October 2, 2023

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Submitted electronically via: https://cara.fs2c.usda.gov/Public//CommentInput?Project=63176

Re: Comments on the Dry Riverside Project Environmental Assessment

Dear Mr. Blazejewski,

WildEarth Guardians (Guardians) respectfully submit these comments to the U.S. Forest Service concerning the agency's environmental assessment (EA) of the Dry Riverside Project located within the Hungry Horse-Glacier View District on the Flathead National Forest. Generally, the proposed action would commercially log 4,205 acres of which 400 acres would be effectively clearcut through seed tree and shelterwood harvest, this in addition to the noncommercial activities across 3,696 acres that includes precommercial thinning, understory removal, vista cuts, controlled burning, and whitebark pine restoration. To accomplish these activities the Forest Service proposes expanding the road system by adding 22.7 miles of previously decommissioned or "historic" roads and reconstructing old road templates. The project also includes constructing 5.2 miles of temporary roads on existing road templates. Altogether, these road actions demonstrate that the only true way to remove roads is to fully obliterate them and recontour the slopes.

Guardians is a nonprofit conservation organization with offices in Montana and seven other states. We have over 182,900 members and supporters across the United States and we work to protect and restore wildlife, wild places, wild rivers, and the health of the American West. Guardians and its members have specific interests in the health and resilience of public lands and waterways. Specifically, we have a long history of advocating for right-sizing the Forest Service road system, and ensuring the agency's transportation system is ecologically sustainable, which is why we vigorously oppose adding roads back onto the system. Not only will this increase the maintenance burden, but it will also hinder the recovery of at-risk species, particularly grizzly bears. For this reason we hereby support and incorporate comments submitted by the Swan View Coalition and Friends of the Wild Swan.

I. The agency must demonstrate that the project will not have significant effects.

The Council for Environmental Quality's (CEQ) regulations (1978) define significance in terms of context and intensity, which includes inter alia the scope of beneficial and adverse impacts, unique characteristics of the geographic area, degree of controversy, degree of uncertainty, and degree to which an action may affect species listed or critical habitat designated under the Endangered Species Act. 40 C.F.R. § 1508.27 (defining "significantly"). The CEQ revised its regulations in 2020, but the Forest Service cannot apply the revised regulations because they were illegally adopted in violation of the Administrative Procedure Act (APA) NEPA, and the Endangered Species Act (ESA). The CEQ is currently revising the 2020 regulations. Given the state of flux and uncertainty regarding the 2020 regulations, the Forest Service continues to rely on the 1978 CEQ definition for "significance."[1] Here the agency must"[f]or all alternatives, be sure to consider the environmental effects in terms of their context and intensity."[2]

> (a) Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality.
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> Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.
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> (b) Intensity. This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:
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> > 1. Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.
> > 2. The degree to which the proposed action affects public health or safety.
> > 3. Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
> > 4. The degree to which the effects on the quality of the human environment are likely to be highly controversial.
> > 5. The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
> > 6. The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

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[1] *See* Forest Service Handbook (FSH) 1909.15 Ch. 10 at 40.

[2] *Id.*

> 7. Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant
> impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.
> 8. The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.
> 9. The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.
> 10. Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.[3]

The Forest Service must demonstrate how the proposed action will not significantly affect the environment, and specifically address each of the factors for intensity. In addition, as we detail in our comments, there is a high degree of uncertainty and scientific controversy regarding the efficacy of the proposed actions in meeting the project's purpose and need.

In enacting NEPA, Congress recognized the "profound impact" of human activities, including "resource exploitation," on the environment and declared a national policy "to create and maintain conditions under which man and nature can exist in productive harmony."[4] The statute has two fundamental two goals: "(1) to ensure that the agency will have detailed information on significant environmental impacts when it makes decisions; and (2) to guarantee that this information will be available to a larger audience."[5]

"NEPA promotes its sweeping commitment to 'prevent or eliminate damage to the environment and biosphere' by focusing Government and public attention on the environmental effects of proposed agency action."[6] Stated more directly, NEPA's "'action-forcing' procedures . . . require the [Forest Service] to take a 'hard look' at environmental consequences"[7] before the agency approves an action. "By so focusing agency attention, NEPA ensures that the agency will not act on incomplete information, only to regret its decision after it is too late to correct."[8] To ensure that the

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[3] FSH 1909.15 Ch. 10 at 40 -42.
[4] 42 U.S.C. § 4331(a).
[5] *Envtl. Prot. Info. Ctr. v. Blackwell*, 389 F. Supp. 2d 1174, 1184 (N.D. Cal. 2004) (quoting *Neighbors of Cuddy Mt. v. Alexander,* 303 F.3d 1059, 1063 (9th Cir. 2002)); see also *Earth Island v. United States Forest Serv.*, 351 F.3d 1291, 1300 (9th Cir. 2003) ("NEPA requires that a federal agency 'consider every significant aspect of the environmental impact of a proposed action ... [and] inform the public that it has indeed considered environmental concerns in its decision-making process.'").
[6] *Marsh v. Or. Natural Res. Council*, 490 U.S. 360, 371 (1989) (quoting 42 U.S.C. § 4321).
[7] *Metcalf v. Daley*, 214 F.3d 1135, 1141 (9th Cir. 2000) (quoting *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 348 (1989)).
[8] Marsh, 490 U.S. at 371 (citation omitted).

agency has taken the required "hard look," courts hold that the agency must utilize "public comment and the best available scientific information."[9] In *Natural Resources Defense Council v. U.S. Forest Service*, for example, the Court faulted the Forest Service for providing empty disclosures that lacked any analysis, explaining the agency "d[id] not disclose the effect" of continued logging on the Tongass National Forest and "d[id] not give detail on whether or how to lessen the cumulative impact" of the logging.[10] The Court explained that "general statements about possible effects and some risk do not constitute a hard look, absent a justification regarding why more definitive information could not be provided."[11] The court reasoned that the Forest Service also must provide the public "'the underlying environmental data' from which the Forest Service develop[ed] its opinions and arrive[d] at its decisions."[12] In the end, "vague and conclusory statements, without any supporting data, do not constitute a 'hard look' at the environmental consequences of the action as required by NEPA."[13] "The agency must explain the conclusions it has drawn from its chosen methodology, and the reasons it considered the underlying evidence to be reliable."[14]

At the project level, as compared to a programmatic decision, the required level of analysis is stringent.[15] At the "implementation stage," the NEPA review is more tailored and detailed because the Forest Service is confronting "individual site specific projects."[16] When the Forest Service fails to conduct that site-specific analysis, the agency "does not allow the public to 'play a role in both the decision-making process and the implementation of that decision.'"[17] "Although the agency does have discretion to define the scope of its actions, . . . such discretion does not allow the agency to determine the specificity required by NEPA."[18] In *State of Cal. v. Block*, for example, the decision concerned 62 million acres of National Forest land, and the Ninth Circuit still required an analysis of "[t]he site-specific impact of this decisive allocative decision."[19] In short, NEPA's procedural safeguards are designed to guarantee that the public receives accurate site-specific information regarding the impacts of an agency's project- level decision before the agency approves the decision.

Analyzing and disclosing site-specific impacts is critical because where (and when and how) activities occurring on a landscape strongly determine the nature of the impact. As the Tenth

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[9] *Biodiversity Cons. Alliance v. Jiron*, 762 F.3d 1036, 1086 (10th Cir. 2014) (internal citation omitted).

[10] *Natural Res. Def. Council v. U.S. Forest Serv.*, 421 F.3d 797, 812 (9th Cir. 2005).

[11] *Or. Natural Res. Council Fund v. Brong*, 492 F.3d 1120, 1134 (9th Cir. 2007) (citation omitted); see also *Or. Natural Res. Council Fund v. Goodman*, 505 F.3d 884, 892 (9th Cir. 2007) (holding the Forest Service's failure to discuss the importance of maintaining a biological corridor violated NEPA, explaining that "[m]erely disclosing the existence of a biological corridor is inadequate" and that the agency must "meaningfully substantiate [its] finding").

[12] *WildEarth Guardians v. Mont. Snowmobile Ass'n*, 790 F.3d 920, 925 (9th Cir. 2015).

[13] *Great Basin Mine Watch v. Hankins, 456 F.3d 955*, 973 (9th Cir. 2006).

[14] *N. Plains Res. Council, Inc. v. Surface Transp. Bd.*, 668 F.3d 1067, 1075 (9th Cir. 2011) (citation and internal quotation marks omitted).

[15] See, e.g., *Friends of Yosemite Valley v. Norton*, 348 F.3d 789, 800-01 (9th Cir. 2003).

[16] *Forest Ecology Ctr., Inc. v. U.S. Forest Serv.*, 192 F.3d 922, 923 n.2 (9th Cir. 1999).

[17] *Id.* at 928 (quoting *Methow Valley Citizens Council*, 490 U.S. at 349).

[18] *City of Tenakee Springs v. Block*, 778 F.2d 1402, 1407 (citing California v. Block, 690 F.2d 753, 765 (9th Cir. 1982)).

[19] *California v. Block*, 690 F.2d 753, 763 (9th Cir. 1982).

Circuit Court of Appeals has explained, the actual "location of development greatly influences the likelihood and extent of habitat preservation. Disturbances on the same total surface area may produce wildly different impacts on plants and wildlife depending on the amount of contiguous habitat between them."[20] The Court used the example of "building a dirt road along the edge of an ecosystem" and "building a four-lane highway straight down the middle" to explain how those activities may have similar types of impacts, but the extent of those impacts – in particular on habitat disturbance – is different.[21] Indeed, "location, not merely total surface disturbance, effects habitat fragmentation,"[22] and therefore location data is critical to the site-specific analysis NEPA requires. Merely disclosing the existence of particular geographic or biological features is inadequate—agencies must discuss their importance and substantiate their findings as to the impacts.[23]

In sum, the Forest Service must comply with NEPA by taking a hard look at the potential environmental consequences of the proposed action, and demonstrate how those effects do not rise to the level of significance, addressing both the factors related to context and intensity, if it proceeds without preparing an environmental impact statement (EIS).

I. Flawed rationales for the claimed purpose and need related to vegetative management.

The Forest Service provides cursory rationales to support its vegetation treatments, namely by stating there are "differences between the existing landscape condition and the desired condition described in the forest plan," and there is a need to "increase species diversity, protect large individual remnant western larch and western white pine, and to promote larger size classes. EA at 5-6. The agency also explains there is a need "to reduce wildland fuel so the expected fire behavior is reduced (FW-DC-FIRE-02)." The agency's underlying assumption that its vegetation management actions will effectively reduce fire intensity are both highly controversial and uncertain, thereby necessitating detailed environmental analysis under an EIS. To ensure that the agency has taken the required "hard look," courts hold that the agency must utilize "public comment and the best available scientific information." *Biodiversity Cons. Alliance v. Jiron*, 762 F.3d 1036, 1086 (10th Cir. 2014) (internal citation omitted). As such, the Forest Service must adequately demonstrate that the widespread use of specific proposed treatments under the proposed actions will improve ecosystem resilience, and that attempting to attain such a goal will in fact restore ecological integrity. In doing so, we caution the Forest Service not to rely on uncertain and controversial assumptions that the proposed treatments will effectively achieve the project's intended purposes and meet the stated needs.

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[20] *New Mexico ex rel. Richardson*, 565 F.3d at 706.
[21] *Id.* at 707.
[22] *Id.*
[23] *Or. Natural Res. Council Fund v. Goodman*, 505 F.3d 884, 892 (9th Cir. 2007).

A. Climate Change & Historical References

The Forest Service describes the project area according to historic fire regimes noting that "Most of the analysis area is classified as fire regime III." EA at 69. It then states that "Much of the Dry Riverside project area is considered condition class 2," which describes the degree of departure from these historic fire regimes. However, recent science calls into question the utility of using these historic fire regimes and classifying departures to justify vegetation manipulations. Specifically the findings question the underlying assumption that some forested landscapes historically experienced low-severity wildfire and current trends toward higher severities are substantially departed from historic ranges of variability. Specifically, researchers explained,

> The structure and fire regime of pre-industrial (historical) dry forests over ~26 million ha of the western USA is of growing importance because wildfires are increasing and spilling over into communities. Management is guided by current conditions relative to the historical range of variability (HRV). Two models of HRV, with different implications, have been debated since the 1990s in a complex series of papers, replies, and rebuttals. The "low-severity" model is that dry forests were relatively uniform, low in tree density, and dominated by low- to moderate-severity fires; the "mixed-severity" model is that dry forests were heterogeneous, with both low and high tree densities and a mixture of fire severities. Here, we simply rebut evidence in the low-severity model's latest review, including its 37 critiques of the mixed-severity model. A central finding of high-severity fire recently exceeding its historical rates was not supported by evidence in the review itself. A large body of published evidence supporting the mixed-severity model was omitted. These included numerous direct observations by early scientists, early forest atlases, early newspaper accounts, early oblique and aerial photographs, seven paleo-charcoal reconstructions, >18 tree-ring reconstructions, 15 land survey reconstructions, and analysis of forest inventory data. Our rebuttal shows that evidence omitted in the review left a falsification of the scientific record, with significant land management implications. The low-severity model is rejected and mixed-severity model is supported by the corrected body of scientific evidence.

