercial timber programs, which means they are not really 'commercial' timber programs at all. In the process, those programs tend to have serious negative environmental impacts."

"The obvious question is why in the early 21st century this pattern is continuing as seen with the logging of the Biscuit Fire?"

"Many of us still see the forest as a warehouse of commercially valuable trees to be extracted, not as a living system that supports us in numerous other important ways. Until that view changes, we will continue to do economically irrational things to our natural landscapes while imagining that we are pursuing economic value. That frame of mind unavoidably impoverishes us."

Review:

- Commentary discussing the Donato et al. 2006 study published in the journal Science as well as the economics of the salvage operations undertaken by the Forest Service after the Biscuit Fire.
- The WFR project is not in the Pacific Northwest or southwestern Oregon so many of the findings in the Biscuit Fire area are not relevant to the Warm Fire. Concepts concerning post-fire regenerative processes and regenerating landscapes on the Kaibab Plateau were considered in designing the WFR project. It is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see natural regeneration assumptions in the "Methodology" section of this report), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities and using existing skid trails where available.

Purdon, Mark, Josée Noël, Antoine Nappi, Pierre Drapeau Ph.D., Brian Harvey Ph.D., Suzanne Brais Ph.D., Yves Bergeron Ph.D., Sylvie Gauthier PH.D. and David Greene Ph.D. "The Impact of Salvage-logging after Wildfire in the Boreal Forest: Lessons from the Abitibi." A report by the NSERC-UQAM-UQÀT Industrial Chair in Sustainable Forest Management. 2002.

http://inr.oregonstate.edu/download/impact_of_salvage-logging_after_wildfire_in_boreal_forests.pdf

"Most of the SFM Chair's studies have focused on comparing effects of fire alone and when followed by salvage logging. The reasoning for this is straightforward: forests have evolved ecological mechanisms of resilience which allow them to re-establish after natural disturbances such as fire."

"Because tree harvesting and the additional physical site disturbance it induces have the potential to significantly affect ecological processes after fire, a better understanding of these processes is essential to ensuring that forests are managed sustainably."

"A common thread running through all of these studies was the importance of snags. Even dead trees have an important ecological role in the forest. They provide nesting and foraging habitat for wildlife and a seed source for regenerating tree species such as black spruce for several years after fire. They may provide favourable microclimate conditions for establishment and growth of seedlings and understorey vegetation, and constitute nutrient reserves, especially for stands with an important deciduous component."

Review:

- This paper is about impacts of salvage logging in boreal forests. There are no boreal forests in Arizona and this paper is not relevant.
- Maintaining snags within salvaged areas, as well as the untreated areas, to provide this habitat element for wildlife associated species was incorporated into the project design features.

Quigley, Thomas M. Ph.D., tech. ed. 1996. "The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment." Gen. Tech. Rep. PNW-GTR-382; Page 178.

http://64.233.167.104/search?q=cache:G_BzzkmXaWUJ:www.fs.fed.us/pnw/pubs/gtr_382a.pdf+PNW-GTR-382&hl=en&lr=lang_en

"Can salvage timber sales be compatible with ecosystem-based management? Our findings suggest that this type of harvesting is not compatible with contemporary ecosystem-based management. Ecosystem-based management would emphasize removing smaller green trees with greater attention to prevention of mortality rather than removal of large dead trees."

(page 178 in Chapter 7)

Review:

- Discussion about salvage harvest in the context of ecosystem-based management.
- The authors start off the discussion by saying "They (salvage harvest timber sales) can be (compatible with ecosystem base management), but much depends on the types of stand structures that are harvested." Most of the discussion in this section is in reference to other than post-fire salvage. The authors do go on to suggest that "Salvage harvest methods in burned areas will also need to consider minimizing surface soil disturbance and reducing road-related sediment problems." These concepts were taken into consideration in the development of the WFR project design. Specifically, in reference to the type of stand structure that is harvested, the project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ will be left standing.

Rasmussen, Ray Ph.D., Environmental News, Volume 1, Issue 1, November 2001.

http://www.ualberta.ca/~ersc/enews/EN2001a.pdf

"Forest fires have long been regarded as an interference with normal forestry practices by removing potentially viable timber allocations. Furthermore, provincial forest policies have encouraged quick clearcut harvesting of any merchantable trees (dead or alive) left within the mapped perimetre of a fire … otherwise known as salvage logging. And because beetles colonise immediately and bore into the trees (ruining their use for lumber) harvesting also happens immediately to out race the economic loss to insects. When this happens, the natural link in boreal forest succession is ultimately broken."

Review:

- Newsletter article discussing an experimental study to evaluate the bird community response to burned boreal forest habitat in Alberta, Canada. There are no boreal forests in Arizona and this paper is not relevant.
- Maintaining snags within salvaged areas, as well as the untreated areas, to provide this habitat element for wildlife associated species was incorporated into the project design features.

Reeves, G. H., P. A. Bisson, B. E. Rieman and L. E. Benda. 2006. Postfire logging in riparian areas. Conservation Biology 20:994-1004.

Review:

- The authors review the effects of fires on riparian areas in the Western U.S. They conclude that the riparian areas are sufficiently resilient to fire as to not need post-wildfire treatment. They find that the risk of negative impacts to riparian areas from logging activities is not warranted considering the resiliency of riparian zones.

- The WFR project will not be treating riparian areas. There are no perennial streams in the project area and all other stream channels with a definable bed or bank will receive a no equipment/treatment buffer.

Reice, Seth, Ph.D. from a press conference with Senator Robert Torricelli, April 28, 1998.

http://www.saveamericasforests.org/news/ScientistsStatement.htm

"Disturbances, from windthrown trees to fires, are natural in forests and are essential for forest ecosystem well being. For example, fire is a disturbance in forests, but it is also beneficial. While disturbances kill some individuals, they also open up ecological living space for recolonization by many previously excluded species.

Without fire, natural succession is upset. In a forest where fire has been unnaturally suppressed for many years (50 or more), fire intolerant trees grow unchecked, suppressing and outcompeting the normally dominant fire resistant trees. Overall biodiversity is reduced. As the tree diversity declines, the habitat becomes unsuitable for a large portion of the forest species. Animal species are lost, since the animals use the fire tolerant variety of tree species for food, shelter and nest sites.

Clearcutting is not ecologically equivalent to fire, and it does not mimic the beneficial effects of fire. We need large tracts of unfragmented forests so that fires can return as a normal part of the overall forest ecosystem. If fire is unnaturally suppressed, a Southeastern longleaf pine savannah is transformed into an oak-hickory forest. The most famous fire dependent species of the longleaf pine ecosystem is the Red Cockaded Woodpecker. In order to nest and reproduce, it needs the tall, old, isolated pines which have survived repeated fires. Without fire, the Red Cockaded Woodpecker will go extinct.

Scientific understanding of forest ecosystems has advanced tremendously since the establishment of the national forests. The Act to Save America's Forests would harmonize federal forest management with these new understandings, and would restore and maintain dynamic living ecosystems with native plants and animals for the long term benefit of future generations of Americans."

Review:

- Press conference statement concerning the Act to Save America's Forests.
- The WFR EIS acknowledges that before effective fire suppression began early in the 20th century, the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity, and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement ("uncharacteristic") fire, and killed all or most of the large trees.
- There is no clearcutting proposed in the WFR project.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The

long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project EIS documents a desired condition on the landscape and analyzes the resulting conditions of three action alternatives and one no action alternative in terms of progressing toward that desired condition. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

Reinhardt, E. D. and K. C. Ryan. 1998. Analyzing effects of management actions including salvage, fuel treatment and prescribed fire on fuel dynamics and fire potential. Pp. 206-209 in: T.L. Pruden and L.A. Brennan (eds.). Fire in Ecosystem Management: Shifting the Paradigm From Suppression to Prescription – Tall Timbers Fire Ecology Conf. Proc. No. 20. Tall Timbers Res. Sta.: Tallahassee, FL.

Review:

- This paper reviews fuel treatments against no action and compares the fire behavior associated with those treatments over time. Salvage logging was compared to unsalvaged logging over time. Salvage logging was found to be effective in the long run for reducing fire behavior. This reference has been incorporated into the fuels report.

Robichaud, Peter R.; Beyers, Jan L.; Neary, Daniel G. 2000. Evaluating the effectiveness of postfire rehabilitation treatments. Gen. Tech. Rep. RMRS-GTR-63. Fort Collins: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 85 p.

http://www.fs.fed.us/psw/publications/robichaud/psw_2000_robichaud000.pdf

"Methods that consider only the value of harvestable timber may underestimate the consequences of site productivity loss to other ecosystem components." (pg. 45)

"Seeding has a low probability of reducing the first season erosion because most of the benefits of the seeded grass occurs after the initial damaging runoff events."

