COMMENTS ON NOTICE OF INTENT (NOI) TO AMEND REGION 5 AND 6 FOREST PLANS UNDER THE NORTHWEST FOREST PLAN (88 FR 87393)[1]

[2]PREPARED BY DRS DOMINICK A. DELLA SALA (WILD HERITAGE), WILLIAM BAKER (EMERITUS PROFESSOR), CHAD HANSON (JOHN MUIR PROJECT), AND BRYANT BAKER (SPATIAL ANALYST, LOS PADRES FORESTWATCH)

Submitted by Wild Heritage, February 2 2024

We submit these detailed scoping comments regarding the NOI to amend the Northwest Forest Plan (NWFP). Please note hyperlinks to the published materials cited in our comments as the best available science are provided for 115 pdfs submitted along with these detailed comments to the public record. Some publications have paywall restrictions and only the abstracts were linked as noted. Our comments focus mainly on the following:

(1) The unique ecosystem and carbon benefits from restrictions on logging under the NWFP, a global model in ecosystem management and biodiversity conservation.
(2) Best available science supports the **expansion of the reserve network** to comply with the 2012 planning rule emphasis on science and ecosystem integrity and ensure all remaining mature and old-growth forests (MOG) are included in the reserve network.
(3) Mixed-severity fires and other natural disturbances are key ecosystem processes that maintain the ecological integrity of forest ecosystems. They should not be grouped together as “threats” with timber harvest given they yield completely different disturbance outcomes, successional trajectories, and impacts to biodiversity and carbon sequestration and storage. We note that the Forest Service has not provided sufficient time for the public to analyze its related threat analysis “Introductory Report” that was released at roughly the same time comments were due on the NWFP and national Old Growth Amendment. All of this has flooded the comment period with intersecting timelines and not enough time to analyze MOG loss vs recruitment rates for example. Moreover, to analyze whether natural disturbances are affecting MOG recruitment into the reserves requires GIS raster files on the agencies’ old-growth mapping (historic vs. contemporary) and recruitment data from monitoring that has not been provided despite our prior requests.

---

[1] Submitted via: https://cara.fs2c.usda.gov/Public//CommentInput?Project=64745

[2] Given restrictions on the number and size of files via the Forest Service comment portal, we request that you include in the public record all the links to publications cited herein. In a related submission of our comments on the Northwest Forest Plan amendment, we received this email on January 25, 2024 regarding pdf links in comments: *“Schlichting, Dean - FS, OR: Good morning, I did get some additional guidance on this; links are fine as long as they are not to personal data servers. Public websites only.”* We note that the Forest Service technically cannot post pdfs on its comments server without violating copyright laws with the journals that own the rights to the publications and therefore we submit the links to the pdfs as the only means for supplying the necessary source materials given file size restrictions in your portal, copyright issues, and limitations of splitting our comments into separate submissions to clear the file size problem.

(4) We request development and analysis of a conservation alternative that builds on the NWFP by: (a) additions to the reserve network; (b) compliance with the President's Executive Order (EO 14008) on protecting 30% of the nation's lands and waters by 2030 (i.e. 30 x 30); (c) the Paris Climate Agreement emphasis on maintaining carbon sinks and reservoirs; (d) the Glasgow Forest Pledge (signed by President Biden) to end deforestation and forest **degradation;** and (e) the Presidential Executive Order 14072 on conservation of mature and old-growth (MOG) forests (see below).

We note that the following "active management" approaches are but a sample of the **numerous threats to MOG and other NWFP ecosystems that cumulatively degrade integrity** (we request you acknowledge them in the plan revision):

- Post-disturbance "salvage" and clearcut logging.
- Thinning and selective removal of large (>20 in dbh) trees; thinning that dries out understories, increases wind penetration within stands, and facilitates the spread of invasive species; thinning that type converts closed canopy forests to "park-like" open savannahs; thinning in spotted owl habitat.
- Pile burning that damages soil horizons and mycorrhizae connectivity, thereby facilitating weed invasions.
- All forms of logging/thinning for biomass utilization.
- All forms of road building (temporary or permanent).
- ORVs, mining, and livestock grazing.