Baker et al., 2023. In other words, the Forest Service cannot rely on one interpretation of historic reference conditions to formulate its vegetation treatments. This is especially true given the agency must account for the fact that climate change is fundamentally altering the agency's assumptions about the efficacy of the proposed actions. Rather than rely on departures from historical fire regimes, the agency must look beyond them and inform restoration objectives based on reference sites that represent current ecological conditions of the project area. Such sites would have experienced broadscale disturbances in areas that have a passive management emphasis. In addition, the Forest Service should analyze how those reference conditions may change over the next 50 -100 years based on the best available climate models. It is likely that such analysis will indicate the best management approach is to allow for natural adaptation as a recent study suggests:

> Forests are critical to the planetary operational system and evolved without human management for millions of years in North America. Actively managing forests to help them

> adapt to a changing climate and disturbance regime has become a major focus in the United States. Aside from a subset of forests wherein wood production, human safety, and experimental research are primary goals, we argue that expensive management interventions are often unnecessary, have uncertain benefits, or are detrimental to many forest attributes such as resilience, carbon accumulation, structural complexity, and genetic and biological diversity. Natural forests (i.e., those protected and largely free from human management) tend to develop greater complexity, carbon storage, and tree diversity over time than forests that are actively managed; and natural forests often become less susceptible to future insect attacks and fire following these disturbances. Natural forest stewardship is therefore a critical and cost effective strategy in forest climate adaptation.

Faison et al. 2023. In fact, Forest Service actions that seek to resist natural adaptation need careful evaluation to determine if such resistance will in fact meet restoration goals, especially given that "in a time of pervasive and intensifying change, the implicit assumption that the future will reflect the past is a questionable basis for land management (Falk 2017)." Coop et al., 2020. While it is useful to understand how vegetative conditions have departed from those in the past, the Forest Service cannot rely on those departures to define management actions, or reasonably expect the action alternatives will result in restoring ecological processes.

Given changing climate conditions, the Forest Service should emphasize reference conditions based on current and future ranges of variability, and less on historic departures. Further, the agency needs to shift its management approach to incorporate the likelihood that no matter what vegetation treatments it implements, there are going to be future forest wildfire-triggered conversions to other vegetation types. As such, the Forest Service cannot rely on the success of resistance strategies, as Coop 2020 explains:

> Contemporary forest management policies, mandates, and science generally fall within the paradigm of resisting conversion, through on-the-ground tactics such as fuel reduction or tree planting. Given anticipated disturbance trajectories and climate change, science syntheses and critical evaluations of such resistance approaches are needed because of their increasing relevance in mitigating future wildfire severity (Stephens et al. 2013, Prichard et al. 2017) and managing for carbon storage (Hurteau et al. 2019b). Managers seeking to wisely invest resources and strategically resist change need to understand the efficacy and durability of these resistance strategies in a changing climate. Managers also require new scientific knowledge to inform alternative approaches including accepting or directing conversion, developing a portfolio of new approaches and conducting experimental adaptation, and to even allow and learn from adaptation failures.

Coop et al., 2020. Further, equally important to acknowledging the limitations of resistance strategies is the fact that other pertinent scientific findings show warming and drying trends are having a major impact on forests, resulting in tree die-off even without wildfire or insect infestation. See, e.g., Parmesan, C. 2006; Breshears et al. 2005; Allen et al. 2010, 2015; Anderegg et al. 2012; Williams et al. 2013; Overpeck 2013; Funk et al. 2015; Millar and Stephenson 2015; Gauthier et al. 2015; Ault et al. 2016 ("business-as-usual emissions of greenhouse gases will drive regional warming and drying, regardless of large precipitation uncertainties"); Vose et al. 2016 ("In essence, a survivable drought of the past can become an intolerable drought under a warming climate").

Given the fallacies of using historic conditions as a reference for desired conditions and the uncertainty that treatments will maintain or restore ecological integrity in the context of climate change and likely forest conversion scenarios, the Forest Service must reevaluate its assumptions about its proposed vegetative treatments. In fact, many of the agency's assumptions run contrary to the most recent science regarding the impact of logging on wildfire behavior, resilience of the forest to large-scale disturbances, and ability to provide quality wildlife habitat.

Many of the scientific studies cited within our comments call into question the Forest Service's assumption that its proposed actions will achieve the stated purpose and need. Ultimately, the agency cannot assert that there is broad consensus in the scientific literature that commercial timber harvest or thinning in combination with prescribed fire reduces the potential for high severity wildfire to the extent characterized in the project scoping letter. In fact, such an approach has been broadly questioned within the scientific literature:

> Fire suppression policies and "active management" in response to wildfires are being carried out by land managers globally, including millions of hectares of mixed conifer and dry ponderosa pine (Pinus ponderosa) forests of the western USA that periodically burn in mixed severity fires. Federal managers pour billions of dollars into command-and-control fire suppression and the MegaFire (landscape scale) Active Management Approach (MFAMA) in an attempt to contain wildfires increasingly influenced by top down climate forcings. Wildfire suppression activities aimed at stopping or slowing fires include expansive dozerlines, chemical retardants and igniters, backburns, and cutting trees (live and dead), including within roadless and wilderness areas. MFAMA involves logging of large, fire-resistant live trees and snags; mastication of beneficial shrubs; degradation of wildlife habitat, including endangered species habitat; aquatic impacts from an expansive road system; and logging-related carbon emissions. Such impacts are routinely dismissed with minimal environmental review and defiance of the precautionary principle in environmental planning. Placing restrictive bounds on these activities, deemed increasingly ineffective in a change climate, is urgently needed to overcome their contributions to the global biodiversity and climate crises. We urge land managers and decision makers to address the root cause of recent fire increases by reducing greenhouse gas emissions across all sectors, reforming industrial forestry and fire suppression practices, protecting carbon stores in large trees and recently burned forests, working with wildfire for ecosystem benefits using minimum suppression tactics when fire is not threatening towns, and surgical application of thinning and prescribed fire nearest homes.

DellaSala et al., 2022. This article comes in response to an article, Prichard et al. 2021, that we see the Forest Service often cite to support its proposed actions and assert broad scientific consensus as to their efficacy. Yet, even here the researchers raise several factors that the Forest Service must address in a detailed analysis. For example, they explain:

> Fuel reduction treatments are not appropriate for all conditions or forest types (DellaSala et al. 2004, Reinhardt et al. 2008, Naficy et al. 2016). In some mesic forests, for instance, mechanical treatments may increase the risk of fire by increasing sunlight exposure to the forest floor, drying surface fuels, promoting understory growth, and increasing wind speeds that leave residual trees vulnerable to wind throw (Zald and Dunn 2018, Hanan et al. 2020).

Such conclusions indicate that treatments within areas of mesic site conditions may not be appropriate. In addition, Prichard et al, 2021 explains the following:

> In other forest types such as subalpine, subboreal, and boreal forests, low crown base heights, thin bark, and heavy duff and litter loads make trees vulnerable to fire at any intensity (Agee 1996, Stevens et al 2020). Fire regimes in these forests, along with lodgepole pine, are dominated by moderate- and high-severity fires, and applications of forest thinning and prescribed underburning are generally inappropriate.

Ultimately, what the agency proposes is a long-term active management regime that will require repeated tree removal and controlled burning since nowhere does the Forest Service state it has any plans to allow unmanaged wildfire to play a natural ecological role. This equates to perpetual management with logging and burning, which is hardly ecological restoration and the Forest Service's misguided efforts to mimic natural disturbance patterns fail to allow natural processes to function creating even more novel ecosystems with unknown long-term results.

A. Assumptions And Uncertainty About Vegetation Treatments And Wildfire

Ultimately, we question the agency's assumptions that reducing tree densities and fuel loadings will result in less intense fire behavior. Powell, H. 2019 ("what fire scientists call a forest's 'fuel load' is not the main cause of large, unstoppable fires; it's climate factors such as temperature, humidity, and especially wind. But the weather is ephemeral and invisible, while thick underbrush is easy to see and photograph) Exhibit 1; see also, ProPublica, 2020 "Despite What the Logging Industry Says, Cutting Down Trees Isn't Stopping Catastrophic Wildfires" (Exhibit 2) and Mountain Town News, 2020 "Colorado's Troublesome megafire" (Exhibit 2).

Science shows that fuel treatments have a modest effect on fire behavior, and that fuel reduction does not necessarily suppress fire. Lydersen, et al., 2014 (explaining that reducing fuels does not consistently prevent large forest fires, and seldom significantly reduces the outcome of large fires). Studies from the Forest Service's own Rocky Mountain Research Station refute the Forest Service's assumptions that vegetation treatments will result in less intense fire behavior. Calkin, D.E., et al., 2014 (explaining, "[p]aradoxically, using wildfire suppression to eliminate large and damaging wildfires ensures the inevitable occurrence of these fires").

Large fires are driven by several conditions that completely overwhelm fuels. Meyer, G and Pierce, J. 2007. Because weather is often the greatest driving factor of a forest fire, and because the strength and direction of the wildfire is often determined by topography, fuels reduction projects cannot guarantee fires of less severity. Rhodes, J. 2007, Carey, H. and M. Schumann, 2003.

Vegetation treatments based on historical reference conditions to reduce high-intensity wildfire risk on a landscape scale are undermined by the fact that land managers have shown little ability to target treatments where fires later occur. Barnett, K. et al, 2016, Rhodes, J. and Baker, W. 2008 (finding that fuel treatments have a mean probability of 2-8% of encountering moderate- or high- severity fire during the assumed 20-year period of reduced fuels). Analysis of the likelihood of fire is central to estimating likely risks, costs and benefits incurred with the treatment or nontreatment of fuels. If fire does not affect treated areas while fuels are reduced, treatment impacts are not counterbalanced by benefits from reduction in fire impacts. Results from Rhodes and Baker 2008 indicate that "even if fuel treatments were very effective when encountering fire of any severity, treatments will rarely encounter fire, and thus are unlikely to substantially reduce effects of high-severity fire."

Fuel treatments could even make fire worse—exacerbating the problems the Forest Service is claiming to address. Fuel reduction may actually exacerbate fire severity in some cases as such projects leave behind combustible slash through at least one dry season, open the forest canopy to create more ground-level biomass, and increase solar radiation which dries out the understory. Graham, R.T., et al, 2012, Martinson, E. J. and P. N. Omi, 2013 (finding that in about a third of cases reviewed mechanical fuel reductions increased fire spread). Also fuel reduction can exacerbate fire spread by opening up a forest to wind penetration.

We question the wisdom of attempting to control wildfire instead of learning to adapt to fire. See Powell 2019 (Exhibit 1 - noting that severe fires are likely inevitable and unstoppable). See also Schoennagel, T., et al., 2017 (explaining, "[o]ur key message is that wildfire policy and management require a new paradigm that hinges on the critical need to adapt to inevitably more fire in the West in the coming decades"). The Forest Service must recognize that past logging and thinning practices may have actually increased risk of intense fire behavior on this landscape. But instead of learning from these past mistakes, here the Forest Service is committing to the same mistakes by proposing widespread tree cutting and repeated burning across the landscape. It is well-established that communities (homes) are best protected from fire by home hardening, and judicious removal of fuels within the surrounding 100 - 200 ft radius. Syphard et al. 2014, Cohen, 2000.[24] The Forest Service needs to address the fact that addressing the home ignition zone will do more to protect property than the proposed action.

[24] See also, Exhibit 3 containing a series of articles featuring Dr. Cohen.

We also question the need to reduce wildfire, a natural forest process. While some may view wildfires negatively, natural ecology shows otherwise. See Powell 2019, (Exhibit 1 - explaining how a young burned forest is an essential natural process and "nature's best-kept secret," providing new habitat for a plethora of birds, abundant wildflowers, insects, mushrooms, etc.). Further, in 2019 conservation scientists Dr. Dominick DellaSala and Dr. Chad Hanson published a study disputing the assumption that high-severity has increased in recent decades. In this megafire trend study, the researchers analyzed data on large high-severity burn patches across 11 western dry pine and mixed-conifer forests over three decades. They found no significant increase in the size of large high-severity burn patches since the early 1990s. DellaSala, Hanson, 2019. Most research studies define high severity as 90% tree mortality. (Moritz et al. 2014). Therefore, the Forest Service may be overestimating any increase of the amount of high severity wildfire that has been occurring in recent decades. This leads to a bias towards carrying out widespread and intensive fuel treatments to respond to the ostensive increase in high intensity fire.

Impacts from climate change, including changing weather patterns and drought, are the driving factors for wildfires. *Id.* Instead of relying on thinning and controlled burning to manage the forest, the Forest Service should focus on how it needs to change its practices to adapt to the changing climate. At an absolute minimum, these studies demonstrate that the proposed treatments are controversial, ill-supported, and have the potential for significant impacts requiring preparation of an EIS.