Review:

- Gen. Tech. Rep. RMRS-GTR-63 is a literature review and evaluation of Burned Area Emergency Rehabilitation (BAER) treatments. The paper discusses the current (2000) use of various rehabilitation practices and their perceived effectiveness in reducing or controlling erosion on burned watersheds. Key recommendations to come out of the report were increased treatment effectiveness monitoring at the hillslope and subcatchment scale, streamlined post-fire data collection needs, increased training on evaluation of post-fire watershed conditions, and development of an easily accessible knowledge base of BAER techniques.
- The quote refers to the discussion of BAER assessments and the process to estimate the cost of potential changes in soil productivity resulting from the burned watershed condition. The Warm Fire BAER report (07/10/06) did indicate that there is a long-term threat to soil productivity from soil erosion. However, the report did not disclose any quantified numbers to express changes in cost due to loss of soil productivity. The Warm Fire Recovery project includes various project design features, best management

practices, and mitigation measures; and these are aimed at alleviating concerns of impacts to watershed resources from proposed project activities.

Robinson, J. and J. Alexander. The draft coniferous forest bird conservation plan: a strategy for protecting and managing coniferous forest habitats and associated birds in California. Version 1.0, 2002.

"California's coniferous forests have been severely altered by forest management practices over the previous century and continue to remain under threat of further degradation and development. While some western coniferous forests have been developed for agricultural or housing purposes, the primary threats to our forests have been fire suppression and logging (i.e., activities associated with the timber industry). Forest management practices during the past century have included major fire suppression, clearcutting, salvage logging, thinning, livestock grazing and short rotations. Such practices have resulted in highly altered, and often simplified, forests. Prior to such management, natural processes including fire, floods, insects, winds, and disease helped shape our coniferous forests (Pickett and White 1985)."

"Olive-sided Flycatcher densities have been found to increase in habitats that have been opened up by fires. In some areas they have been found to be closely associated with post-fire habitat. Allowing fires to burn and refraining from salvage logging is recommended. The loss of natural forest processes has had a detrimental effect upon this species."

Review:

- This draft conservation plan addresses forest habitats in California and is not relevant to the project area (does not address ponderosa pine forests in Arizona).

Robinson, George Ph.D. and Jeffrey Zappieri. "Conservation Policy in Time and Space: Lessons from Divergent Approaches to Salvage Logging on Public Lands." Conservation Ecology Volume 3, Issue 1. June 1999.

http://www.earthscape.org/r2/coneco/vol03/issue_01/con_eco_03_01_03.html#Con

"Federal salvage policy in western states has largely escaped ecological scrutiny. We echo many others in noting that the wide range of ecosystems and the multiple management objectives of these various forests ought to produce a variety of salvage-related policy goals. Under current legislative mandates, however, a science-based salvage policy has not been effectively developed. Western forest ecologists may be poised to contribute significantly, but their expertise has been excluded from the decision-making process."

Review:

- Discussion and concern that Federal salvage policy in Western states has largely escaped ecological scrutiny. Suggest that the wide range of ecosystems and the multiple management objectives of these various forests ought to produce a variety of salvage-related policy goals.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The

long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

Rose C. L., Marcot B. G., Mellen T. K., Ohmann J. L., Waddell K. L., Lindely D. L., Schrieber B. 2001. Decaying wood in Pacific Northwest forests: concepts and tools for habitat management. Pages 580—623 in Johnson D.H., T.A. O'Neil (eds.). Wildlife-Habitat Relationships in Oregon and Washington. Corvallis: Oregon State University Press.

Review:

- This paper talks about the importance of decayed wood in ecosystems. It talks about the stages and structures of decaying wood, biological agents of wood decay, functions of decaying wood, and a host of other topics relating to wood decay and decayed wood usefulness. It has long been known that decayed wood serves a vital function in ecosystems. The design features for this project incorporate the retention of coarse woody debris, down logs, and snags that will eventually fall and become down wood.

Rothermel, R. 1991. Predicting behavior and size of crown fires in the northern Rocky Mountains. USDA For. Serv. Rocky Mtn. Res. Sta. Gen. Tech. Rep. INT-GTR-438. Ogden, UT.

Review:

- This paper discusses the development of crown fire prediction and the parameters that go into modeling and prediction. This document serves as background information for the fuels report.

Roy, D. F. 1956. Salvage logging may destroy Douglas-fir reproduction. USDA For. Serv. Res. Note 107.

Review:

- A copy of this research note could not be located.
- It is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see natural regeneration assumptions in the "Methodology" section of the silviculture report), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities, and using existing skid trails where available.

Rumbaitis del Rio, Cristina, Ph.D., University of Colorado, Boulder "Compound Disturbance in a Managed Landscape: Ecological Effects of Catastrophic Blowdown, Salvage-Logging, and Wildfire in a Subalpine Forest." Aquilegia. The Newsletter of the Colorado Native Plant Society June-July 2006

http://www.conps.org/pdf/Aquilegia/2006%20June-July.pdf

"In contrast, mechanized salvage logging resulted in elevated soil temperatures, soil compaction and erosion, and reduced rates of nitrogen cycling in soil. Seedling density and understory vegetation cover were also reduced; new seedling establishment was minimal. Conditions in salvage-logged areas were similar to south-facing clearcuts where failures in natural regeneration are common, suggesting that if new seedling establishment remains low, reestablishment of forest cover in salvage-logged areas will be delayed. Thus, salvage logging following windthrow disrupts recovery mechanisms, converting a biologically intact ecosystem into a modified state, where a shift in ecosystem regime is possible."

Review:

- Discussion of a study that evaluated the potential compounding effect of salvage logging and wildfire following wind disturbance on seedling regeneration, understory composition, and ecosystem processes in Routt National Forest, a subalpine forest that sustained a 10,000-acre blowdown in 1997, was partially salvage-logged in 1999, and burned in 2002.
- The WFR project is in ponderosa pine and mixed conifer forest types in Arizona burnt by wildfire. This study was carried out in a subalpine forest in Colorado after blowdown and wildfire. This study is not relevant to the WFR project.

Saab, V., and J. Dudley. 1998. Responses of cavity-nesting birds to stand replacement fire and salvage logging in ponderosa pine/Douglas-fir forests of southwestern Idaho. USDA For. Serv. Res. Pap. RMRSRP-1 1.

Review:

- The authors studied the effects of stand-replacement fire and salvage logging on cavity-nesting birds. The paper states that they monitored 695 nests of 9 cavity-nesting bird species. However, 10 species are listed in Table 1, which displays the number of cavity-nesting birds monitored. Nests and vegetation were monitored in three treatments: standard-cut salvage logged, wildlife prescription salvage logged, and unlogged controls. In salvage logged units, about 50 percent of the trees were harvested.
- Five of the 10 bird species had more nests in standard salvage logged areas than in either the wildlife salvage logged areas, or the unlogged areas. The other five species had more nests in unlogged areas than either the standard salvage logged or wildlife salvage logged areas. Among the species monitored, black-backed woodpeckers, hairy woodpeckers, white-headed woodpeckers, and mountain bluebird used nest sites with the highest tree densities (unlogged), while Lewis' woodpeckers, American kestrel, northern flicker, and western bluebird selected relatively open nest sites (standard salvage logged). The authors also note that some of the monitored species selected the largest, most decayed snags, while other species (black-backed woodpecker) selected

the hard, small snags.

- Other findings include: (1) cavity nesters as a group selected clumps of trees rather than uniformly-spaced trees; (2) cavity-nesting birds used heavily decayed, larger snags more than in proportion to availability; (3) retaining clumps of trees rather than uniformly distributed trees would benefit the entire cavity-nesting bird community; and (4) in burned forests, retaining more large (20″ d.b.h or greater) snags is beneficial because such snags are known to have greater longevity than smaller snags.
- In summary, different species of cavity nesters select different site conditions (open vs. more dense, logged vs. unlogged, hard snags vs. decayed snags…). The authors did recommend leaving snags in clumps and leaving the largest snags available. This project incorporates both of those recommendations as design features.
- This paper was considered in the analysis for wildlife and is cited in the wildlife report.