All of these threats are typical within the NWFP area, often on the same sites, leading to cumulative degradation of forest ecosystems, loss of integrity, and greatly compromised resilience to climate change. They are much more consequential to forest ecosystems than natural disturbances even as rates of logging have declined on federal lands under the NWFP. Historical and current logging, particularly on nonfederal lands, continues to delay ecosystem recovery rates that depart from the 100-year timeline of the NWFP. Eliminating these threats within MOG is the only actual threat abatement that can be effectively and quickly accomplished. This is because of limitations regarding the agencies' ability to mitigate natural disturbance processes that are beyond your control, especially through use of management activities that are damaging to ecosystem processes, as noted.

A CONSERVATION ALTERNATIVE IS NEEDED TO PROHIBIT LOGGING AND RELATED IMPACTS WITHIN MOG BY BUILDING ON THE NWFP RESERVES

While the NOI cites both Executive Orders (EO) 14008 ("Tackling the Climate Crisis at Home and Abroad" - i.e., 30 x 30) and 14072 ("Strengthening the Nation's forests, communities, and local Economies"- i.e., the national MOG inventory for "conservation purposes"), it is unclear how the Forest Service will implement these two directives within the purpose and need of the NWFP revision. Therefore, we request that the agency **develop and analyze a conservation alternative** that builds on at least the following core issues.

(1) Protect from **logging and related threats (described above) all remaining mature and old-growth forests** (e.g., Old Growth Structure Index [OGSI] OGSI ≥ 80 and OGSI ≥200, herein referred to as MOG collectively) on all federal designations to better comply with EO 14008 (30 x 30). This should include a GAP status analysis of MOG in terms of what actually is protected using GAP status codes 1 and 2 to define protection and with respect to the representation of MOG within and outside protected areas. The conservation alternative should include what the Forest Service and Biden administration can do to elevate protection status to contribute to 30 x 30 targets (e.g. conferring GAP 1 and 2 level protections to additional areas). Importantly, while Late-Successional Reserves (LSRs) and Inventoried Roadless Areas (IRAs) offer some protections, they do not count as GAP 1 or 2 (or International Union for Conservation of Nature [IUCN] protection equivalents), as the international standard in protection is not met for these types. However, IRAs and LSRs without any logging of trees ≥80 years old may be coded as GAP 2.5 if they are at least as protective as the roadless conservation rule (DellaSala et al. 2022a, DellaSala et al. 2023). Prohibiting the logging of trees ≥80 years old should carry through all plan revisions and all reserve designations be they in wet or dry forests.

(2) Prioritize fire-risk reduction to treatments nearest homes (see Cohen 2000, Schoennagel et al. 2017, Calkin et al. 2023, Law et al. 2023) and in flammable young tree plantations (see Bradley et al. 2016, Zald and Dunn 2018 for high flammability of plantations) where fire risks are highest. MOG should be the lowest priority for mechanical treatments ("thinning") given these areas function as fire and climate refugia and tend to burn in lower fire severities (see Lesmeister et al. 2019, Lesmeister 2021 for spotted owl habitat as fire refugia).

(3) The focus of MOG treatments should be on prescribed and cultural burning practices (not pile burning, which is damaging to soils and below-ground processes and typically follows logging activities that are unnecessary or counterproductive in MOG). Removing large trees is not necessary prior to conducting prescribed or cultural burning, which can be introduced under low fire weather to minimize escaped fires (Knapp et al. 2005, Knapp et al. 2006, Knapp et al. 2007 [only the abstract is available online given paywall restrictions, though the paper was co-authored by Forest Service researchers and should therefore be easily available to you] van Mantagem et al. 2011, van Mantagem et al. 2016).

(4) Increase natural wildland fire use for ecosystem benefits under safe conditions (cross reference to wildfire use comments submitted by Dr. Tim Ingalsbee of FUSEE), which should include closing and obliterating roads to reduce unwanted ignitions for stepped-up transportation planning as the most effective ignition risk reduction (see Balch et al. 2017 for highest fire risks closest to populated areas).