II. Expand project's purpose to include the Forest Service's duty to identify the minimum road system.

Over twenty years ago, the Forest Service recognized the challenges related to its oversized and deteriorating road system. In 2001, the Forest Service promulgated the Roads Rule (referred to as "subpart A").[25] The Roads Rule created two important obligations for the agency. One obligation is to complete a Travel Analysis Report and identify unneeded roads to prioritize for decommissioning or to be considered for other uses.[26] Another obligation is to identify the minimum road system needed for safe and efficient travel and for the protection, management, and use of National Forest system lands.[27]

Under subpart A, the Forest Service has a substantive duty to address its over-sized road system. Identifying a resilient future road system is one of the most important endeavors the Forest Service can undertake to restore aquatic systems and wildlife habitat, facilitate adaptation to climate change, ensure reliable recreational access, and operate within budgetary constraints. This underlying substantive duty must inform the scope of, and be included in, the agency's NEPA analysis. After 20 years since finalizing the subpart A rules, the Forest Service can no longer delay in addressing this

[25] 36 C.F.R. part 212, subpart A. 66 Fed. Reg. 3206 (Jan. 12, 2001).
[26] 36 C.F.R. § 212.5(b)(2).
[27] *Id.* § 212.5(b)(1).

duty. Yet, the Forest Service fails to incorporate this duty within the project's purpose and need, thereby failing to ensure the road system provides for the protection of Forest Service System lands, reflects long-term funding expectations and minimizes adverse impacts. See 36 C.F.R. 212.5(b).

As such we urge the agency to include subpart A compliance as part of the project's purpose, especially given the likelihood that the agency will need to evaluate its road system within the project area in order to comply with NEPA. In doing so, we urge the Forest Service to update its previous Travel Analysis Report to reflect any changed circumstances. In addition, we urge the Forest Service to recognize that roads and motorized trails provide vectors for human wildfire ignitions, which is a risk that should be included in any Travel Analysis Process. WildEarth Guardians issued a 2020 report (Exhibit 4) that expands on these issues and provides a scientific literature review—including the Forest Service's General Technical Report synthesizing the scientific information on forest roads (Gucinski 2001)—on a wide range of road-related impacts to ecosystem processes and integrity on National Forest lands.

Complying with subpart A is a win-win-win approach: (1) it's a win for the Forest Service's budget, closing the gap between large maintenance needs and inadequate (and declining) funding through congressional appropriations; (2) it's a win for wildlife and natural resources because it reduces negative impacts from the forest road system; and (3) it's a win for the public because removing unneeded roads from the landscape allows the agency to focus its limited resources on the roads we all use, improving public access across the forest and helping ensure roads withstand strong storms. More than 20 years after finalizing the subpart A rules, the Forest Service can no longer delay in addressing this duty. We detail the agency's failure to comply with its obligations under subpart A in the enclosed report.[28]

III. Failure to adequately assess and disclose direct, indirect, and cumulative impacts, including detailed, site-specific information.

Federal agencies must discuss the direct, indirect, and cumulative effects of their actions and reasonable alternatives in the EIS. 40 C.F.R. §§ 1502.16, 1508.8. An EIS must analyze the direct, indirect, and cumulative impacts of "past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." 40 C.F.R. § 1508.7; see also §§ 1508.8 (including ecological, aesthetic, historical, cultural, economic, social and health impacts) and 1508.25(a)(2), (c). Cumulative effects are "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions." 40 C.F.R. § 1508.7 (1978). Forest Service regulations define reasonably foreseeable future actions as "[t]hose Federal or non-Federal activities

[28] See Exhibit 5. A Dilapidated Web of Roads - The USFS's Departure from a Sustainable Forest Road System. Jan 2021_WildEarth Guardians.

not yet undertaken, for which there are existing decisions, funding, or identified proposals." 36 C.F.R. § 220.3.

The Forest Service may not ignore topics if the information is uncertain or unknown. Where information is lacking or uncertain, the Forest Service must make clear that the information is lacking, the relevance of the information to the evaluation of foreseeable significant adverse effects, summarize the existing science, and provide its own evaluation based on theoretical approaches. Further, site-specific analysis is crucial to NEPA's goal of ensuring informed and science-based decision-making. The Forest Service must provide sufficient information for the public to understand the scope of the proposed activities. In order to fully comply with NEPA, the Forest Service must adequately assess and disclose numerous impacts, including impacts from forest roads and motorized use, logging, climate change, and impacts to wildlife. The Forest Service must also assess and disclose the cumulative impacts of forest roads, access and fire; and forest roads and climate change. Yet, the EA lacks the necessary information and analysis that is essential for understanding impacts and providing meaningful, informed public comment as we explain below and as described in the comments provided by Swan View Coalition and Friends of the Wild Swan.

A. Inadequate consideration of mature and old growth trees and stands

While the Forest Service provided some analysis of the vegetation types within the project area, the agency did not disclose how the proposed action would be consistent with President Biden's Executive Order 14072, and specifically how the project analysis defines and identifies mature trees.

Before explaining our concerns we recognize, appreciate and support the Forest Service's commitment to retain old growth forests: "No old growth or late successional forest would be harvested, nor would stands adjacent to old growth." EA at 28. However, the agency proposes commercially logging thousands of acres of what are likely mature trees in stands that fall within cool-moist, riparian and cold potential vegetation types where wildfire is typically infrequent and where natural disturbance patterns should be allowed to proceed unhindered. In fact, the Forest Service states that most of the project area occurs within Fire Regime Group III, but the agency fails to distinguish between the FRG IIIa and IIIb:[29]

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[29] See LANDFIRE Biophysical Settings Attribute Data Dictionary (listing the new Fire Regime Groups based on the 2016 LANDFIRE Remap), Exhibit 6.

Table 1. **LANDFIRE Fire Regime Groups**
I-A Percent replacement fire less than 66.7%, fire return interval 0-5 years
I-B Percent replacement fire less than 66.7%, fire return interval 6-15 years
I-C Percent replacement fire less than 66.7%, fire return interval 16-35 years
II-A Percent replacement fire greater than 66.7%, fire return interval 0-5 years
II-B Percent replacement fire greater than 66.7%, fire return interval 6-15 years
II-C Percent replacement fire greater than 66.7%, fire return interval 16-35 years
III-A Percent replacement fire less than 80%, fire return interval 36-100 years
III-B Percent replacement fire less than 66.7%, fire return interval 101-200 years
IV-A Percent replacement fire greater than 80%, fire return interval 36-100 years
IV-B Percent replacement fire greater than 66.7%, fire return interval 101-200 years
V-A Any severity, fire return interval 201-500 years
V-B Any severity, fire return interval 501 or more years

The Forest Service does not explain how each of the potential vegetation types align with the biophysical settings or show which of those BPSs align with the Fire Regime Groups. Notwithstanding the fundamental flaws with LANDFIRE we describe above, if the Forest Service is going to use departures of FRGs as a rationale for logging mature trees, it should disclose this information. Regardless, we do not consider FRG III to represent frequent fire regimes as return intervals beyond 35 years begin to shift to more infrequent fires, and especially by the time return intervals reach 100 years. In fact, we recognize there is ecological value and need for high-intensity, high severity, stand-replacement events. As such the purpose of harvesting mature trees appears to be solely to provide timber, which is not consistent with EO 14072.

On Earth Day 2022, President Biden issued an executive order requiring the Forest Service and Bureau of Land Management (BLM) to "define, identify, and complete an inventory of old-growth and mature forests" on their respective lands and to "make such inventory publicly available."[30] The order set forth several actions each agency must complete. First, the Agencies must "define" mature and old-growth forests, "accounting for regional and ecological variations." *Id.* Second, after the Agencies have defined mature and old-growth forests, they must then "identify" where those forests are and "complete an inventory" of those forests and make that inventory available to the public. *Id.* Third, after the inventory process is complete, the Agencies must then (i) "coordinate conservation and wildfire risk reduction activities, including consideration of climate-smart stewardship of mature and old-growth forests," with other agencies, States, Tribal Nations, and private landowners, (ii) "analyze threats to mature and old-growth forests," and (iii) "develop policies" that address threats to mature and old-growth forests." *Id.*

On April 20, 2023, the Forest Service and BLM took the first step in complying with EO 14072 by publishing *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* (MOG Report, see Exhibit 7). The MOG Report "contains the first national inventory of old-growth and mature forests focused specifically on Forest Service and BLM lands." (MOG Report, p. 1) Importantly, the report's findings are only "*initial* estimates of old-growth and mature forests" on Forest Service and BLM lands. *Id.* (emphasis

[30] *See* Strengthening the Nation's Forests, Communities, and Local Economies, 81 Fed. Reg. 24851, 24852 (Apr. 22, 2022) ("EO 14072").

added). Indeed, throughout the MOG Report, the Agencies repeatedly affirm the sequential nature of EO 14072 and that the current definitions and inventory are preliminary in nature.

- "The ***initial*** inventory and definitions for old-growth and mature forests are part of an overarching climate-informed strategy to enhance carbon sequestration and address climate-related impacts, including insects, disease, wildfire risk, and drought. ***Initial*** inventory results will be used to assess threats to these forests, ***which will allow consideration of appropriate climate-informed forest management, as required by subsequent sections of Executive Order 14072***." (MOG Report, p. 1)
- "The ***initial*** inventory will ***then*** be used to assess threats to these forests, ***which will allow consideration of appropriate climate-informed forest management***, as required by subsequent sections of the Executive order." (MOG Report, p. 4)
- "***Once the definitions and inventory are established***, section 2c then calls on the Forest Service and BLM to:
    - Coordinate conservation and wildfire risk reduction…
    - Analyze the threats to mature and old-growth forests on Federal lands…and…
    - Develop policies…to institutionalize climate-informed management and conservation strategies that address threats to mature and old-growth forests on Federal lands." (MOG Report, pp. 10-11)
- "This ***initial*** inventory represents the current condition of forests managed by the Forest Service and BLM at the time of the most recent FIA measurement; it does not provide any information on resilience or climate response of these forests … The team plans to apply working definitions for old-growth and mature forest to prior FIA data, which will inform how these forests have changed over the past 10-20 years. In addition, ***the team will explore how old-growth and mature forests are distributed in additional land use allocations that are currently grouped into the 'other' category.***" (MOG Report, p. 26)
- "Executive Order 14072 section 2c and USDA Secretarial Memo 1077-004 provide some clarity on ***next steps*** following the initial classification presented here." (MOG Report, p. 26)

Contemporaneous to the publication of the MOG Report, the Forest Service also published an advance notice of proposed rulemaking (ANOPR) that, in part, "[b]uilds on ongoing work to implement" EO 14072.[31] The ANOPR explains that EO 14072 "calls particular attention to the importance of Mature and Old-Growth (MOG) forests on Federal lands for their role in contributing to nature-based climate solutions by storing large amounts of carbon and increasing biodiversity." *Id.* at 24498. Elsewhere, the ANOPR stresses "the importance of mature and old-growth forests" for "large tree retention and conservation" and that "[o]lder forests often exhibit structures and functions that contribute ecosystem resilience to climate change." *Id.* at 24502-24503. Finally, the ANOPR states the MOG inventory that is currently "being developed"

[31] *See* Organization, Functions, and Procedures; Functions and Procedures; Forest Service Functions, 77 Fed. Reg. 24497 (Apr. 21, 2023).

will "help inform policy and decision-making on how best to conserve, foster, and expand the values of mature and old-growth forests on our Federal lands." *Id.* at 24501.