Saab, Victoria A. Ph.D., H. D. W. Powell, N. B. Kotliar and K. R. Newlon. 2005. "Variation in fire regimes of the Rocky Mountains: implications for avian communities and fire management." Studies in Avian Biology 30: 76-96.

http://www.rmrs.nau.edu/publications/rmrs_2005_saabv001/rmrs_2005_saabv001.pdf

"Densities of cavity nests were two to three times higher in unlogged (18 nesting species) compared to salvage-logged plots (eight nesting species). Mayfield nest success for the three most abundant species was higher in unlogged than salvage-logged treatments for Northern Flicker (95% vs. 67%, respectively, both N = 24 nests) and Mountain Bluebird (67%, N = 25 vs. 34%, N = 15)."

"Caton (1996) also found lower densities of cavity nests in salvage-logged compared to unlogged burned forests. Relative abundance of tree-foraging species was significantly lower in salvage-logged plots."

Review:

- This paper reviewed studies that looked at bird responses to fire in different forest types. In ponderosa pine, the historical fire regime was for frequent, low severity fires. These regimes have been altered by fire suppression, livestock grazing, and logging and their effects on historical fuel structure. Fire intervals have lengthened and high-severity fires are more common.
- They then tried to look at bird reproductive success in burned stands compared to unburned stands. In many cases they were comparing burned stands and unburned stands in different parts of the country, where there may have been other variables affecting reproductive success. But overall, they found higher nest success for six species in burned habitats, including hairy woodpecker.
- They did note three exceptions, one of which is relevant to this project. Hairy woodpeckers in unburned mixed conifer-aspen forest of the Mogollon Rim had the same or greater nest success than in burned ponderosa pine in Idaho.
- The sections quoted from Artley are based on lodgepole pine forests and are not relevant to this project.

Sackett, S. S. and S. M. Haase. 1996. Pp. 187-192 in: Fuel Loading in Southwestern Ecosystems of the United States: Effects of Fire on Madrean Province Ecosystems. USDA For. Serv. Gen. Tech. Rep. RM-GTR-289. Ogden, UT.

Review:

- This paper examines the forest fuel loading effects in the Southwest. It points out that fire severity can be exacerbated by burning of heavy fuels. Information from this document was been integrated into the fuels report.

Sallabanks, R. and J. D. Mclver. 1998. Response of breeding bird communities to wildfire in the Oregon Blue Mountains: The first three years following the Twin Lakes fire, 1995—1997. P. 85— 89 in Fire and Wildlife in the Pacific Northwest: Research, Policy and Management: Proceedings of the Annual Meeting of the Northwest Section of the Wildlife Society. Oregon State University Printing, Corvallis, OR.

Review:

- This is a study of changes in the vegetation structure of the burned forest and how breeding bird communities responded. The authors found that as the degree of burn increased, snag density increased, live tree density decreased, crown closure decreased, understory structure decreased, live ground cover decreased, and percent bare ground increased. This alteration of habitat was correlated with several changes in avian community composition.
- In general, the Twin Lakes Fire was found to cause small declines in overall avian abundance and species richness with these measures decreasing as the degree of burn increased. Two avian guilds (foliage feeders and overstory nesters) and five species (Golden-crowned Kinglet, Mountain Chickadee, Swainson's Thrush, Townsend's Warbler, and Varied Thrush) appeared to be negatively affected by the fire. However, one avian guild (aerial feeders) and two species (American Robin and Mountain Bluebird) were found to be positively correlated with degree of burn. Significant bird-habitat relationships were derived for 17 species of bird to identify the specific habitat variables that were correlated with a particular bird species' abundance.
- Study results are useful to forest managers because they provide information on which bird species are likely to be present given different burn conditions. Relevance to the Warm Fire Recovery project is that it provides insight into what species respond positively to post-fire conditions, and that those are the species that could be negatively impacted by salvage logging.

Sampson, R. N., L. R. Clark, and L. Z. Morelan. 1995. Forest ecosystem health in the inland west. American Forests March/April: 53-62.

Review:

- A paper that discusses forest ecosystem health in the inland West in terms of what is affecting these forests, why they are responding differently to climate stress than they did in the past, and what needs to be done to improve their health and resilience.
- There is a discussion of post-fire salvage logging. The authors state that "Most conservationists and managers agree that salvage is primarily an economic activity, and managers should be very conservative in applying it to post-fire management." This concept was taken into consideration in the design of the WFR project. One of the purpose and need statements for the WFR project is, "Recover the economic value from burned timber." Secondly, it is recognized that uncharacteristic stand-replacement fires in dry forests can produce uncharacteristic levels of post-fire fuels, including standing dead and down trees. We also considered the concept that removing portions of that particular biological legacy may be appropriate as part of an intelligent ecological restoration program, and not simply as salvage but to progress toward a desired condition typical of a fire-adapted ecosystem.

Santiago, Melissa J. and Amanda D. Rodewald Ph.D. "Dead Trees as Resources for Forest Wildlife." Ohio State University Extension Service Factsheet. Winter 2004.

http://ohioline.osu.edu/w-fact/pdf/0018.pdf

"Because so many animals rely on dead wood during some part of their lives, snag, limb, and log retention is an essential component of any wildlife conservation or management plan."

Review:

- This paper summarizes the importance of dead trees (both standing snags and downed logs) for forest wildlife. It also includes factors to consider in snag retention: diameter, species of tree, level of decay, and location.
- This paper was not used in the analysis, but it has long been recognized that snags and downed logs have values for wildlife. The forest plan includes direction for snag and downed log retention. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest. The analysis for wildlife species that use snags and downed logs incorporate that into the analysis, and appendix C of the wildlife report is a discussion and analysis of snags and downed logs.

Sapsis, D. B. and C. Brandow. 1997. Turning plantations into healthy, fire resistant forests: Outlook for the Granite Burn. California Dept. Forestry & Fire Protection, Fire and Resource Assessment Program.

http://frap.cdf.ca.gov/projects/granite_burn/gb.html

Review:

- This paper discusses the fire hazard consequences of a reforestation strategy that was implemented after a 1973 wildfire in California.
- The concept that native species are adapted to natural patterns and processes of disturbance and recovery in the landscape of the Kaibab Plateau was considered in designing the reforestation strategy for the WFR project. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire. It is recognized that there is going to be high levels of variation across the landscape after the Warm Fire due to aspen sprouting, variable and sometime heavy natural regeneration adjacent to existing seed sources, variable planting densities and survival in areas identified for planting and slow (in some cases 100+ years) recolonization of conifers in harsher areas with no seed sources.

Savage, M. and J. N. Mast. 2005. How resilient are southwestern ponderosa pine forests after crown fires? Canadian Journal of Forest Research 35: 967-977.

Review:

- This study explores the regeneration response of ponderosa pine and other species to crown fires that occurred in the Southwestern Region from the late 1940s to the mid-1970s.
- This study found two main trajectories of recovery: (1) establishment of unnaturally dense ponderosa pine stands vulnerable to further crown fire and (2) establishment of nonforested grass or shrub communities The authors conclude that high density post-crown fire stands may be vulnerable to future crown fires. These concepts were taken into consideration in the development of the reforestation strategy and post-fire forest vegetation development. This paper was referenced in the silviculture report.
- Savage and Mast (2005) and Strom and Fulé (2007) reviewed literature illustrating disturbance processes that "switch" a system into a different trajectory of community development. Contemporary forest conditions have led to the Warm Fire and a host of other uncharacteristic fire events in the Southwest over the last few decades. Savage and Mast (2005) investigated 10 post-burn sites in Arizona and New Mexico where "natural recovery," i.e., no post-fire harvest or planting occurred. All the sites developed into uncharacteristic stands. Relative to the historic range of variation, they either developed into "hyperdense" forests or underwent a type conversion to shrubfield or meadow. These uncharacteristic stands have persisted for at least 3 to nearly 6 decades and remain vulnerable to future high-severity fire. Repeat, uncharacteristic fires could create a self-perpetuating community structure (Savage and Mast 2005) rather then acting as the "vital disturbance process described by Beshta et al. (2004).
- Strom and Fulé (2007) surveyed seven paired sites 2 years after the Rodeo-Chediski Fire, the largest fire in Southwestern history. Seven stands had been pre-commercially thinned before the fire. Eight sites (five untreated and three treated) had no tree regeneration. Gambel oak, juniper, and New Mexico locust strongly dominated regeneration, creating a very different forest from the ponderosa pine dominated

overstory that had previously existed on the sites. Vegetation development was modeled for 100 years. Basal area in treated stands was 60 percent ponderosa pine but was only 35 percent pine in the untreated areas. The authors reviewed studies from Arizona, Mexico, and Spain that assessed results of intense fire in pine-oak forest systems. Similar to Savage and Mast (2005), results indicated a shift to a more shrub-dominated forest or a conversion to an alternative steady-state such as a shrub field or grassland (Strom and Fulé 2007).