(5) Expand the restoration objectives of the Aquatic Conservation Strategy (ACS, watershed analysis) by: (a) increasing road closures and road obliteration and continuing restrictions on logging out to at least two-tree heights in Riparian Reserves; (b) designating beavers as a keystone species of conservation concern for water storage, flood abatement, and riparian restoration; (c) removing livestock near streams, springs, wetlands, and seeps; (d) expanding culvert repair and culvert enlargement for flood abatement; and (e) prohibiting post-disturbance "salvage"

logging. Logging needs to be reduced at watershed scales—not just within riparian buffers. A central focus of the ACS in revision should be to build on the gains noted in ACS monitoring reports via reduction of logging levels (e.g., riparian functionality, water quality and watershed integrity all have improved because of reduced logging and road removal). Mass wasting events, fire intensities, and ambient temperatures all increase with logging and road building, and this should be acknowledged and properly mitigated,[3] along with restrictions on livestock grazing, as the top threats to aquatic systems.

(6) Analyze and reduce cumulative impacts from wildfire suppression (DellaSala et al. 2022b), mining, livestock grazing (Beschta et al. 2012, Kauffman et al. 2022), ORVs, biomass utilization, energy development

(7) Reject any proposal to use the national forests as repositories for pumping carbon underground.

(8) Continue and build on the "survey and manage" program by ensuring updated monitoring of rare species status and incorporation of their habitat within the reserve network.

Overall, we anticipate that the conservation alternative would have far lower cumulative impacts than all other alternatives that emphasize intensive "active management" that otherwise lead to forest degradation (damaged integrity) as noted. In this context, natural disturbances are not treated as a "threat" but rather are essential to ecosystem integrity. Working with wildland fire for ecosystem benefits under safe conditions (cross reference to FUSEE), along with prescribed and cultural burning, are emphasized. Any thinning in MOG areas should not be based on economically valued tree removals as this incentivizes forest

---

[3] PNW old-growth forests maintain water balance in forested watersheds. Jjang et al. 2019 https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/ecs2.2692. Also see Perry and Jones 2016: Analysis of 60-year records of daily streamflow from eight paired-basin experiments in the Pacific Northwest (Oregon) revealed conversion of old-growth to Douglas-fir plantations had a major effect on summer streamflow (abstract only due to paywall restriction - https://onlinelibrary.wiley.com/doi/10.1002/eco.1790). Average daily streamflow in summer (July through September) in basins with 34- to 43-year-old plantations of Douglas-fir was 50% lower than streamflow from reference basins with 150- to 500-year-old forests. Young Douglas-fir trees, which have higher sapwood area, higher sapflow per unit of sapwood area, higher concentration of leaf area in the upper canopy, and less ability to limit transpiration, appear to have higher rates of evapotranspiration than old trees of conifer species, especially during dry summers. Reduced summer streamflow in headwater basins with forest plantations may limit aquatic habitat and exacerbate stream warming, and it may also alter water yield and timing in much larger basins. https://onlinelibrary.wiley.com/doi/abs/10.1002/eco.1790 (abstract only due to paywall). Also see Frissell in Williams et al. 1997. In general, uncut watersheds with older forests are more functional and with higher levels of biodiversity. https://fisheries.org/bookstore/all-titles/professional-and-trade/x55024xm/ (paywall restricted). Also see Ham 1982. Net precipitation under old growth Douglas-fir in the Bull Run Municipal Watershed (Portland, Oregon) totaled 1739 mm during a 4-week period, 387 mm more than in adjacent clearcut areas. Expressing data on a full water year basis and adjusting gross precipitation for losses due to rainfall interception suggest fog drip could have added 882 mm (35 in) of water to total precipitation during a year when precipitation measured 2160 mm in a rain gage in a nearby clearing. Standard rain gages installed in open areas where fog is common may be collecting up to 30 percent less precipitation than would be collected in the forest. Long term forest management (Le., timber harvest) in the watershed could reduce annual water yield and, more importantly, summer stream flow by reducing fog drip. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1752-1688.1982.tb00073.x (paywall restricted).

degradation. Even removal of small trees needs to avoid heavy soil-damaging equipment and must leave intact representative native understories (e.g., stops and gaps in thinning) to prevent excessive drying. Alternatively, killing some large fire intolerant firs, rather than removing them offsite, can be used to create more structure in both forests and aquatic systems and are not a fire threat given the needles drop within 1-3 years following mortality and felling trees to create logs are an important source of moist microclimates for soils, mycorrhizae, invertebrates, terrestrial mollusks, and salamanders (many of which are "survey and manage species" and rare endemics especially in the Klamaths).