The ANOPR also announced the "beta version of a new Forest Service Climate Risk Viewer"[32] that "was developed with 38 high-quality datasets and begins to illustrate the overlap of multiple resource values with climate exposure and vulnerability." *Id.* at 24501. "Core information from the [initial] MOG inventory has been integrated into the viewer" to "help inform policy and decision-making on how best to conserve, foster, and expand the values of mature and old-growth forests on our Federal lands." *Id.* The initial MOG inventory displayed in the Climate Risk Viewer was derived from the Forest Inventory and Analysis (FIA) field plot networks, the "primary source for information about the extent, condition, status, and trends of forest resources across the U.S." *See* Climate Risk Viewer. The map displays MOG estimates on Forest Service land within 250,000-acre fireshed polygons, which are considered "the appropriate scale for statistical inference using FIA plots." *Id.* The matrix colors indicate the degree of mature or old-growth forest within each polygon (light-to-dark pink = low-to-high mature forest; light-to-dark blue = low-to-high old-growth forest). *Id.* Polygons classified as "low" indicate 0-25,000 acres of mature or old-growth forest, "intermediate" (25,000-75,000 acres), and "high" (75,000-250,000 acres). *Id.*

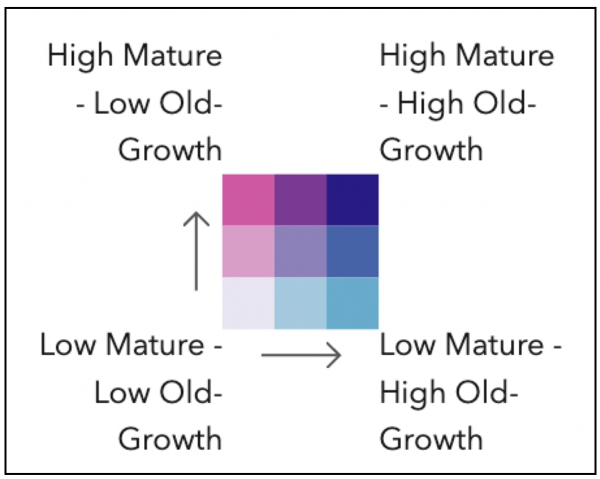

Figure 3 - Mature and Old-Growth Estimates in Forest Service Climate Risk Viewer

The Project area is within polygons that fall between "high mature-low old growth" indicating the project area has significant existing and potential carbon storage benefits. ***The Forest Service must further refine this inventory in a detailed statement and disclose the exact amount of mature and old growth trees in the Project area at the stand level, and how the proposed action may affect these inventories.*** In doing so, we urge the agency to consider other approaches from independent researchers. Specifically, in September 2022, researchers published the "first comprehensive and spatially explicit assessment of MOG in the conterminous United States,"[33] and made the result

[32] The Forest Service Climate Risk Viewer is available at: https://storymaps.arcgis.com/collections/87744e6b06c74e82916b9b11da218d28?item=8.

[33] DellaSala, D.A. et al (2022) Mature and old-growth forests contribute to large-scale conservation targets in the conterminous United States. *Front. For. Glob. Change*, 5:979528, 3

publicly available.[34] Here, researchers "mapped the relative level of forest structural maturity using three published spatial data sets that include forest canopy cover, canopy height, and above-ground living biomass derived from modeled satellite data (Table 1)." *Id.* The results were calibrated with FIA plot data, and found that on the Flathead National Forest approximately 1,177,326 acres have reached maturity, of which 22.5 percent are within Inventoried Roadless Areas. *Id.* at Table. S1. Another approach utilizes carbon as the basis for defining maturity. Here scientists explained the following.

> Our approach requires addressing two components: (1) individual trees referred to as the "larger" trees in a forest; and (2) mature forest stand development represented by stand age. This method for identifying larger trees in mature stands—and the related assessment of above-ground live carbon stocks and annual carbon accumulation—is intended to be broadly applicable and readily implementable independent of how mature stands are defined. We settled on defining stand maturity with respect to the age of maximum Net Primary Productivity (NPP), which is estimated as the annual net quantity of carbon removed from the atmosphere and stored in biomass (see section 2.2 for definitions of key terms). (Birdsey et al 2023).[35]

Researchers then provided the following definition: "Mature forests are defined as stands with ages exceeding that at which accumulation of carbon in biomass peaks as indicated by NPP," and used Culmination of Net Primary Productivity (CNPP) "to describe the age at which NPP reaches a maximum carbon accumulation rate." With this approach, scientists used FIA plot data for 11 national forests in the lower 48 states including those dominated by frequent-fire return intervals associated with dry pine and dry mixed conifer forest sites. Researchers found that trees within these stands on the Flathead National Forest reach CNPP at 9 inches dbh.

Both Birdsey et al. (2023) and DellaSala et al. (2022) demonstrate the ability to define mature forests, quantify their capacity to store carbon, and provide a specific inventory. The Forest Service now has its own FIA-based inventory as well, and together all three approaches demonstrate the agency has the tools to perform site-specific, field-verified inventories within mature and old-growth stands. As such, we urge the Forest Service to complete such an inventory across the project area as part of a detailed analysis necessary to comply with NEPA. Such a stand-level inventory is essential to conduct adequate carbon accounting that we discuss below. The importance of identifying and preserving these forests cannot be overstated as they are part of "nature-based climate solutions" for mitigating the effects of anthropogenic global warming. (MOG Report, p. 3) DellaSala et al 2022 explains how mature forests "provide superior values compared to logged forests as natural climate solutions" to meet the objectives of EO 14072. *Id.* at 16 (citations omitted). But "the current status quo management of MOG and low protection levels on all lands presents unacceptable risks at a time when the global community is seeking ways to reduce the rapidly accelerating biodiversity and climate crises." *Id.* at 16-17 (citation omitted). Further, we urge the Forest Service to recognize that as they mature, forests sequester and accumulate massive amounts of atmospheric carbon stored

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[34] *See* https://www.matureforests.org/data (last accessed September 30, 2023)

[35] Birdsey R.A., DellaSala D.A., Walker W.S., Gorelik S.R., Rose G. and Ramírez C.E. (2023) Assessing carbon stocks and accumulation potential of mature forests and larger trees in U.S. federal lands. Front. For. Glob. Change 5:1074508. http://doi.org/10.3389/ffgc.2022.1074508

mainly in large trees and soils making an invaluable contribution to climate smart management and international climate commitments. (Stephenson et al 2014,[36] Mildrexler et al 2020.[37]). Other studies demonstrate that unmanaged forests can be highly effective at capturing and storing carbon (Luyssaert et al 2008[38]). Further, forests have received increased global attention in climate fora (IUCN 2021)[39] and in the scientific community as natural climate solutions (Moomaw et al 2019[40]). Notably, Article 5.1 of the Paris Climate Agreement calls on governments to protect and enhance "carbon sinks and reservoirs." Article 38 of the UNFCCC COP26 Glasgow Climate Pact emphasizes "the importance of protecting, conserving and restoring nature and ecosystems, including forests … to achieve the long-term global goal of the Convention by acting as sinks and reservoirs of greenhouse gasses and protecting biodiversity…" (UNFCCC 2021[41]). The USA was also one of 140 nations at the COP26 that pledged to end forest degradation and deforestation by 2030. Logging both mature and old-growth forests is a form of forest degradation as it removes important forest structural features.

In addition, several studies demonstrate that maintaining forests rather than cutting them down can help reduce the impacts of climate change. "Stakeholders and policy makers need to recognize that the way to maximize carbon storage and sequestration is to grow intact forest ecosystems where possible" (Moomaw, et al 2019).

Another report concludes:

> *Allowing forests to reach their biological potential for growth and sequestration, maintaining large trees (Lutz et al 2018), reforesting recently cut lands, and afforestation of suitable areas will remove additional CO2 from the atmosphere. Global vegetation stores of carbon are 50% of their potential including western forests because of harvest activities (Erb et al 2017).* Clearly, western forests could do more to address climate change through carbon sequestration *if allowed to grow longer* (T. Hudiburg et al 2019).[42]

Also, a June 2020 paper from leading experts on forest carbon storage reported:

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[36] Stephenson, N & Das, Adrian & Condit, Richard & Russo, S & Baker, Patrick & Beckman, Noelle & Coomes, David & Lines, Emily & Morris, William & Rüger, Nadja & Alvarez Davila, Esteban & Blundo, Cecilia & Bunyavejchewin, Sarayudh & Chuyong, George & Davies, S & Duque, Alvaro & Ewango, Corneille & Flores, O & Franklin, Jerry & Zavala, Miguel (2014) Rate of tree carbon accumulation increases continuously with tree size. Nature. 507. 10.1038/nature12914

[37] Mildrexler, David & Berner, Logan & Law, Beverly & Birdsey, Richard & Moomaw, William (2020) Large Trees Dominate Carbon Storage in Forests East of the Cascade Crest in the United States Pacific Northwest. Frontiers in Forests and Global Change. 3. 10.3389/ffgc.2020.594274

[38] Luyssaert, Sebastiaan & Ernst Detlef, Schulze & Borner, A. & Knohl, Alexander & Hessenmöller, Dominik & Law, Beverly & Ciais, Philippe & Grace, John. (2008). Old-growth forests as global carbon sinks. Nature. Nature, v.455, 213-215 (2008). 455(11). *See also* Law et al (2018), Hudiburg et al (2009)

[39] IUCN (2022) IUCN 2021 annual report. Gland, Switzerland: IUCN. Exhibit 8.

[40] Moomaw, William & Masino, Susan & Faison, Edward (2019) Intact Forests in the United States: Proforestation Mitigates Climate Change and Serves the Greatest Good. 27. 10.3389/ffgc.2019.00027

[41] Exhibit 9: Article 38 of the UNFCCC COP26 Glasgow Climate Pact

[42] Hudiburg, Tara & Law, Beverly & Moomaw, William & Harmon, Mark & Stenzel, Jeffrey (2019) Meeting GHG reduction targets requires accounting for all forest sector emissions. Environmental Research Letters. 14. 095005. 10.1088/1748-9326/ab28bb.

> *There is absolutely no evidence that thinning forests increases biomass stored (Zhou et al. 2013).* It takes decades to centuries for carbon to accumulate in forest vegetation and soils (Sun et al. 2004, Hudiburg et al. 2009, Schlesinger 2018), and it takes decades to centuries for dead wood to decompose. We must preserve medium to high biomass (carbon-dense) forest not only because of their carbon potential but also because they have the greatest biodiversity of forest species (Krankina et al 2014, Buotte et al 2019, 2020). (B. Law, et al 2020).[43]

To address the climate crisis, agencies cannot rely on the re-growth of cleared forests to make up for the carbon removed when mature forests are logged. One prominent researcher explains: "It takes at least 100 to 350+ years to restore carbon in forests degraded by logging (Law et al 2018, Hudiburg et al 2009[44]). If we are to prevent the most serious consequences of climate change, we need to keep carbon in the forests because we don't have time to regain it once the forest is logged (IPCC, 2018)." *Id.*

Clearly the role of mature and old-growth forests to store carbon and serve as a natural climate-crisis solution must be part of any detailed project-level analysis. The Forest Service owes a duty to the public to ensure that these forests remain standing so that they can continue to perform their vital function of "storing large amounts of carbon." MOG Report 3; *see also Light v. U.S.*, 220 U.S. 523 (1911) ("the public lands . . . are held in trust for the people of the whole country."); *Juliana v. U.S.*, 217 F.Supp.3d 1224, 1259 (D. Or. 2016) ("[t]he federal government, like the states, holds public assets . . . in trust for the people.") (*rev'd on other grounds*, *Juliana v. U.S.*, 947 F.3d 1159 (9th Cir. 2020)); *Selkirk-Priest Basin Ass'n Inc. v. State ex rel Andrus*, 899 P.2d 949, 952-54 (Idaho 1995) (public trust doctrine permits challenge to timber sales since increased sedimentation could impact trust resources).

Continuing to cut down and remove mature trees and forests before the "definitions and inventory are established" and the current rulemaking is completed undermines the administration's focus on "nature-based climate solutions" for "storing large amounts of carbon."

B. The Forest Service must retain mature & old trees for climate resilience

Available scientific evidence strongly suggests that logging mature trees and forests will often undermine climate resilience on federal forests. For a variety of reasons, mature and old trees tend to be well positioned to survive the disturbance-enhancing effects of climate change. These trees develop structural and physiological attributes with age that enable them to better resist disturbance-induced mortality (e.g., thicker bark, higher crowns, deeper roots, etc.). Evidence to suggest that mature trees are more vulnerable to increased mortality from climate change compared to younger trees remains limited. While forests are becoming increasingly vulnerable to various stressors, some theories about increasing forest resilience to climate change through logging remain largely speculative - particularly when applied to entire landscapes. Moreover, logging mature trees

[43] B. Law et al (2020) The Status of Science on Forest Carbon Management to Mitigate Climate Change. Exhibit 10.

[44] Hudiburg, Tara & Law, Beverly & Turner, David & Campbell, John & Donato, Daniel & Duane, Maureen (2009) Carbon dynamics of Oregon and Northern California forests and potential land-based carbon storage. Ecological applications : a publication of the Ecological Society of America. 19. 163-80. 10.1890/07-2006.1.

and forests is well-known to significantly reduce or even eliminate many of the key natural values they provide. The relative resistance of mature trees and stands to climate change, as well as the well-established negative effects of logging them, point toward the critical importance of protecting mature and old trees from logging on federal lands. We reiterate and expand on these points in the enclosed white paper titled, "The Critical Importance of Mature & Old Trees for Climate Resilience." Exhibit 12. The Forest Service must fully analyze any loss of mature trees in the context of climate resilience and the reduction in the forest ability to adapt to the climate crisis.