- Pine dominated forest structure within a natural range of variation may not return to such sites for the foreseeable future (Savage and Mast 2005). Preliminary data from a study site within the Warm Fire describes no conifer regeneration, but New Mexico locust and aspen sprouting was common Gambel oak and sprouting (on file, Kaibab Supervisor's Office). Species requiring sustainable forest with canopy connectivity such as Kaibab squirrels and MSO would suffer habitat loss across broad portions of the Warm Fire if no action led to a type conversion described by the above research. Research to date suggests active management proposed in this project may enhance habitat recovery and ecosystem resilience.

Reference:

- Strom, B. A. and P. A. Fulé. 2007. Pre-wildfire fuel treatments affect long-term ponderosa pine forest dynamics. International Journal of Wildland Fire, Vol. 16, pgs 128-138.

Schoennagel, Tania, Ph.D. from an article written by Matthew Koehler "Scientists Warn Congress Against Fast-Track Logging in Forests Recovering from Fire." New West, March 15, 2006

http://www.newwest.net/citjo/article/scientists_warn_congress_against_fast_track_logging_in_forests_recovering_f/C13/L8/

"Post-disturbance logging can increase the reburn potential of the site by concentrating flammable slash (small branches) at or near the ground, which can easily ignite and spread fire. The large, less ignitable fuels (tree trunks), which provide important perching, nesting, and feeding sites for wildlife, are removed by logging."

Review:

- This article reports on a letter by a group of scientists sent to members of Congress concerning the Forest Emergency Recovery and Research Act.
- The WFR EIS discloses the effects of logging for three action alternatives.
- In terms of wildlife habitat considerations, we have acknowledged the pros and cons of salvage logging within the WFR project and designed the project by considering biodiversity. The project design includes a series of salvage units adjacent to untreated corridors and drainages creating a mosaic of salvage and no-salvage logged areas. Within the salvage units, a proportion of the dead trees larger than 14″ as well as the majority of the dead trees less than 14″ would remain on site.

Sedell, J. R.; Bisson, P. A.; Swanson, F. J.; and S. Gregory. 1988. What We Know About Large Trees That Fall Into Streams and Rivers. In: Maser, Chris; Tarrant, Robert F.; Trappe, James M.; and Jerry F. Franklin (eds.). 1988. From the Forest to the Sea: A Story of Fallen Trees. USDA-FS and USDI-BLM Gen. Tech. Rep. PNW-GTR-229. 153p.

Review:

- The authors studied the benefits of large tree and logs to streams and fish in the Pacific Northwest.
- This paper is not relevant to the WFR project. There are no fisheries or perennial streams in the WFR project area. The paper discusses concepts and makes findings that are more relevant to the Pacific Northwest.

Sexton, T. 1994. Effects of Post-Fire Salvage Logging and Grass Seeding on Pinus ponderosa and Purshia tridentate Survival and Growth. Corvallis, OR: Department of Rangeland Resources. (Unpublished manuscript) 27-p.

http://maps.wildrockies.org/ecosystem_defense/Resources_Species_Topics/Fire/Sexton-p-pine%20fire%20salv.doc

"Salvage logging forested areas following wildfire results in significant differences in site microclimate, soil moisture, and soil nutrient dynamics. Microclimate, and associated soil moisture regimes will be significantly different between salvage and non-salvage areas. This will occur due to removal of forest structure that moderates temperature, relative humidity, and vapor pressure deficit extremes."

"Much of the rationale given for why post-fire salvage logging is necessary (as part of fire restoration) hinges on the commodity value of the timber."

"Several studies have demonstrated increased erosion and soil disturbance as a result of salvage operations (Swanson, et.al., 1989). Klock (1975) compared five different post-fire salvage logging methods on a *P. ponderosa* site in eastern Washington. There were district differences in soil disturbance and erosion from the various logging systems. However, even with helicopter logging (the least disturbing method) 12% of the logged area soil was disturbed. Conventional tractor systems disturbed almost 75% of the area and caused erosion on over 30% of the area. Other studies have demonstrated adverse soil structure effects from logging that increase erosion (Steinbrenner and Gessel, 1955) and reduce reforestation success (Garrison and Rummell, 1951). Dyrness (1972) and Woolridge (1960) evaluated effects on soil from logging with low impact systems (balloon and skyline). Both researchers noted damage to the soil. None of these studies noted any beneficial effects to the soil from logging."

"Removal of the structure afforded by fire-killed trees in salvage operations causes greater extremes in surface temperatures and reduces the water retention."

"Salvage logging can affect soil structure in several ways. Compaction, displacement, and increased susceptibility to frost heave (through microclimate changes) are a few of the effects that can reduce seedling survival and growth (Harvey, et al. 1989)."

Review:

- This paper is a literature review and study plan for a Masters Thesis. This study, nor any of the studies referenced above occurred in the ponderosa pine or mixed conifer forests of northern Arizona.
- In reference to the discussion on change in microclimate, this concept was taken into consideration in the reforestation analysis and planting design features in the WFR silviculture report. The project design includes planting ("micrositing") seedlings adjacent to the remains of large trees and down logs to help ameliorate the changed conditions (loss of canopy cover) that exist after a stand-replacing fire.

Sexton, 1.0. 1998. Ecological effects of post-wildfire management activities (salvage logging and grass-seeding) on vegetation composition, diversity, biomass, and growth and survival of *Pinus ponderosa* and *Purshia tridentata*. M.S. thesis. Oregon State University, Corvallis.

Review:

- A copy of this thesis cannot be located. This study did not occur in the dry ponderosa pine or mixed conifer forests of northern Arizona.
- The WFR EIS discloses the wildfire effects to forest plants and animals. The EIS also acknowledges that before effective fire suppression began early in the 20th century, the ponderosa pine and mixed conifer forested ecosystems on the Kaibab Plateau were subject to frequent low to moderate intensity, and short fire return intervals. The fire suppression program was so effective that it allowed the fuel loads to accumulate to levels that created the conditions for the Warm Fire which burned as a previously unknown high intensity, stand-replacement fire, and killed all or most of the large trees.
- The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.
- Short-term adverse effects to soils from salvage logging ground-disturbing activities is well documented. The WFR project includes project design features and best management practices to minimize adverse impacts to soil and vegetation resources. Using existing skid trails and road templates will reduce the potential ground disturbance area. Proposed planting is designed to move the areas that experienced high levels of mortality that are lacking seed sources toward desired forested conditions. Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands and successful conifer reforestation on the salvage and planted areas (USDA Forest Service 2008).
- Breaking up the future large fuel component is one of the purposes for the WFR project. Future fires would expose the soils beneath and directly around coarse woody debris to high heat for extended periods of time, exposing roots to lethal temperatures (Monsanto

and Agee 2008). Monsanto and Agee (2008) noted lethal cover ranged up to 24.7 percent on unsalvaged portions of a past fire area, almost twice the lethal cover noted on salvaged portions. Monsanto and Agee (2008) also note "most of the concerns regarding salvage logging have dealt with short-term issues (Beschta et al. 2004). Longer term ecological effects, such as some of the effects of excessively high levels of coarse woody debris, should be factored into the decisionmaking process. In dry forest types there may be some long-term advantages for managers if excessive coarse woody debris loads are reduced early in the post-wildfire period."

References:

- Monsanto, Philip; James Agee. 2008 Long-term post wildfire dynamics of coarse woody debris after salvage logging. College of Forest Resources, University of Washington. Seattle, WA.
- USDA Forest Service. 2008. Higgins, B. 2008. A comparative analysis of forest recovery on the Summit, Willis, Bridger-Knoll and Hockderffer fires in ponderosa pine forest. USDA Forest Service, Kaibab National Forest unpublished report. Williams, AZ. 17 p.

Smith, R. B., and E. F. Wass. 1980. Tree growth on skidroads on steep slopes logged after wildfires in central and southeastern British Columbia. BCR-6. Can. For. Serv., Pac. For. Res. Ctr., Victoria, BC.

Review:

- Although this paper was not available, the WFR project considered effects of skid trails and roads on reforestation.
- Concepts concerning post-fire regenerative processes and regenerating landscapes on the Kaibab Plateau were considered in designing the WFR project. It is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see natural regeneration assumptions in the "Methodology" section of this report), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities and using existing skid trails where available.
- Short-term adverse effects to soils from salvage logging ground-disturbing activities are well documented. The WFR project includes project design features and best management practices to minimize adverse impacts to soil and vegetation resources. The majority of the area proposed for salvage logging are on slopes less than 20 percent. Use of existing roads and skid trails is incorporated in the project design features to reduce potential area impacted by salvage activities.
- Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands, and

successful conifer reforestation observed on the salvaged and planted areas (USDA Forest Service 2008).