C. The Forest Service must account for greenhouse gas emissions and provide a total carbon budget.

The Forest Service must provide detailed analysis for a project of this scope and scale which uses readily available methods and models that represent high quality information and accurate greenhouse gas accounting[45] when undertaking environmental reviews of logging projects on federal lands. Research, including studies done by the U.S. government,[46] indicates that logging on federal forests is a substantial source of carbon dioxide emissions to the atmosphere.[47] Notably, logging emissions—unlike emissions from natural disturbances—are directly controllable. Models and methods exist that allow agencies to accurately report and quantify logging emissions for avoidance purposes at national, regional, and project-specific scales. As such, the Forest Service has the ability and responsibility to disclose estimates of such greenhouse gas emissions using published accounting methods with the express purpose of avoiding or reducing the greenhouse gas associated with logging, and acknowledge the substantial carbon debt created by logging mature and old-growth trees and forests on federal lands.[48]

In particular, we recommend that:

1. The agency should identify and assess the carbon stock of mature and old-growth forests and trees[49] given the substantial carbon value of such trees and forests;[50]

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[45] Hudiburg, T.W. et al (2011) Regional carbon dioxide implications of forest bioenergy production. Nature Climate Change 1:419-423 https://www.nature.com/articles/nclimate1264 Hudiburg, T.W. et al (2019) Meeting GHG reduction targets requires accounting for all forest sector emissions. Environmental Research Letters 14 (2019) 095005 https://doi.org/10.1088/1748-9326/ab28bb

[46] Merrill, M.D. et al (2018) Federal lands greenhouse emissions and sequestration in the United States—Estimates for 2005–14, Scientific Investigations Report. https://doi.org/10.5066/F7KH0MK4

[47] Harris, N.L. et al (2016) Attribution of net carbon change by disturbance type across forest lands of the conterminous United States. Carbon Balance Manage:11-24 https://doi.org/10.1186/s13021-016-0066-5

[48] Hudiburg, Tara W., Beverly E. Law, William R. Moomaw, Mark E. Harmon and Jeffrey E. Stenzel. "Meeting GHG reduction targets requires accounting for all forest sector emissions." *Environmental Research Letters* (2019): n.pag. https://doi.org/10.1088/1748-9326/ab28bb

Harmon et al. "Forest Carbon Emission Sources Are Not Equal: Putting Fire, Harvest, and Fossil Fuel Emissions in Context." Frontiers For. Glob. Change (2022) https://www.frontiersin.org/articles/10.3389/ffgc.2022.867112/full

[49] Krankina, O. et al (2014) High biomass forests of the Pacific Northwest: who manages them and how much is protected? Environmental Management. 54:112-121. Law, B.E., et a. 2021. Strategic forest reserves can protect biodiversity in the western United States and mitigate climate change. Communications Earth & Environment | https://doi.org/10.1038/s43247-021-00326-0

[50] Mackey, B., et al (2013) Untangling the confusion around land carbon science and climate change mitigation policy. Nature Climate Change, Vol. 3 (June 2013)| VOL 3 | JUNE 2013 | www.nature.com/natureclimatechange Keith, H. et al (2019) Contribution of native forests to climate change mitigation. Environmental Science and Policy 93:189-199 https://www.sciencedirect.com/science/article/abs/pii/S146290111830114X. Law, B.E. et al (2022) Creating strategic reserves to protect forest carbon and reduce biodiversity losses in the United States. Land

2. The agency should identify and assess ***gross*** emissions from logging, particularly logging mature and old-growth trees and forests on federal lands, and including the emissions from logging on site and downstream emissions through the entire chain of custody of milling, manufacturing, and transportation; and
3. The agency should provide a high standard of scientific support for any asserted offsets of gross emissions, including discussion of timing factors that address the carbon debit created from logging vs avoiding logging and allowing stocks to further accrue.[51] We also note that storing some carbon in short-lived wood product pools is not compensatory as an offset or avoidance for using other carbon-intensive materials in construction.[52]

The Forest Service must disclose direct and indirect climate pollution from removing, transporting, and milling wood. This includes emissions from loss of stored carbon during the removal at the forest (in-boundary) and manufacturing and transport process (out-of-boundary). That is, Guidance should more closely specify the need to disclose the GHG emissions from logging on site through the entire chain of custody of milling, manufacturing, and transportation, including:

- construction, reconstruction, and maintenance of logging access routes;
- all forms of logging operations (clearcut, selective, postfire, commercial thinning, etc.), including any herbicides, insecticides, and related treatments;
- transport of logs to mills;
- milling of the wood; and
- transport of products to other sectors.

These emissions and others are all foreseeable impacts of logging projects. In some cases, these impacts may be considerable. For example, the South Plateau Project in Montana, will result in at least 40,000 trips by fully loaded logging trucks to remove the 83 million board feet of timber and will involve the construction (and subsequent obliteration) of up to 57 miles of temporary road. We note that in addressing the impacts of coal mine expansions, federal agencies have disclosed the GHG emissions of equipment used to mine coal and to transport it to market. Land management agencies can and should make similar projections for GHG pollution associated with vegetation removal projects.

The Forest Service routinely asserts that the impacts of logging on carbon stores will be minimal because carbon from logged trees will be stored long-term in forest products. Such assertions are contrary to research indicating that much of the carbon stored in removed trees is lost in the near term, and little carbon is stored long-term in wood products.

For example, a 2019 study evaluated the quantification of biogenic emissions in the state of Washington, which included GHG emissions from logging, but not decomposition of wood

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https://doi.org/10.3390/land11050721. DellaSala, D.A. et al (2022) Mature and old-growth forests contribute to large-scale conservation targets in the conterminous United States. Front. For. Glob. Change 5:979528. doi: 10.3389/ffgc.2022.979528. Birdsey, R. et al (2023) Assessing carbon stocks and growth potential of mature forests and larger trees in U.S. federal lands. Frontiers For. Glob. Change. https://www.frontiersin.org/articles/10.3389/ffgc.2022.1074508/full

[51] Moomaw, W.R. et al (2019) Intact forests in the United States: proforestation mitigates climate change and serves the greatest good. Frontiers in Forests and Global Change. https://doi.org/10.3389/ffgc.2019.00027

[52] Harmon, M.E. (2019) Have product substitution carbon benefits been overestimated? A sensitivity analysis of key assumptions. Environmental Research Letters (2019) https://iopscience.iop.org/article/10.1088/1748-9326/ab1e95

products. The study concluded that the failure to address decomposition losses amounted to as much as a 25% underestimation of carbon emissions.[53]

Losses from decomposition vary over time and depend on the lifetime of the wood product being produced from the timber. Paper and wood chips, for example, have very short lifetimes and will release substantial carbon into the atmosphere within a few months to a few years of production. Bioenergy production and burning has been found to release more emissions than burning even coal, including methane. Product disposal in landfills results in anaerobic decomposition that also releases methane. Methane has a global warming potential about 30 times that of carbon dioxide over 100 years, and over 80 times that of carbon dioxide over 20 years,[54] magnifying the impact of disposal of short-term wood products.

Longer term wood products can store carbon for many decades, but this depends on the life of the product. To give a sense of the larger picture, a study modeling carbon stores in Oregon and Washington from 1900-1992 showed that only 23% of carbon from logged trees during this time period was still stored as of 1996.[55] Similarly, > 80% of carbon removed from the forest in logging operations in West Coast forests was transferred to landfills and the atmosphere within decades.[11] Hudiburg (2019) concludes that state and federal carbon reporting had erroneously excluded some product-related emissions, resulting in a 25-55% underestimation of state total CO_2 emissions from logging.[11] Many of the aforementioned decomposition emissions could be avoided if trees were left standing, especially by protecting carbon stocks from logging of mature and old-growth trees and forests on federal lands.

The detailed NEPA analyses we are calling for would disclose the trade-off and the importance of maintaining the stock value of mature and old-growth trees. The analysis should quantify both the short-term *and* long-term gross and net impacts of logging projects. This will allow agencies to disclose and assess the trade-offs between increasing GHG emissions via logging now—when decreases are most sorely needed—versus alleged increases in storage later. Detailed NEPA analysis would also avoid ignoring short-term carbon losses due to logging based on the erroneous assumption that the residual forest will have significantly reduced potential to have its carbon stores diminished by high-severity fires. Decades of research, however, call these sorts of blanket assertions into question.[56] Moreover, this is not a basis for failing to disclose emissions from the logging itself, especially in comparison to fire. Research shows that emissions from logging greatly exceed those from all natural disturbances combined (fire, insects, windstorms).[57]

Further, the CEQ recently issued Guidance clarifying that agencies must address the emissions and storage impacts of project-specific vegetation removal projects, "such as prescribed burning, timber

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[53] Hudiburg, Tara W., Beverly E. Law, William R. Moomaw, Mark E. Harmon and Jeffrey E. Stenzel (2019) "Meeting GHG reduction targets requires accounting for all forest sector emissions." *Environmental Research Letters* (2019): n.pag. https://doi.org/10.1748-9326/ab28bb

[54] Intergovernmental Panel on Climate Change, AR6 WG1 (2021): Forster, Piers; Storelvmo, Trude (2021) "Chapter 7: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity." See Exhibit 12.

[55] Harmon, M.E., Harmon, J.M., Ferrell, W.K. et al (1996) Modeling carbon stores in Oregon and Washington forest products: 1900–1992. *Climatic Change* 33, 521–550 (1996). https://doi.org/10.1007/BF00141703

[56] DellaSala et. al., 2022.

[57] Harris, N.L. et al (2016) Attribution of net carbon change by disturbance type across forest lands of the conterminous United States. Carbon Balance Manage:11-24 DOI 10.1186/s13021-016-0066-5 and Merrill, M.D. et al (2018) Federal lands greenhouse emissions and sequestration in the United States—Estimates for 2005–14, Scientific Investigations Report. https://doi.org/10.5066/F7KH0MK4. Zald, H.J., and Dunn, C.J. (2018) Severe fire weather and intensive forest management increase fire severity in a multi-ownership landscape. Ecological Applications 28(4):1068-1080 https://doi.org/10.1002/eap.1710

stand improvements, fuel load reductions, and scheduled harvesting."[58] We support this direction. In addition, the Forest Service should also assess emissions from pile burning related to forestry operations, as such actions can intensify carbon release.

The nature of the global warming emergency is based on multiple points of emission sources, with each contributing to the problem cumulatively. Therefore, project level analysis is a critical undertaking and one for which land management agencies now have the tools to quantify the contribution of each federal action, including in cumulative effects analyses.

Given the significant climate impact of logging on federal lands, it is critical that agencies estimate and quantify greenhouse gas emissions associated with each individual logging project and provide annual estimates associated with total logging on federal lands. All agencies should expand their abilities and expectations around accounting for logging emissions as a significant contributor to climate change in tandem with continued progress in fire emissions accounting that more accurately captures actual carbon emissions from forest fires.[59]

Finally, the need to provide detailed carbon accounting was a central feature in a recent U.S. District Court (Montana) decision (*Center for Biological Diversity et al v. U.S. Forest Service*; CV 22-114-M-DWM, where Judge Molloy states:

> Ultimately, "[greenhouse gas] reduction must happen quickly" and removing carbon from forests in the form of logging, even if the trends are going to grow back, will take decades to centuries to re-sequester. FS-038329. Put more simply, logging causes immediate carbon losses, while re-sequestration happens slowly over time, **time that the planet may not have**. FS-020739 (I[t] is recognized that global climate research indicates the world's climate is warming and that most of the observed 20th century increase in global average temperatures is very likely due to increased human-caused greenhouse gas emissions.").
>
> …NEPA requires more than a statement of platitudes, it requires appraisal to the public of the actual impacts of an individual project. …(T)he USFS has the responsibility to give the public an accurate picture of what impacts a project may have, no matter how "infinitesimal" they believe they may be.

We agree and the Forest Service must provide the requisite analysis that acknowledges and addresses the court's opinion. We recognize the Forest Service attempts to address the issue in its analysis and corresponding project file titled "Dry Riverside Forest Carbon Cycling Report" See project file R-29. Yet, the analysis contains the same fatal flaws as those the court noted in the analysis for the Black Ram Project for several reasons:

- The Forest Service asserts that any loss of carbon would be inconsequential when compared to national and global scales: "In summary, this proposed action impacts a relatively small amount of forest land and carbon on the Flathead National Forest and, in the near-term, might contribute a small quantity of change in carbon relative to national and global scales." PF R-29.
- The Forest Service inappropriately tiers to the 2018 Revised Forest Plan analysis to provide the requisite site-specific analysis, thus failing to provide a project-level carbon accounting: "The Flathead National Forest is the most appropriate scale for analyzing carbon cycling,

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[58] CEQ, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, 88 Fed Reg. at 1196.
[59] Harmon, M.E., Hanson, C.T., and DellaSala, D.A. (2022) Combustion of aboveground wood from live trees in megafires, CA, USA. Forests. Forests 13 (3)391; https://doi.org/10.3390/f13030391

> carbon emissions, carbon storage, and their effects." *Id.* To support this approach, the agency cites to the 2016 CEQ guidance, which fails to acknowledge or follow the CEQ's 2023 Interim Guidance.[60]

Further, the Forest Service relies on arbitrary and capricious assumptions as a rationale to forego the requisite detailed analysis NEPA requires. For example, the agency states, "The science used in the Forest Plan EIS remains the most current assessments of carbon pools and influence of disturbance to carbon." PF R-29. As we demonstrate here in our comments, there is a large and growing body of research that the Forest Service must consider as part of its carbon analysis. In addition, these papers refute the agency's assertion that "Projected impacts of fire and insect/disease on forest cover and potential loss of carbon is up to 15 times greater than the projected amount of harvest activity." *Id.* Given the agency did not include a project-specific carbon assessment and that the Forest Service relies on programmatic analysis from the Revised Forest Plan, the project's analysis fails to meet the hard-look threshold expected by the court.

D. Consider the Role of Mycorrhizal Fungi in Maintaining Ecological Integrity

The Forest Service has a long history of conducting soils analysis solely through the lens of timber production and how logging and related activities may contribute to detrimental soil conditions, a trend the agency repeats in its analysis of the Dry Riverside Project. Here the agency identifies specific indicators meant to measure impacts to soil function and long-term soil productivity (where productivity is measured as the ability to grow more trees). This 20th century approach is outdated and fails to recognize the importance of soil biota, particularly soil fungi and mycorrhizae, which is necessary to ensure the ecological integrity of all forest types.

1. General Mycorrhizal Scientific Background

Study after study has revealed that soil biota, particularly fungi that form symbioses with plant roots (mycorrhizae), provide a suite of ecosystem services that support the integrity and resiliency of natural and human communities (Markovchick et al. 2023), especially forests. Mycorrhizae are known to reduce erosion and nutrient loss (e.g. Burri et al. 2013; Mardhiah et al. 2016), increase plant water use efficiency and water retention and cooling capacity in the landscape (Querejeta et al. 2006; Gehring et al. 2017; Wu & Xia 2005), store carbon in the ground (e.g. Orwin et al. 2011; Nautiyal et al. 2019), help plants adapt changes in climate (Gehring et al. 2017; Patterson et al. 2019), and resist pests and pathogens (Reddy et al. 2006; Rinaudo et al. 2010).

Many reports suggest that beneficial native fungi, including native mycorrhizae, are rare and frequently in decline. The Survey and Manage Standards and Guidelines of the Northwest Forest Plan found that 55% of the 234 fungal taxa in the program were found at fewer than 20 locations, and 42% were found at 10 or fewer sites (Molina 2008). For comparison, the Eastern prairie fringed

[60] See 88 Fed Reg. at 1196.

orchid (*Platanthera leucophaea*) is extant in 59 populations and listed as threatened (USFWS 2019), while its relative, the chaparral rein orchid (*Platanthera cooperi*) is found at 162 locations and is considered vulnerable (The Calflora Database 2022).

The decline of mycorrhizal fungi can be more difficult to assess because this category includes fungi that do not form large fruiting bodies above ground, such as with Arbuscular mycorrhizal fungi (AMF). However, many studies report declines in mycorrhizal fungi due to various causes including land use change, invasive species, pollution deposition, and herbicide use (e.g. Meinhardt & Gehring 2012; Swaty et al. 2016; Lilleskov et al. 2019). Climate change also appears to be threatening the type of mycorrhizal fungi known to best support carbon sequestration called ectomycorrhizal fungi (EMF)(Baird & Pope 2021).

In some cases, the dangers facing beneficial fungi mirror those for other species, and the same conservation strategies could benefit fungi (Minter 2011). For example, Clemmensen et al. (2013) found that habitat fragmentation, a common threat to biodiversity, is also a concern for mycorrhizal fungi and conservation mycology. Thus, conservation programs targeting the mitigation of fragmentation could benefit both charismatic taxa and lesser known taxa like mycorrhizal fungi. However, Cameron et al. (2019) documented geographic mismatches between terrestrial aboveground and soil (including mycorrhizal) biodiversity, finding that these mismatches cover 27% of the earth's terrestrial surface. Thus, efforts to protect areas of aboveground biodiversity may not sufficiently reduce threats to soil biodiversity (Cameron et al. 2019).

Even within areas that are protected, disturbances such as logging and thinning (Wiensczyk et al. 2002), the treatment of invasive vegetation with pesticide (Helander et al. 2018), or self-reinforcing soil legacies left after invasion by exotic vegetation (e.g. Meinhardt & Gehring 2012), may quietly continue to reduce beneficial fungi, if these impacts are not recognized and specifically addressed as part of land management planning (Davoodian 2015; May et al. 2018; Willis 2018; Markovchick et al. 2023). These effects are not short-term, and ripple throughout the ecosystem, as evidenced by study after study that shows the need for, and effectiveness of, restoring diverse native mycorrhizal communities after various kinds of disturbance. For example, Pankova et al. (2018) found that a single fungicide application left mycorrhizal inoculum and plant outcomes far from reference levels even after five years.

While much of the science demonstrating the importance of mycorrhizal interactions is recent, the concepts are not new. For example, the Forest Service's own scientists (Harvey et al., 1994) invoked the relationship between chemical properties and biological properties: "Productivity of forest and rangeland soils is based on a combination of diverse physical, chemical and biological properties." In addition, due to its biodiversity, soil, far from being an inert, non-biological substrate, has been called the "poor man's tropical rainforest" (Giller 1996). The soil microbial world is known to be a foundational driver determining the habitat type, health, resiliency, and ecosystem services of natural areas (e.g. Singh & Gupta 2018; Cameron 2010; Wubs et al. 2016; Peay et al. 2016). Over 1,000 scientists and 70 institutions have urged agencies to recognize the broad relevance of the microbial world to sustaining healthy ecosystems and life on earth, and protect and harness this utility in responding to climate change (Cavicchioli et al. 2019). Yet, the USFS continues to ignore microbial communities when considering the tools available to support and enhance forest resilience, and when considering the impacts of their actions.

2. **Mycorrhizal Ecosystem Services**
    a. Forest Service Ecosystem Services Policy & Direction

In 2005, the United Nations issued a report titled, "The Millennium Ecosystem Assessment" that significantly advanced the concepts and definitions of ecosystem services. The report identified four main categories:

- Provisioning Services such as food, clean water, fuel, timber, and other goods;
- Regulating Services such as climate, water, and disease regulation as well as pollination;
- Supporting Services such as soil formation and nutrient cycling; and
- Cultural Services such as educational, aesthetic, and cultural heritage values, recreation, and tourism.

Importantly, the Forest Service adopted these categories and definitions in its 2012 National Forest System Land Management Planning Rule

- (a) Integrated resource management for multiple use. The plan must include plan components, including standards or guidelines, for integrated resource management to provide for ecosystem services and multiple uses in the plan area.

- …Ecosystem services. Benefits people obtain from ecosystems, including:
    - Provisioning services, such as clean air and fresh water, energy, fuel, for- age, fiber, and minerals;
    - Regulating services, such as long term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood control; and disease regulation;
    - Supporting services, such as pollination, seed dispersal, soil formation, and nutrient cycling; and
    - Cultural services, such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

(36 C.F.R. § 219.10, § 219.19)

When defining soil function, the Forest Service internal directives provides the following:

- Soil biology. The presence of roots, fungi, and micro-organisms in the upper sections of the soil.

- Soil hydrology. The ability of the soil to absorb, store, and transmit water, both vertically and horizontally.
- Nutrient cycling. Soil stores, moderates the release of, and cycles nutrients and other elements.
- Carbon storage. The ability of the soil to store carbon.
- Soil stability and support. Soil has a porous structure to allow passage of air and water, withstand erosive forces, and provide a medium for plant roots. Soils also provide anchoring support for human structures and protect archeological treasures.
- Filtering and buffering. Soil acts as a filter to protect the quality of water, air, and other resources. Toxic compounds or excess nutrients can be degraded or otherwise made unavailable to plants and animals.

Forest Service Manual 2550.5 at 8-9. As detailed in the following section, ecosystem services provided by mycorrhizal fungi directly relate to those identified by the Forest Service as important soil functions, and the significant benefits provided by mycorrhizal fungi must be considered in detailed environmental analysis.

b. Scientific Background on Mycorrhizal Ecosystem Services

Ecosystem services are defined as ecological functions and processes that contribute to human wellbeing (Costanza et al. 1997). Available data highlight the many and meaningful contributions of mycorrhizae to ecosystem services and integrity, ranging from drought resilience to pest control to climate stabilization (e.g. Christensen, 1989; Peay et al. 2016).

In the following sections, we include the definitions for each category from Costanza et al. (1997) and briefly review the fungal contributions. In Table 1, we highlight many of these studies and provide examples of some of the magnitudes of effects seen due to mycorrhizae (see effect sizes and percent changes).

Table 1: Some examples of mycorrhizal ecosystem services and effects sizes.

Ecosystem Service Category	Study	Effect Type	% Change[2]	Effect Size[3]
Climate	Clemmensen et al. 2013	carbon storage	50-70%	
Climate	Orwin et al. 2011	carbon storage	14%	
Climate	Nautiyal et al. 2019	carbon storage	82%	
Disturbance regulation	Auge et al. 2015	drought adaptation	111%	0.75
Disturbance regulation	Auge et al. 2015	drought adaptation	49%	0.4

Ecosystem Service Category	Study	Effect Type	% Change[2]	Effect Size[3]
Disturbance regulation	Auge et al. 2015	drought adaptation	24%	0.2
Disturbance regulation	Miozzi et al. 2020	reduction in disease severity	200%	
Disturbance regulation	Ruiz-Lozano & Azcón 1995	support plant growth	938%	2.34
Disturbance regulation	Ruiz-Lozano & Azcón 1995	support plant growth	3542%	3.60
Disturbance regulation	Stella et al. 2017	remove soil toxins	19%	
Disturbance regulation	Stella et al. 2017	remove soil toxins	41%	
Disturbance regulation	Stella et al. 2017	remove soil toxins	51%	
Disturbance regulation	Wulandari et al. 2016	increase plant health & growth at toxic site	125%	0.81
Disturbance regulation	Wulandari et al. 2016	increase plant health & growth at toxic site	200%	1.10
Disturbance regulation (Restoration)	Koziol & Bever 2017	support plant survival	40%	
Disturbance regulation (Restoration)	Koziol & Bever 2017	support plant growt/health	300%	
Disturbance regulation (Restoration)	Koziol & Bever 2017	increased leaves/tillers	200%	
Disturbance regulation (Restoration)	Koziol & Bever 2017	increased species richness	55%	
Disturbance regulation (Restoration)	Koziol & Bever 2027	increased species diversity	70%%	
Disturbance regulation (Restoration)	Maltz & Treseder 2015	support plant growt/health		0.63
Disturbance regulation (Restoration)	Neuenkamp et al. 2019	boost species richness	30%%	
Disturbance regulation (Restoration)	Neuenkamp et al. 2020	boost restoration plant growth		1.70
Disturbance regulation (Restoration)	Rua et al. 2016	support plant growt/health		0.25 to 1.25

Ecosystem Service Category	Study	Effect Type	% Change[2]	Effect Size[3]
Disturbance regulation, Pollination	Botham et al. 2009	support plant growt/health	30%	
Disturbance regulation, Pollination	Botham et al. 2009	support plant growt/health	23%	
Disturbance regulation, Water	Egerton-Warburton et al. 2008	support water uptake/movement	up to 7 μmol/m/hr	
Disturbance regulation, Water	Egerton-Warburton et al. 2008	support water uptake/movement	up to 6.5 μmol/m/hr	
Disturbance regulation, Water	Querejeta et al. 2006	drought adaptation	111%	0.75
Erosion control	Burri et al 2013	reduce erosion & increase soil stability	74%	0.94
Erosion control	Graf and Frei 2013	reduce erosion & increase soil stability	533%	1.85
Erosion control	Mardhiah et al 2016	reduce erosion & increase soil stability	16%	
Erosion control	Rillig et al 2010	reduce erosion & increase soil stability	116%	0.77
Erosion control	Rillig et al 2010	reduce erosion & increase soil stability	18%	0.17
Erosion control	Zheng et al 2014	reduce erosion & increase soil stability	267%	1.30
Erosion control	Zheng et al 2014	reduce erosion & increase soil stability	13%	0.12
Erosion control, Water	Andrade et al 1998	reduce erosion & increase soil stability	14%	0.13
Genetic resources	Ina et al. 2013	medical contributions by EMF	54%	0.43
Genetic resources	Ina et al. 2013	medical contributions by EMF	39%	0.33
Genetic resources	Ina et al. 2013	medical contributions by EMF	10%	
Genetic resources	Zeng et al. 2013	medical contributions by AMF	84-270%	
Habitat & biodiversity	Stevens et al. 2018	ecosystem abundance/diversity from AMF-contributed phosphorus	48%	
Habitat & biodiversity	Tracy & Markovchick 2020	habitat suitability for endangered bird	1.2 hectares	
Habitat & biodiversity	van der Heijden et al. 2015	land plants that rely on native mycorrhizae	86%	
Nutrient cycling	Bonneville et al. 2009	mineral weathering & supply	50-75%	1.61
Nutrient cycling	Quirk et al. 2015	mineral weathering & supply	400%	1.61
Nutrient cycling	Taylor et al. 2012	mineral weathering & supply	100%	0.69