Smith, Jane Kapler, ed. "Wildland Fire in Ecosystems: Effects of Fire on Fauna." USDA Forest Service Rocky Mountain Research Station. General Technical Report RMRS-GTR-42-volume 1. January 2000.

http://nps.gov/fire/download/fir_eco_wildlandfireJan2000.pdf

"Species that breed exclusively in the first 30 years after fire may be difficult to maintain in the ecosystem without fire. Fire exclusion and post-fire salvage of dead trees after fire may reduce populations of these species over large geographic areas."

Review:

- This publication summarizes direct and indirect effects of fire, and includes effects based on cover type and category of wildlife (birds, mammals, etc.).
- The citation is found at page 33 in a discussion of lodgepole pine and aspen communities in the Western states as two examples of effects of fire exclusion on forests with stand-replacement fire regimes. In lodgepole pine-spruce-fir forests, the most productive period for bird communities appears to be the first 30 post-fire years.
- The Warm Fire occurred in ponderosa pine and mixed conifer communities. Fire regimes range from high frequency, low intensity in ponderosa pine to mixed severity in the mixed conifer communities. The wildlife report for the Warm Fire Recovery addresses hairy woodpeckers, which increase post-fire. That analysis addresses how salvage affects habitat availability.

Smucker, K. M., R. L. Hutto and B. M. Steele. 2005. Changes in bird abundance after wildfire: importance of fire severity and time since fire. Ecological Applications 15:1535-1549.

Review:

- This study analyzes changes in bird assemblages after the severe fires of 2000 in the Bitterroot Valley, Montana. The findings underscore the importance of fire severity and time since fire and imply that both factors must be considered to understand the complexities of fire effects on biological communities. It was found that changes in bird response to fire, depends on fire severity and time since fire, and that the kind of response to fire (negative or positive) depends on bird species. Some bird species increase in abundance after fire; of those some respond positively to high severity fire, while others do not. Some species respond positively to moderate severity or low severity fire, and still other species respond negatively to any fire (lower abundance).
- This study does not address the impacts to bird assemblages of salvage logging in a post-fire forest.
- This paper was considered in the analysis for wildlife and is cited in the wildlife report.

Sollins, P.; Cline, S. P.; Verhoeven, T.; et al. 1987. Patterns of Log Decay in Old-Growth Douglas-fir Forests. Canadian Journal of Forest Research. 17:1585-1595.

Review:

- In this study, fallen logs of Douglas-fir, western hemlock, and western red cedar in old-growth stands of the Cascade Range of western Oregon and Washington were compared with regard to their physical structure, chemistry and levels of microbial activity to determine patterns of decay. This study is not relevant to the dry ponderosa pine and mixed conifer forests of the Southwest.

Stephens, S. L. 1998. Evaluation of the effects of silvicultural and fuels treatments on potential fire behavior in Sierra Nevada mixed-conifer forests. Forest Ecology and Management 105:21-35.

Review:

- This paper models fire behavior in a Sierra Nevada mixed conifer forest and investigates how silvicultural and fuels treatments affect potential fire behavior.
- One of the silvicultural treatments this study investigates is salvage harvest. The salvage harvest that the paper discusses is removal of dead trees within an otherwise green stand of trees. The treatments in WFR project are salvage logging a high severity burn landscape with very few, if any, green trees remaining. This study is not relevant to the WFR project.

Stone, Richard. 1993. Spotted owl plan kindles debate on salvage logging. Science. 261: 287.

Review:

- This paper pertains to the management of northern spotted owl habitat in the Pacific Northwest.
- Although this paper is not directly relevant to the WFR project area, effects to Mexican spotted owls and their habitat were analyzed and the forest consulted with the USFWS as required under Section 7 of the Endangered Species Act.

Strittholt, James R. Ph.D and Heather Rustigian. 2004. Ecological Issues Underlying Proposals to Conduct Salvage Logging in Areas Burned by the Biscuit Fire. Conservation Biology Institute.

http://www.consbio.org/cbi/professional_services/biscuit/biscuit_logging.htm

"Natural post-fire recovery is generally rapid with no deleterious consequences; therefore, active post-fire rehabilitation of any kind is usually not needed, and may even be counter-productive."

"The notion that salvage logging and post-fire restoration (e.g., replanting, erosion and invasive species control) are intimately connected ecologically is a fallacy."

"There is no ecological justification for post-fire salvage logging in <u>any</u> post-fire environment

and most definitely not in the Biscuit Fire where so many important biodiversity values are rare and at risk."

Review:

- This report was prepared to provide an independent examination of the post-fire management options considered for the Biscuit Fire (2002) within the Siskiyou National Forest in southwestern Oregon.
- The WFR project is not in the Pacific Northwest or southwestern Oregon so many of the findings in the Biscuit Fire area are not relevant to the Warm Fire. Concepts concerning post-fire regenerative processes and regenerating landscapes on the Kaibab Plateau were considered in designing the WFR project. It is recognized that salvage logging after a fire can have a negative affect on natural regeneration. While it is difficult to make precise estimates of the extent of natural regeneration after a wildfire (see FEIS "Vegetation" section, natural regeneration assumptions in the "Methodology"), the WFR project was designed to decrease the risk of salvage operations disturbing natural regeneration by salvaging only in areas that have a low probability of natural regeneration (i.e. salvage operations will occur within high and mixed-high fire mortality areas of the project area), limiting the salvage to fire-killed trees without green needles, restricting skidders and other fuels treatment equipment to designated skid trails during non-winter harvest and fuels reduction activities and using existing skid trails where available.

Strittholt, James, Ph.D. and Dominick DellaSala, Ph.D. "Biscuit fire salvage will harm forest." Guest Viewpoint, Eugene Register Guard. September 24, 2005.

http://www.consbio.org/cbi/media/newspaper_articles/ed.col.biscuit.0924.html

"Let's be clear: No scientific evidence supports the position that salvage logging benefits forest ecosystem health. In fact, existing studies show that such activities virtually always damage recovering soils, native plants and salmon. Salvage has everything to do with economics for a few, and little or nothing to do with forest health. It is time for a real public debate about post-fire management on public lands."

Review:

- Editorial concern over the effect of salvage logging on the long-term sustainability and health of Oregon forests guided by sound science.
- The WFR project is not in the Pacific Northwest or southwestern Oregon so many of the findings in the Biscuit Fire area are not relevant to the Warm Fire.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

Swanson, F.; Clayton, L.; Megahan, W. F.; and G. Bush. 1989. Erosional Processes and Long-Term Site Productivity. In: Maintaining the Long-Term Productivity of Pacific Northwest Forest Ecosystems. Edited by: D. A. Perry; R. Meurisse; B. Thomas; R. Miller; J. Boyle; J. Means; C. R. Perry; and R. F. Powers. Timber Press. pp. 164-184.

Review:

- The authors examined the natural erosion regimes in the Pacific Northwest and how management activities may influence site productivity within those erosion and disturbance processes.
- Effects to soils were analyzed and included in chapter 3 of the EIS. Appendix A lists the project design features and best management practices included to protect water quality, soil productivity and to minimize bare soil and ground disturbance.

"Post-Fire Logging: What Scientists Say". A letter written to members of congress. August 1, 2006.

The entire letter and signatories may be read at.
http://www.conservationnw.org/library/otherpub/document-2006-03-15-7573536098

"When we, as scientists, see policies being developed that run counter to the lessons of science, we feel compelled to speak up. Proposed post-disturbance legislation (specifically the Forest Emergency Recovery and Research Act [HR 4200] and the related Forests for Future Generations Act [S. 2079]), crafted as a response to recent fires and other disturbances, is misguided because it distorts or ignores recent scientific advances. Under the labels of 'recovery' and 'restoration,' these bills would speed logging and replanting after natural disturbances."

"Although logging and replanting may seem like a reasonable way to clean up and restore forests after disturbances like wildland fires, such activity would actually slow the natural recovery of forests and of streams and creatures within them. Many scientist-reviewed studies and syntheses (please see the selected citations appended to this letter) have recently come to this conclusion. For example, no substantive evidence supports the idea that fire-adapted forests might be improved by logging after a fire. In fact, many carefully conducted studies have concluded just the opposite. Most plants and animals in these forests are adapted to periodic fires and other natural disturbances. They have a remarkable way of recovering (literally rising from the ashes) because they have evolved with and even depend upon fire."