Ecosystem Service Category	Study	Effect Type	% Change[2]	Effect Size[3]
Pest regulation	Abdalla & Abdel-Fattah 2000	pathogen reduction by AMF	80%	
Pest regulation	Babikova et al. 2013	residence time of pest controls	333%	
Pest regulation	Babikova et al. 2013	residence time of pests	186%	
Pest regulation	Karst et al. 2015	tree growth after pests	700%	2.08
Pest regulation	Karst et al. 2015	monoterpene production	500%	1.79
Pest regulation	Reddy et al. 2006	AMF reduction of pathogen	70%	-1.20
Pest regulation	Reddy et al. 2006	AMF reduction of pathogen	75%	-1.39
Pest regulation	Rinaudo et al. 2010	AMF reduction of invasive vegetation	45%	-0.60
Pest regulation	Rinaudo et al. 2010	AMF reduction of invasive vegetation	25%	-0.29
Pest regulation	Waller et al. 2016	AMF reduction of invasive vegetation	29%	-0.34
Pollination	Aguilar-Chama and Guevara 2012	flower mass	100%	0.69
Pollination	Cahill et al. 2008	pollinator visitation rates	193%	1.08
Pollination	Cahill et al. 2008	type of pollinators	shifted pollinator species	
Pollination	Gange and Smith 2005	flower number	63%	0.49
Pollination	Gange and Smith 2005	flower nectar sugar content	55%	0.44
Pollination	Gange and Smith 2005	pollinator visitation rates	33%	0.29
Pollination	Gange and Smith 2005	pollinator visitation rates	200%	1.10
Pollination	Gange and Smith 2005	pollinator visitation rates	100%	0.69
Pollination	Gange and Smith 2005	nectar production	50%	0.41
Pollination	Gange and Smith 2005	nectar production	81%	0.60
Pollination	Lu and Koide 1994	days to flowering	23%	0.26
Pollination	Lu and Koide 1994	flowering duration	76%	0.57
Pollination	Lu and Koide 1994	fruits produced	200%	1.10
Pollination	Lu and Koide 1994	fruits produced	350%	1.50

Ecosystem Service Category	Study	Effect Type	% Change[2]	Effect Size[3]
Pollination	Lu and Koide 1994	fruits produced	20%	0.18
Pollination	Poulton et al. 2001	flowers per plant	113%	0.75
Pollination	Poulton et al. 2001	flowers per plant	90%	0.64
Pollination	Wolfe et al. 2005	pollinator visitation rates	100%	0.69
Pollination	Wolfe et al. 2005	seed set	167%	0.98
Food & Raw materials	Elliot et al. 2020	small mammal diet	80%	
Food & Raw materials	Willis 2018	edible mushroom market	US$42B/yr	
Water	van der Heijden 2010	reduction in nutrient leaching due to AMF	60%	

Table 1 Notes:

1) See Markovchick et al. 2023 Supplement S1 for an expanded list of studies and more detailed explanation. Ecosystem service categories are abbreviated from Costanza et al. 1997, see Markovchick et al. 2023 for details.
2) Absolute value of percent change seen (always an improvement, but sometimes the improvement is an increase, and sometimes it is a decrease, for example in disease severity).
3) Effect size is either the statistic provided in the paper (there are various ways of calculating this and not all mean the same thing, see Sullivan and Feinn (2012) for a summary), or calculated as ln(mycorrhizal mean / control) from the statistics provided in the publication (if no effect size was calculated in the paper). This measure of effect size has the advantage of being directly related to percent change (Pustejovsky 2017), which can be calculated using the following equation: $(e^{\ln(R)} - 1) \times 100\%$. For example, an effect size of 0 indicates a 0% change, 0.5 indicates a 65% change, and 0.75 indicates a 110% change in the mean between treatment and control (Pustejovsky 2017).

i. Disturbance Regulation & Response

This category includes boosting the ability of ecosystems to respond to environmental fluctuations and dampening the influence of disturbances on the integrity of the ecosystem. Mycorrhizas assist in site clean-up, vegetation return, and protection of plants against toxins at polluted sites (e.g. Wulandari et al. 2016). They reduce invasive vegetation (e.g. Rinaudo et al. 2010). Mycorrhizal fungi enhance plant water status, survival, and productivity, including during and after droughts (e.g. Querejeta et al. 2006; Kivlin et al. 2013).

ii. Erosion Control & Sediment Retention

This service category includes retaining soil within an ecosystem. Mycorrhizas increase the stability of soils through entangling soil particles in a "sticky string bag" to form soil aggregates. These aggregates are structured by hyphae and enhanced by stabilizing substances that hyphae secrete, such as glomalin (Rillig & Mummey 2006; Nautiyal et al. 2019). As a result, mycorrhizas play critical roles in stabilizing soil and protecting it from surface water flows (Mardhiah et al. 2016) and wind erosion (Burri et al. 2013).

iii. Food & Raw Materials

This category includes the portion of gross primary production consisting of food and raw materials. In addition to their use to promote crop production (Reddy et al. 2006; Rinaudo et al. 2010), 350 species of mushrooms (many of which are mycorrhizal fungi) are known to be used for food (Willis 2018). Many kinds of fungi, including some that are mycorrhizal, are used to create medicines, enzymes used in industry, and sustainable clothing, packaging, and construction materials (e.g. Bhat, 2000; Willis 2018).

iv. Gas & Climate Regulation

This category includes regulating the chemical composition of the atmosphere, global temperature, and other climatic processes mediated by organisms. Clemmensen et al. (2013) found that a majority of boreal forest soil-stored carbon is in roots and root-associated microorganisms (including mycorrhizal fungi). Orwin et al. (2011) found that improved plant nutrient access due to mycorrhizal symbioses increased carbon sequestration. Fungal hyphae also produce exudates that promote the formation of soil aggregates, stabilizing soil and supporting continued carbon sequestration in the soil (e.g. Nautiyal et al. 2019). Mycorrhizas compete with saprotrophs (decomposers) for soil nutrients, reducing decomposition (decomposition releases carbon) and increasing soil carbon storage (Read & Perez-Moreno 2003; Fernandez & Kennedy 2016).

v. Genetic Resources

This category includes unique biological materials and products, and their sources. An enormous variety of medical compounds are derived from or produced by fungi (see Markovchick et al. Supplement S1). Mycorrhizal symbioses improve plant nutrition and enhance the active ingredients of medicinal plants (Zeng et al. 2013). The effects of fungal genetics likely cascade through ecosystems. For example, ectomycorrhizal fungi are linked via plant genetics to insects, lichens, pathogens, endophytes, and soil decomposing fungi and bacteria (Lamit et al. 2015). Given the role of fungi as foundational taxa that help to structure ecosystems (e.g. Tedersoo et al. 2014), their genetic diversity may be crucial to conserving and supporting the genetic diversity at other community levels and stabilizing our ecosystems (e.g. Hazard et al. 2017).

vi. Habitat & Biodiversity

This category includes habitat for resident and migratory populations, a refuge for species and biodiversity. Nearly all plants depend on the presence of mycorrhizal fungi (van der Heijden et al. 2015). Fungal contributions to plant nutrition and performance cascade through ecosystems, influencing habitat quality and resource quantity for most terrestrial species. One recent modeling effort suggests that the biomass of organisms in the Serengeti would be reduced by half without just the phosphorus provided by arbuscular mycorrhizal fungi (Stevens et al. 2018). Another preliminary, smaller-scale model indicated that simply including appropriate mycorrhizal inoculation in restoration efforts could increase the useable habitat for an endangered bird from 0 to 1.2 hectares six years after restoration (Tracy & Markovchick 2020), see Exhibit 13.[61]

vii. Nutrient Cycling & Soil Formation

This service category includes the processes involved in forming, cycling, storing, and processing soil and nutrients. With complex enzymatic capabilities that allow them to access nutrients bound in recalcitrant forms, mycorrhizal fungi can forage for nutrients and mine them (e.g. Fernandez & Kennedy 2016). They may also indirectly facilitate decomposition by free-living soil microbes as they forage for nutrients in soil organic matter (e.g. Talbot et al. 2008). Mycorrhizal fungi also structure soils and reduce nutrient losses (Rillig & Mummey 2006; Parihar et al. 2019), permitting retention of nutrients necessary to build fertile soils (van der Heijden 2010).

viii. Pest & Insect Regulation

This category includes regulation of populations, such as insect pests, invasive vegetation, and disease. Mycorrhizas and endophytes play key roles in this area. For example, Karst et al. (2015) found that mycorrhizas increase monoterpene production, a key chemical defense against herbivory. Mycorrhizal fungi also reduce viral symptoms, disease and invasive vegetation (e.g. Miozzi et al. 2020; Reddy et al. 2006; Rinaudo et al. 2010). Mycorrhizal fungi also appear to share pest warning signals through underground networks, permitting a coordinated call that attracts insects that control plant pests (e.g. attracting parasitoids that reduces aphids in Babikova et al. 2013).

ix. Pollination

This category is defined as moving and assisting floral reproduction. Our knowledge of fungal impacts on plant-pollinator interactions remains limited, and largely focused on arbuscular mycorrhizal fungi (Barber & Gorden 2015). However, these mycorrhizas can increase average flower number, flower mass, pollen tube length, seed production, nectar production and sugar content, pollinator visitation rates, and the number of fruits produced per plant (Aguilar-Chama and Guevara, 2012; Cahill et al. 2008; Gange & Smith 2005; Lu & Koide 1994; Poulton et al. 2001; Wolfe et al. 2005). Mycorrhizas could also assist plant reproduction under climate change in two ways: 1)

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[61] Tracy J, Markovchick L (2020) Using mycorrhizal fungi in restoration to improve habitat suitability for an endangered bird. RiversEdge West Riparian Restoration Conference; February 4-6; Grand Junction, Colorado, United States

they can decrease time to initial flowering and increase flowering duration, reducing potential mismatches between flowering and pollinator activity (Barber & Gordon 2015; Lu & Koide 1994), and 2) they can encourage clonal growth, which could assist plant survival if pollination is reduced or impossible (Botham et al. 2009).

x. Water Quality & Supply

This combined service category includes the regulation, retention, and cleansing of water. Mycorrhizas enhance nutrient retention in vegetation, mycelium and soils - decreasing leaching that negatively affects water quality (van der Heijden 2010). Mycorrhizal mycelia aggregate soil particles, improving soil porosity, and enhancing water infiltration and moisture retention (e.g. Augé et al. 2001; Rillig & Mummey 2006). They mediate hydrological functioning by modulating surface soil-to-water attraction and repellency (e.g. Rillig et al. 2010; Zheng et al. 2014). Mycorrhizal hyphae infiltrate bedrock and tiny soil pores to access water, and contribute to the soil-plant-atmospheric-continuum of water dynamics and nocturnal hydraulic lift of water to upper soil layers (Allen, 2009; Bornyasz et al. 2005; Querejeta et al. 2007).

A Special Note on Common mycorrhizal networks

Although the exact function of common mycorrhizal networks (the roots of separate plants linked by a network of fungal strands) is challenging to ascertain under field conditions, even critics recognize their existence in the field and demonstrated functions under controlled conditions (e.g. Karst et al. 2023). For example, these underground networks are known to share resources between trees, shrubs, and other understory plants in the field, with some plants known as mycoheterotrophs being entirely dependent on this setup (e.g. Karst et al. 2023; Selosse et al. 2006). Under laboratory conditions, the use of autoradiography, dye tracers, and air gap treatments provide convincing evidence that resources are shared via the connections between plants provided by mycorrhizal fungi, including carbon (e.g. Finlay et al. 1986; Brownlee et al. 1983; Wu et al. 2001), phosphorus (e.g. Finlay 1989), water (e.g. Warren et al. 2008; Plamboeck et al. 2007; Egerton-Warburton et al. 2007), and defense signals (Babikova et al. 2013). This ability to spread resources (Peay et al. 2016) in the field would reduce risk and increase the inherent stability of ecosystems the way that financial portfolios reduce the risk of investing (Schindler et al. 2015).

While trees communicate chemically all the time through the volatile organic chemicals they produce wafting through the air, research indicating communications and resources are shared through soil, root systems, and common mycorrhizal networks (e.g. Babikova et al. 2013; Bingham & Simard 2011; Simard et al. 2015) poses special new questions for the land and natural resources communities, due to the ability of land management actions to impact the soil community. If the ability of trees to communally send stronger insect control signals or share resources in times of need is impacted by current tree density reduction practices, as suggested by the scientific literature referenced herein, then the government would be liable for ignoring this large body of science, and the impact of its actions. Even the critics of the available current technologies acknowledge that given what we know about plant and fungal biology, these underground linkages, "should be common" (Karst et al. 2023), and the indications of the science are clear - this issue is not constrained to one or a few environments or biomes.