"We are concerned that HR 4200 and S. 2079 will bind us to land management practices that, perhaps logical in the past, are no longer tenable in the light of recent scientific understanding. Specifically, post-disturbance logging impedes regeneration of forest landscapes when it compacts soils, removes or destroys so-called biological legacies (such as soil organic material, seeds in the soil, large standing and downed trees), damages riparian corridors, introduces or spreads invasive species, causes erosion, delivers sediment to streams from logging roads and steep slopes, degrades water quality, and damages populations of many aquatic species."

"In short, neither ecological benefits nor economic efficiency result from post-disturbance logging. We therefore urge you to defeat these legislative efforts because they will set back

forest recovery. We urge you to work with your fellow lawmakers to craft legislation that will rely on the most up-to-date scientific knowledge to protect the natural resources of the nation's public lands."

Sincerely,

Signed by several hundred biological scientists … most with PH.D.s.

Review:

- Letter to Congress concerning proposed legislation on how to treat post-fire forested landscapes and the need to rely on science to inform our decisions.
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies. The WFR project silviculture report and "Vegetation" section in the EIS references multiple scientific studies in the discussion on vegetation response to fire.

Tanner, G. W. Ph.D., W. R. Marion Ph.D., and J. J. Mullahey Ph.D. "Understanding Fire: Nature's Land Management Tool" A Florida Cooperative Extension Service publication, July, 1991

http://edis.ifas.ufl.edu/UW124

"Ecological benefits of fire:

- Promotes flowering of herbaceous species and fruit production of woody species.
- Improves nutritional quality of plants for both wild and domestic animals.
- Enhances nutrient cycling of some elements and elevates soil pH.
- Maintains required habitat conditions for fire-adapted plant and animal species.
- Results in a more heterogenous and diverse habitat--if natural fires are patchy--leaving pockets of unburned areas.
- Prohibits wildfire conditions from developing (i.e., vast accumulation of highly-flammable, dead vegetation.)"

Review:

- A pamphlet produced by the Florida Cooperative Extension Service discussing fire ecology in Florida.
- The WFR project is on the Kaibab Plateau in Arizona. Fire ecology in Florida is not relevant to the WFR project. However, local fire ecology was considered and impacts to vegetation, soils, and wildlife were analyzed.

Thomas, Jack Ward Ph.D. "Dead Wood: From Forester's Bane to Environmental Boon." Keynote address at the symposium on ecology and management of deadwood in western forests, Reno, Nevada. 1999. (See Thomas, J.W. 2002. USDA PSW-GRT-181)

http://64.233.167.104/search?q=cache:SavhPwhMt-oJ:199.128.173.130/psw/publications/documents/gtr-181/003_Thomas.pdf+%22jack+ward+thomas%22+keynote+1999+reno&hl=en&lr=lang_en

"Forest managers are increasingly aware of the significance of Aldo Leopold's admonition that 'to keep every cog and wheel is the first rule of intelligent tinkering.' Dead wood, standing and down, is one of those 'cogs and wheels'."

"In the early stages of our careers, dead wood in any form was considered the bane of foresters who had been trained to focus on the most efficient commercial production of wood and wood fiber. Snags (standing dead trees) were considered a safety hazard to woodland workers and a potential source of spreading sparks that ignited spot fires. Down woody material was considered 'fuel' that facilitated the spread of fire, a haven for vertebrate pests that hampered reforestation, and unsightly (Maser and others 1979)."

"I often ponder why Aldo Leopold's admonition about keeping 'cogs and wheels' is widely quoted and how often we are surprised at the consequences, both ecological and political, when it is ignored. By now, we should have learned that all the segments of a 'naturally' functioning ecosystem play some role in that system … whether or not we understand all the relationships. And we should have learned by now that biological systems are significantly simplified at some peril to the maintenance of that system."

"In retrospect, it is amazing that forest managers did not realize that dead wood was a critical habitat component for vertebrate and invertebrate wildlife and for the forest itself."

"Perhaps the greatest challenge that faces professionals engaged in forest research and management is the organization of knowledge and insights into forms that can be readily applied. To say we don't know enough is to take refuge behind a half-truth and ignore the fact that decisions will be made regardless of the amount of information available. In my opinion it is far better to examine available knowledge, combine it with expert opinion on how the system operates, and make predictions about the consequences of alternative management actions."

Review:

- This speech discussed the importance of dead wood, both standing and downed. It has long been recognized that snags and downed logs have values for wildlife. The forest plan includes direction for snag and downed log retention. Project design features include an emphasis on retention of larger diameter snags, in clusters, as well as retention of snags close to green forest. The analysis for wildlife species that use snags and downed logs incorporate that into the analysis, and appendix C of the wildlife report is a discussion and analysis of snags and downed logs.
- The GTR-181 describes the evolving change in the viewpoint concerning dead wood in forest ecosystems. Thomas presents a basic overview of the importance of dead wood for forest species. He then discusses the need for the synthesis of new research and information into land management practices and policy. He goes on to present some

examples where researchers and land managers have been able to synthesize scientific work and information into a form where land managers are able to implement the new science on the ground.

- The Warm Fire Recovery project is addressing dead wood through project design feature requirements to leave volumes of coarse woody debris (CWD) that are appropriate for the ecosystem and the burned landscape condition. The Warm Fire Recovery interdisciplinary team has worked to incorporate the latest information on the volumes of CWD that are needed to help maintain forested ecosystems in northern Arizona. All project design features considered information provided by Graham (1994), Brown (2003), and Brewer (2008).

Thomas, J. W.; Anderson, R. G.; Maser, C.; and E. Bull. 1979. Snags. In: Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington. Agriculture Handbook 553. USDA-FS Washington Office. P. 60-77.

Review:

- The chapter in this handbook talks about the importance and necessity of snags as habitat for some wildlife species. This has long been understood by wildlife professionals. The chapter addresses types of snags, snag succession, snag requirements, retention levels, distribution, and other topics relating to snags. The handbook does not specifically address harvesting snags in a burned forest. It does provide guidelines in table format for minimum number and size of snags required to support various percentages of maximum woodpecker populations. For the species that would be present in the Warm Fire project area, minimum number and sizes of snags ranges from 0.38 to 2.25 snags per acre with a minimum d.b.h of 12″ to support populations at 100 percent. Project design features for this project would retain snags at a higher level.

Trombulak, S. C. and C. A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30

Review:

- The authors conducted a literature review concerning roads and their impacts to the physical and biological environment. Generally they found that roads have several negative impacts to the physical and biological environment.

Turner, M. G.; Romme, W. H.; and R. H. Garner. 1999. Prefire Heterogeneity, Fire Severity, and Early Postfire Plant Reestablishment in Subalpine Forests of Yellowstone National Park, Wyoming. International Journal of Wildland Fire 9(1):21-36.

Review:

- This is a study of the effects of a large infrequent disturbance on a natural community within the 1988 fires in Yellowstone National Park. The forest vegetation types and fire regimes on the Kaibab Plateau and within the WFR project are very different than the lodgepole pine forests in Yellowstone NP.

- Although this study is not relevant to the WFR project, reforestation is discussed in the WRP analysis within the "Vegetation" resource section in chapter 3. Forest monitoring observations (USDA Forest Service 2008) of four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred. A lack of conifer reforestation was observed in the non-salvaged stands, and successful conifer reforestation on the salvage and planted areas (USDA Forest Service 2008).

Turner, M. G., W. H. Romme, and D. B. Tinker. 2003. Surprises and lessons from the 1998 Yellowstone Fires. Frontiers in Ecology and the Environment 1:351-358.

Review:

- This paper discusses the fires in Yellowstone National Park in 1988 in terms of size and severity and post-burn plant response.
- The forest vegetation types and fire regimes on the Kaibab Plateau and within the WFR project are very different than the lodgepole pine forests in Yellowstone NP. This paper is not relevant to the WFR project.

USDA Forest Service 1999. Dead and dying trees: essential for life in the forest. PNW Science Findings. Issue twenty / November 1999. (Bull, E., T. Torgersen, C. Parks.1999.)

Review:

- In this issue of Science Findings, the authors share their latest findings, which include the fact that snags and logs are colonized by organisms representing a broader array of plants, invertebrates, and vertebrates than was previously recognized. Twenty years after publication of a report on wildlife habitat in managed east-side forests, Pacific Northwest Research Station scientists Evelyn Bull, Catherine Parks, and Torolf Torgersen, are updating that report and discovering that the current direction for providing wildlife habitat on public forest lands does not reflect findings from research since 1979. More snags and dead wood structures are required for foraging, denning, nesting, and roosting than previously thought. However, at least one author (Torgersen) questions whether the levels of snags and logs they are finding in some forests is reflective of natural conditions prior to decades of aggressive fire suppression, especially in ponderosa pine forests that were historically wide open and clean from frequent underburns.