3. **To comply with NEPA, the Forest Service must consider soil function, mycorrhizal interactions and impacts to mycorrhizal assisted ecosystem services in a detailed environmental analysis.**

Many kinds of activities and disturbance can harm soil biota, including mycorrhizal fungi. Examples of impacts include the changes to microclimates and soil compaction caused by logging and thinning activities, the application of herbicides and pesticides, pollution deposition, and the presence of, and soil legacy left behind by, non-native vegetation (Wiensczyk et al. 2002; Hartmann et al. 2014; Meinhardt & Gehring 2012; Koziol & Bever 2017; Helander et al. 2018). Appropriately protecting and restoring native mycorrhizal diversity and abundance offers a crucial tool to support forest resiliency. Conversely, when mycorrhizae are not protected from these effects, or are not appropriately restored, this can negatively impact forest regeneration and resiliency for many years. Unfortunately, soil biota like mycorrhizal fungi are frequently ignored in forest planning and projects, despite Forest Service policies requiring their protection (Markovchick et al. 2023), and a regulatory and legal framework requiring their consideration and mitigation of impacts to them.

The Forest Service may not ignore topics if the information is uncertain or unknown. Where information is lacking or uncertain, the Forest Service must make clear that the information is lacking, the relevance of the information to the evaluation of foreseeable significant adverse effects, summarize the existing science, and provide its own evaluation based on theoretical approaches. As such, the Forest Service has a mandatory duty to analyze the direct, indirect and cumulative impacts of the proposed action on soil function, mycorrhizal interactions and impacts to mycorrhizal related ecosystem services in a detailed environmental analysis.

a. Failure to adequately assess and disclose direct, indirect, and cumulative impacts, including detailed, site-specific information

The Forest Service must analyze the direct, indirect, and cumulative impacts of a proposed action. Colo. Envtl. Coal. v. Dombeck, 185 F.3d 1162, 1176 (10th Cir. 1999); see also 40 C.F.R. § 1508.25(c) (1978) (when determining the scope of an EIS, agencies "shall consider" direct, indirect, and cumulative impacts). Cumulative impacts are "the impact[s] on the environment which result[] from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." 40 C.F.R. § 1508.7 (1978). Forest Service regulations define reasonably foreseeable future actions as "[t]hose Federal or non-Federal activities not yet undertaken, for which there are existing decisions, funding, or identified proposals." 36 C.F.R. § 220.3.

Further, site-specific analysis is crucial to NEPA's goal of ensuring informed and science-based decision-making. The Forest Service must provide sufficient information for the public to understand the scope of the proposed activities. In order to fully comply with NEPA, the Forest Service must adequately assess and disclose impacts of the proposed action on soils, and particularly mycorrhizae, including impacts from forest road construction, vegetative management actions such as commercial harvest, non-commercial thinning, controlled burning and related actions (i.e. fireline construction). Such disclosure must address each of the mycorrhizal ecosystem services we describe above and the potential impacts to common mycorrhizal networks, ***unless the agency can demonstrate their absence in the project area.***

b. Inappropriate reliance on soil design features

The Forest Service cannot rely on best management practices, design features or resource protection measures as a rationale for omitting proper analysis. Yet, the agency makes numerous references to those rather than properly disclose potential environmental consequences under the action alternative(s) in violation of NEPA. The agency repeats this error by providing eight soil specific design features, all of which fail to address the need to preserve soil biota, including mycorrhizae. Even if such practices or measures have a demonstrated history of success, the agency cannot assume they will be implemented correctly 100 percent of the time, or that they will be 100 percent effective. As such, the Forest Service must disclose the environmental impacts of each action alternative without assuming 100 percent BMP efficacy, either by providing the worst-case scenario or a range of effectiveness.

Further, existing BMPs for this project are inadequate for many reasons. First, the analysis, and the resulting BMPs do not directly consider soil biota or mycorrhizal fungi. As a result, none of the above the canopy gap and understory plant needs, soil compaction impacts, or non-native plant impacts on mycorrhizal communities are considered, and project BMPs fail to provide measures to protect and restore mycorrhizal fungi. For example, the effects of actions on the mycorrhizal community are not considered at all, and there is no provision for their restoration, or protection via crafting thinning designs that allow their full diversity, crucial to maintaining the full range of ecosystem services in national forests, to persist.

Additionally, existing BMPs actually provide measures such as leaving the most vigorous looking trees, which directly contradict existing scientific literature on the need to preserve tree diversity, and as a result, fungal diversity and the ecosystem's ability to respond to, and be resilient in the face of, different kinds of stressors. For example, Gehring et al. (2017) and Patterson et al. (2019) provide evidence that Pinyon trees (*Pinus edulis*) in the southwestern United States contain a genetic and stress-resilience diversity related to, or partially determined by, their mycorrhizal affiliations. Based on this evidence, if only the most vigorous-looking trees were left (moth tolerant), the drought tolerant trees (and their mycorrhizal community which helps confer drought tolerance) would be selected for harvesting and thinning. This would result in a forest that appears vigorous because it is more resistant to moth herbivory, until a drought occurs, and then it would experience much higher mortality than a forest where this uninformed selective management had taken place.

c. Failure to adhere to applicable directives per the Forest Service Manual

The Forest Service Manual (FSM) includes a specific objective that "Ecosystems are ecologically or functionally restored so that over the long term they are resilient and can be managed for multiple use and provide ecosystem services, including but not limited to carbon storage and sequestration." (FSM 2020.2). Further, the manual directs that "Responsible soil stewardship [promotes and sustains], biological and hydrologic function, [and that], chemical, physical, and biological soil properties [will all be used to] assess existing soil condition for watershed condition and ecological assessments." (FSM 2550.3). Yet, a main driver of restoration, resiliency, and ecosystem services including hydraulic lift and water infiltration, retention, and efficient use by vegetation - mycorrhizal fungi - are nowhere to be found in the forest plan or project. In fact, no biological aspects of the soil appear to be monitored.

In addition, the manual defines biological properties that support "the productive capacity of the land, its ecological processes, such as hydrological function of watersheds, and… ecosystem services" as part of desired soil conditions. (FSM 2550.5). This in fact seems to specifically point to soil biota such as mycorrhizal fungi as something to be monitored and supported.

The Forest Service also directs the following: "Use adaptive management (FSM 1905) to design and implement land management activities in a manner that achieves desired soil conditions and objectives….," monitor soil conditions and trends to ensure that soil and water conservation practices are implemented and effective…, [and] "Determine how changes in soil properties will affect desired soil conditions and objectives related to ecosystem function." (FSM 2551.03). Yet, it is unclear how the agency could possibly meet this direction without monitoring, protection and restoration of mycorrhizal fungi, given the extensive evidence of the roles they play in ensuring ecosystem services, productivity, and unimpaired future functioning of the land in all the ways laid out in the Forest Service Manual. In fact, the manual section on monitoring calls for monitoring sufficient "to determine the soil condition and the cause and effect relationships associated with those conditions…." [and] "Use soil quality monitoring to validate and refine management decisions." (FSM 2551.13) The information collected allows land managers "to determine if land management plan desired conditions are being achieved." *Id.* This section clearly states, "The major objective of soil quality monitoring is to ensure that ecologically sustainable soil management practices are being applied…. " [and] "Monitoring is conducted to detect changes in physical, chemical, or biological soil properties caused by management activities." *Id.* Since no monitoring of mycorrhizal fungi occurs, much less monitoring sufficient to determine how management actions are impacting this part of the ecosystem, clearly the intent of the manual is not being carried out.

The manual also states that "current science and key soil functions and attributes/indicators/soil properties representing those functions" should be considered in developing land management monitoring, standards and guidelines. (FSM 2551.3). Despite this, at least one entire Kingdom which helps to determine soil functioning, and enormous scientific evidence demonstrating the key soil functions that mycorrhizal fungi in particular contribute appears to be entirely ignored.

"The focus of forest plan monitoring is to gauge the progress toward achieving or maintaining the desired conditions and objectives." (FSM 2551.61). When these desired conditions and objectives, as set forward by the FSM, clearly include key biological players in soil function such as mycorrhizal fungi, how can they be resoundingly ignored?

Not only does the FSM clearly state in all the passages above, that key soil biology such as mycorrhizal fungi should be the focus of desired conditions, standards and guidelines, and monitoring. The section of the FSM that deals with invasive vegetation also makes it clear that these key players must be monitored, protected, and restored. The manual also clearly states that objective must be to;

> limit the adverse effects of those infestations on native species, human health, and other National Forest System resources [and] implement restoration, rehabilitation, and/or revegetation activities following invasive species treatments to prevent or reduce the likelihood of the reoccurrence or spread of aquatic or terrestrial invasive species.

(FSM 2902). Based on the overwhelming scientific evidence, this simply cannot be achieved without restoring diverse communities of native mycorrhizal fungi appropriately paired to site conditions and planting materials after most invasions by exotic vegetation.

In fact, the Forest Service clearly acknowledges that integrated pest management requires "an ecologically-based holistic strategy that relies on natural mortality factors, such as natural enemies, weather, and environmental management, and seeks control tactics that disrupt these factors as little as possible [specifically including] biological…techniques." (FSM 2902). Based on an overwhelming amount of the best available scientific information, mycorrhizal fungi are key to both managing invasive vegetation, and restoring full function and diversity after invasions. Yet, again, they appear nowhere in this project or forest plan.

In sum, the Dry Riverside Project fails to demonstrate adherence with the Forest Services' own directives, which it must address in a detailed environmental analysis. In addition, such analysis is necessary to demonstrate how the current Forest Plan provides for ecological sustainability of soils and native mycorrhizal fungi. As it stands, the 2018 Revised Plan lacks any direction specific to protecting, restoring or maintaining soil biota, specifically mycorrhizae.

IV. The Forest Service fails to demonstrate compliance with the ESA.

The Forest Service has an independent duty to demonstrate this project complies with the Endangered Species Act (ESA) by ensuring the project will not jeopardize the continued existence of listed species. This determination must be based on the best scientific and commercially available data. The Forest Service fails to make that demonstration here, especially as it relates to grizzly bears. Specifically, the agency continues to rely on maintaining 2011 baseline conditions that the federal district court soundly rejected. See *WildEarth Guardians v. Steele,* (D. Mont. June 24, 2021) at 34-35 ("The mere fact that the population was increasing from 2004-2011 does not justify moving away from the existing management requirements of Amendment 19"). At the heart of this ESA violation is the Forest Service's continued reliance on making road impassable instead of decommissioning and removing them from the ground. As the Swan View Coalition explains in its comments, "The Flathead is adding more miles to its road System as "impassable" by not counting them in calculations of TMRD, even though they will continue to function as roads – thus increasing the number of roads and the number of ineffective road closures over what was included in the 2011 baseline." The Forest Service relies on a revised biological opinion for the 2018 Revised Forest Plan that the US Fish & Wildlife Service issued to replace the one the court found to be flawed. But that revised biological opinion suffers the same fundamental flaws the court rejected, and thus it continues to violate the ESA, and therefore the Dry Riverside Project cannot continue to adopt the same flawed management direction rejected by the court.

Conclusion

The Forest Service must address the fundamental flaws we describe in these comments regarding the lack of analysis; proposing a flawed and limited purpose and need; a failure to protect mature trees and maximize the project area's carbon storage ability; the need to protect and restore soil biota, specifically mycorrhizae, and ultimately abandon its actions to expand the road system to the detriment of grizzly bear recovery.

Cordially,

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Exhibits

1. Powell, Hugh. Old Flames: The Tangled History of Forest Fires, Wildlife, and People. Living Bird, Summer 2019

2. Despite What the Logging Industry Says, Cutting Down Trees Isn't Stopping Catastrophic Wildfires. ProPublica, December 2020; Colorado's Troublesome megafire. Mountain Town News, November 2, 2020
3. Missoula Current. 2022. Part 1 & Part 2: Scientists, Missoula County shift wildfire focus to home ignition zone.; Missoulian. Aug. 2020. DAVE STROHMAIER and JACK COHEN Guest Column: Community destruction during extreme wildfires is a home ignition problem.
4. Environmental Consequences of Forest Roads - WildEarth Guardians - March 2020
5. A Dilapidated Web of Roads - The USFS's Departure From a Sustainable Forest Road System_Jan 2021_WildEarth Guardians
6. LANDFIRE Biophysical Settings Attribute Data Dictionary
7. Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management (MOG Report).
8. IUCN (2022). IUCN 2021 annual report. Gland, Switzerland: IUCN.
9. Article 38 of the UNFCCC COP26 Glasgow Climate Pact
10. B. Law et al., 2020 The Status of Science on Forest Carbon Management to Mitigate Climate Change.
11. White paper - "The Critical Importance of Mature & Old Trees for Climate Resilience."
12. Intergovernmental Panel on Climate Change, AR6 WG1 (2021): Forster, Piers; Storelvmo, Trude (2021). "Chapter 7: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity."
13. Tracy J, Markovchick L (2020) Using mycorrhizal fungi in restoration to improve habitat suitability for an endangered bird. RiversEdge West Riparian Restoration Conference; February 4-6; Grand Junction, Colorado, United States

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