USDA Forest Service Forest Inventory and Analysis (FIA) data collected in 1999 under the Resource Planning Act.

Review:

- This citation noted the majority of trees in the Southwest are 12″ and less. Site-specific project stand data was used in this analysis. Salvage of material was focused on dead tree diameters 14″ and greater since trees of smaller diameter were anticipated to lose economic value 2 years after the fire. The effects of removal of the larger diameter dead trees is disclosed, along with the anticipated residual fuel loading from existing smaller diameter trees based on the stand data.

USDA Forest Service 2002. Dead wood all around us: think regionally to manage locally. PNW Science Findings. Issue forty-two. March 2002.

Review:

- This paper notes that dead wood is a crucial component of healthy, biologically diverse forests and cites a recent study in forests in Oregon and Washington.
- The Warm Fire Recovery project is addressing dead wood through project design feature requirements to leave volumes of coarse woody debris (CWD) that are appropriate for the ecosystem and the burned landscape condition. The Warm Fire Recovery interdisciplinary team has worked to incorporate the latest information on the volumes of CWD that are needed to help maintain forested ecosystems in northern Arizona. All project design features considered information provided by Graham (1994), Brown (2003), and Brewer (2008).

USDA Forest Service. 2003. Draft Environmental Impact Statement for the Rodeo-Chediski Fire Salvage Project, 2003, p. 214.

Review:

- This section is the economic discussion for the Rodeo-Chediski Fire Salvage project. The Warm analysis includes an analysis of the economic costs and benefits of the proposed alternatives in chapter 3. The economic information was updated since the draft EIS to address updated defect estimates.

USDA Forest Service 2006. Does wood slow down "sludge dragons?" the interaction between riparian zones and debris flows in mountain landscapes? PNW Science Findings. Issue eighty six. September 2006.

Review:

- Researchers at the Pacific Northwest Research Station are studying the relationships between large woody debris and debris flows in Pacific Northwest streams. The researchers believe that large wood is an important slowing mechanism for debris flows and helps limit the escape of sediments out of watershed basins. This further helps maintain complex fish habitat with large wood accumulations and spawning gravels

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USDA Forest Service. 2000. Roadless Area Conservation Final Environmental Impact Statement. Washington, D.C.

Review:

- This is an analysis of national roadless area management.
- The WFR project does not include salvage logging within the roadless area; however planting is identified where adequate conifer seed sources are lacking. No new roads are proposed, and no roaded access would be needed for the hand planting of conifer seedlings.

USDA Forest Service. 2008. A Comparative Analysis of Forest Recovery After Uncharacteristic Fire in Ponderosa Pine Forest. June 2008. Unpublished.

Review:

- Four local past fire areas that were salvaged and planted as well as portions where no salvage and planting occurred were reviewed. This study noted a lack of conifer reforestation in the non-salvaged stands, and successful conifer reforestation on the salvage and planted areas.
- This recent site specific information was considered and incorporated into the WFR project analysis.

Van Wagtendonk, J. W. 1996. Use of a deterministic fire growth model to test fuel treatments. In: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project, Final Report to Congress Vol. II, Assessment summaries and management strategies. Wildland Res. Ctr., Univ. California: Davis.

Review:

- This paper examines various treatment alternatives in the Sierra Nevada. Treatments were applied to areas that had not had a recent large fire such as the WFRP. Because of this, fuel loading, arrangement, and type are very different than in the WFRP. This study has limited use in applying to the WFRP.

Waters, T. F. 1995. Sediment in streams: sources, biological effects and control. American Fisheries Society, Bethesda, MD. 251 p. Monograph 7.

Review:

- The author studied the effects of sediment inputs into small stream channels and their effects on stream biota.
- The WFR project will utilize stream buffers and other soil and water conservation practices (see project design features in chapter 2 of the DEIS) to prevent or limit sediment delivery from hillslope treatments.

Weatherspoon, C. P. 1996. Fire-silviculture relationships in Sierra forests. In: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project, Final Report to Congress, Vol. II, Assessment summaries and management strategies. Wildland Res. Ctr., Univ. California: Davis.

Review:

- Silvicultural techniques mimic to varying degrees some of the disturbance functions—such as facilitating establishment of regeneration and influencing forest structure and composition—performed naturally by fire. This paper provides a brief overview of some of these relationships for a range of stand structures and fire regimes within Sierra Nevada forests.

- It is recognized that natural fire played a pivotal role in the development of the ponderosa pine and mixed conifer forests on the Kaibab Plateau. This concept was considered in designing the WFR project as demonstrated by the following sentence within the desired condition statement for the WFR project: "The future forest can be sustained with fire functioning as a key ecological process." The silviculture and fuels reports discuss fire regimes and reference conditions as documented in multiple scientific studies.

Weatherspoon, C. P. and C. N. Skinner. 1995. An assessment of factors associated with damage to tree crowns from the 1987 wildfires in northern California. Forest Science 41:430-451.

Review:

- A study of the relationship between degree of damage caused by the 1987 fires in northern California and prior management activities, fuelbed characteristics and site/stand factors.
- Management activities and resulting fire hazard are a main topic of this study. It is acknowledged there are tradeoffs between different levels of fuels treatment and completely foregoing treatment. This concept was considered as demonstrated by the following WFR project desired condition statement, "Surface fuel levels are such that effects from future fires are acceptable and the benefits to soil productivity and wildlife habitat can be realized." The future forest can be sustained with fire functioning as a key ecological process. Desired fuel conditions in ponderosa pine are 5 to 20 tons per acre in ponderosa pine and dry mixed conifer sites typical within the WFR project area (Brown, Reinhardt, and Kramer, 2003). Achieving these levels over extensive areas is not realistic given the scale of the fire and economic limitations. However, it is desirable to make substantial progress toward these levels in stands that were lethally scorched.

Wells, Jim. "Debate over the impacts of salvage logging continues: There's almost no data to support salvage logging." Guest viewpoint. Eugene Register Guard, January, 2006.

http://www.registerguard.com/news/2006/01/27/ed.col.wells.0127.p1.php?section=opinion

"With Tim Ingalsbee and Catia Juliana, I co-authored the 'Ecology of Fire' alternative in the Warner Fire Recovery Project Final Environmental Impact Statement, which set a number of precedents when it was published in 1991. Later, I wrote the proposal for the world's first fire process research natural area, using the Warner Creek fire area east of Oakridge. So I've been watching the current debate about post-fire salvage logging with great interest."

"There are no statistically significant data to support arguments for post-fire salvage logging. All the evidence cited is what is called 'anecdotal.'"

"Anecdotal evidence from the Warner fire has contradicted every single claim that natural processes would not adequately allow the forests to recover."

Review:

- Guest viewpoint newspaper editorial discussing post-fire salvage logging in west side Cascade forest of Oregon.
- These are totally different forest types than those that occur on the Kaibab Plateau and this editorial is not relevant to the WFR project.

Wilson, Seth M., Conservation Ecologist and John J. Citta, Wildlife Biologist comments submitted to the Montana Department of Natural Resources and Conservationon the Sula State Forest Recovery and Salvage OperationsSeptember 19, 2000

http://64.233.167.104/search?q=cache:NIo9oJIcbfYJ:www.landsinfo.org/ecosystem_defense/Montana_State/Dept_Nat_Res/Sula%2520State%2520Forest/Sula%2520salvage%2520cmt%2520by%2520Wilson%2520and%2520Citta.doc+post-fire+salvage+ph.d.&hl=en&ct=clnk&cd=47&gl=us

"It is well known that cavity nesting birds rely on the presence of dead trees for nesting sites. Hejl et al. (2000), Saab and Dudley (1998), Caton (1996), and Hitchcox (1996) all document a decrease in the presence of cavity nesting birds with salvage logging. In fact, it appears that particularly sensitive species, such as Black-backed Woodpeckers (Picoides arcticus) and Three-toed woodpeckers (Picoides tridactylus) generally disappear with salvage logging. The Black-backed woodpecker is rare enough that the forest service lists it as a 'sensitive species,' and merits special consideration."

"Of cavity nesting birds that remain in post-fire stands that are salvaged, many experience a decrease in nest success (i.e., more of their nests fail to produce young) (See Hejl et al. 2000; Hitchcox 1996). Therefore, the impacts of salvage logging on population dynamics is more complicated than simply whether a bird remains in a salvaged unit or not. Cumulative effects on population dynamics must be considered."

Review:

- The papers cited above have been reviewed. Some of the literature was considered in the wildlife analysis and is cited in the wildlife report.

Wisdom, Michael J. Ph.D., Richard S. Holthausen, Barbara C. Wales, Christina D. Hargis, Victoria A. Saab, Danny C. Lee, Wendel J. Hann, Terrell D. Rich, Mary M. Rowland, Wally J. Murphy, and Michelle R. Eames, "Source Habitats for Terrestrial Vertebrates of Focus in the Interior Columbia Basin: Broad-Scale Trends and Management Implications." Volume 2–Group Level Results. USDA Forest Service and USDI BLM. General Technical Report PNW-GTR-485. May 2000.

http://maps.wildrockies.org/ecosystem_defense/Science_Documents/Wisdom_et_al_2000/Vol_2a.pdf

"Both blue grouse and mountain quail most often are found in areas with a high abundance of shrubs, which most likely are used for cover as well as forage (Brennan and others 1987, Zwickel 1992). Traditional forest managers commonly replanted harvested areas, thus hastening the rate of succession and shortening the time that a stand remains in the early-seral stage (Hann

and others 1997). This practice, coupled with ground-disturbing site preparation before planting, often eliminates the herb, forb, and shrub structures from stands. Management activities such as salvage logging and planting in postfire habitats also may shorten the duration of these early-seral shrub dominated sites."

"Salvage logging in postfire habitats may reduce the availability of tall structures used for singing perches. Hutto (1995) found that the relative abundance of many bird species, including the Lazuli bunting, differed between recently burned and recently harvested forests. Composition of trees, snags, and shrubs subsequent to a burn can differ depending on fire intensity and postfire timber harvest."

Review:

- This publication looked at habitat requirements and trends in habitats for terrestrial species found in the interior Columbia Basin (eastern WA and OR, Idaho and western MT). Specific results are not relevant to this project, but a couple of the concepts quoted by Artley are.
- One is the concept that planting decreases reforestation time and decreases the time in early-seral habitats. It was decided to plant portions of the Warm Fire, due to extended predicted timeframes for natural regeneration. Stand-replacing fires were not a part of the historic fire regime for ponderosa pine types, and mixed conifer had a mixed fire regime, with only part burning as a stand-replacing fire. Species present in the southwestern ponderosa pine types have evolved under these conditions, so generally they aren't dependent on stand-replacing wildfire and extensive early-seral habitats.
- The other is the loss of tall structure within harvested stands. The analysis does look at percent of mixed-high and high mortality areas proposed for harvest, and retention of snags within the areas that are harvested.

Wright, H. A.; and A. W. Bailey. 1982. Fire Ecology. New York: Wiley.

Review:

- This large book has extensive information on fire ecology issues, with the emphasis on the impact of fire on plants and native ecosystems. However, there is limited reference to active or passive management following an uncharacteristic fire as was experienced in the WFR project area.

Wuerthner, George. "Salvage Logging: The Real Threat to Forest Health." International Journal of Ecoforestry. 1995.

http://www.connix.com/~harry/salvage.htm

"There is no legitimate ecological reason to 'salvage' any forest. The recent discovery by the timber industry, western Congressional members, and some Forest Service management personnel that salvage sales present a golden opportunity to log and road much of the remaining native forests of the West is but a reflection of their ecologically uninformed perspective about forests."

Review:

- This commentary discusses salvage logging and road building and effects to wildlife and sedimentation. This essay criticizes USDA Forest Service salvage policy and suggests that foresters do not understand forest ecology (McIver and Starr 2000).
- The WFR project EIS documents a full environmental review informed by science. The concepts of disturbance ecology and post-fire vegetation recovery for the Kaibab Plateau were taken into consideration in the development of the project design. The long-term desired condition for the project area is based on reference conditions as documented in multiple scientific studies.
- The WFR project area has been managed in the past for timber products and has a well developed road system. Salvage logging is identified in the forest plan as an appropriate action to take place in EMA 13 following fires. Project design features and best management practices have been incorporated to reduce potential adverse effects to soil resources and maintain adequate amounts of snags and coarse woody debris to provide for wildlife habitat.

Young, Jock, Anna Noson, Amy Cilimburg, Richard Hutto and Daniel Casey. March 25, 2005. Montana's Coordinated Bird Monitoring Plan – Version 3.0.

<http://avianscience.dbs.umt.edu/documents/CBM_3.0.pdf>

"The nearly annual occurrence of wildfire at some point in a larger landscape has served as the environmental backdrop against which our native wildlife species have evolved. A number of native species are dependent on wildfires or wildfire-created habitats and are nearly restricted in their distribution to such conditions. The importance of stand-replacement fires in this forest system is beginning to make the maintenance of such fires a high priority in land management agencies, especially since policy during the past 70 years has encouraged widespread fire suppression and post-fire salvage logging. The high density of standing dead trees (snags) that remain after stand-replacement fires (conditions that are hard, if not impossible, to replicate without fires) makes this a unique habitat for birds."

"More than a dozen bird species (especially woodpeckers) are more abundant in recently burned forest than in any other natural vegetation type, and one (the Black-backed Woodpecker) is nearly restricted in its habitat distribution to such patches (Hutto 1995). The Black-backed Woodpecker is a species of special management concern for this very reason, and makes it a focal point for potential conflict between meeting its needs and conducting post-fire salvage activities."

"When fires do occur, there is a high likelihood that the trees will be quickly 'salvaged,' because of the perception that the forest has been destroyed and the dead wood will go to waste. Salvage logging removes the very element that makes this habitat a uniquely productive resource for many bird species. Post-fire salvage logging may make some patches unsuitable by reducing nest sites and food resources (Caton 1996, Hitchcox 1996, Hejl unpublished data)."

Review:

- Part of a proposed bird monitoring plan for Montana includes bird communities dependent on stand-replacement fire. Black-backed woodpeckers are mentioned specifically.
- As was discussed in the wildlife report, the mortality as a result of the Warm Fire was higher than what would be predicted based on the historic range of variability. Stand-replacing fires were not a part of the historic fire regime for ponderosa pine types, and mixed conifer had a mixed fire regime, with only part burning as a stand-replacing fire. Species present in the southwestern ponderosa pine types have evolved under these conditions, so generally they aren't dependent on stand-replacing wildfire. Distribution of black-backed woodpeckers does not include Arizona.
- While hairy woodpecker densities have been shown to increase post-fire due to increases in beetles (foraging habitat), they are not dependent on stand-replacing wildfire, but use a variety of habitats.

Ziemer, R. R., and T. E. Lisle, 1993. "Evaluating sediment production by activities related to forest uses--A Northwest Perspective." Proceedings: Technical Workshop on Sediments, February, 1992, Corvallis, Oregon. pp. 71-74.

http://maps.wildrockies.org/ecosystem_defense/Resources_Species_Topics/Fire/Post-fire%20and%20sediment%20science.doc

"Logging effects on soil properties are usually more severe and more persistent than those of fire (USFS and USBLM, Ch. 4, pp. 13, 1997b)."

"These multiple impacts on soil productivity are probably why salvage logging retards post-fire vegetative recovery. Sexton (1998) documented that post-fire salvage logging over snow, reduced regrowth of ponderosa pine and other species relative to adjacent burned, but unlogged, areas. Naturally regenerating groundcover in unlogged areas also had greater survival and growth than plantings on areas that had been salvaged logged after fire. Notably, these adverse effects of logging on regrowth were from over-snow logging (Sexton, 1998)."

"It is highly likely that ground-based logging without snowcover retards regrowth to a greater extent due to its greater negative effects on soils. Kattleman (1996) noted that 'If post-fire treatments of salvage logging and site preparation prevent rapid reestablishment of low vegetation, resulting erosion can be greater than that directly produced by the fire.' Coupled with Sexton's work and the known effects of logging on soil productivity and concomitant effects on revegetation, it appears that post-fire logging creates more erosion and sedimentation than fires."

Review:

- Ziemer and Lisle present a literature review and assessment of the negative impacts of post-fire salvage logging. They both conclude that post-fire logging produces more negative impacts than the initial wildfire. Their findings are based on an assemblage of findings from other authors work and indicate that post-fire logging retards vegetative recovery, and creates more erosion and sedimentation.

- The Warm Fire Recovery project would implement project design features that are intended to minimize the impacts of post-fire logging. Most of the studies cited in the paper by Ziemer and Lisle are related to post-fire salvage logging where project design features were much less stringent and road building was included. The Warm Fire Recovery project would. Further, natural regeneration has been very minimal within the Warm Fire area, so it is not expected that logging or over-snow logging will appreciably impact regrowth.