FOREST SERVICE TREATMENT OF THREATS UNDERSTATES LOGGING AND OVERSTATES NATURAL DISTURBANCES

For all NWFP alternatives, we request that the Forest Service take a **"hard look"** at direct, indirect, and cumulative impacts of anthropogenic disturbances, including within the surroundings at three NWFP time intervals: before the plan, during the plan, and projected out to the plan's 100-year timeline from 1994.

We also call your attention to science that contradicts many of the assertions in the NOI about natural disturbances as "*threats*" (see Appendix A on what constitutes a threat). Historical logging leading up to the NWFP is the **only** threat and reason for why MOG were nearly liquidated by logging prior to the NWFP and why very little remains on nonfederal lands where logging levels are highest (DellaSala et al. 2022a). Importantly, MOG remains largely scattered on certain federal lands across the NWFP area maintained by LSRs (DellaSala et al. 2015a). The federal MOG distribution is uniquely important as climate refugia (Lesmeister et al. 2019, 2021) and carbon sinks (DellaSala et al. 2015b). We request that you acknowledge your unique role in protecting and stewarding what's left of the region's most biodiverse, carbon dense MOG forests and how forest degradation (the main threat) is a consequence of decades of logging and road building, even as those rates have declined on federal lands because of the NWFP. Every acre of MOG is irreplaceably important to the resilience and recovery of the entire ecosystem (i.e., context and importance of the federal lands are magnified by high rates of logging in the surroundings and needs to be part of the cumulative effects analysis).

Wildfire dynamics and epizootic outbreaks are part of the natural ecosystem dynamics, and MOG are uniquely adapted to them. Natural disturbances produce a critical pulse of biological legacies associated with biodiverse and underappreciated complex early seral forests (Swanson et al. 2011, DellaSala et al. 2014). This natural process jump starts the trajectory of pioneering stages toward MOG over time via interconnected seral stages (Donato et al. 2012). The Forest Service has not unequivocally established that natural disturbances are currently or soon to be overriding recovery objectives of MOG within the NWFP area. In fact, we present evidence that wildfire and beetle-drought severities are not increasing (Baker et al. 2023a) (see below regarding high severity fire), and we request that the Forest Service conduct a statistically robust analysis of MOG recruitment vs loss over extended periods of monitoring, including confidence intervals around any observed trends.

To do otherwise, is not statistically valid nor best available science. Visual graphs are not statistically valid—or evidence based—in themselves.

We also request that you acknowledge the clear distinction between natural disturbances and logging in terms of carbon storage, carbon sequestration, and carbon flux (especially gross emissions from logging) that are mostly maintained by natural disturbances but removed by logging. The pulse of biological legacies—particularly large live and dead trees, below-ground processes, seed banks, mycorrhizal relations—are uniquely created by severe wildfires but removed by logging. Severe disturbances uniquely produce complex early seral forests (Swanson et al. 2011, DellaSala et al. 2014) that are as biodiverse as MOG and are interconnected successionally; logging disrupts this connection.

We cannot overstate that fact that while rates of logging have declined precipitously on federal lands due to the NWFP, that does not mean the ecosystem has recovered from expansive **forest degradation** that eliminated all but some 20% of historical MOG (Strittholt et al. 2006, DellaSala et al. 2022a). Degradation from logging (not natural disturbances) continues in the matrix and even in some of the LSRs, especially in the form of postfire salvage logging—and there are planned pre-fire timber sales in MOG. This is in defiance of the president's global pledge to end **forest degradation** and the 30 x 30 EO.

We note that forest degradation can be readily defined and analyzed within the context of recognized science-based criteria for terrestrial (Rogers et al. 2022, Dias et al. 2023) and aquatic ecosystems (Karr et al. 2021). We request such an analysis of forest degradation from the full array of active management disturbances be compared with their ecological integrity (ecosystem condition) counterparts from natural disturbances as exemplified using published sources such as follows. From Rogers et al. 2022:

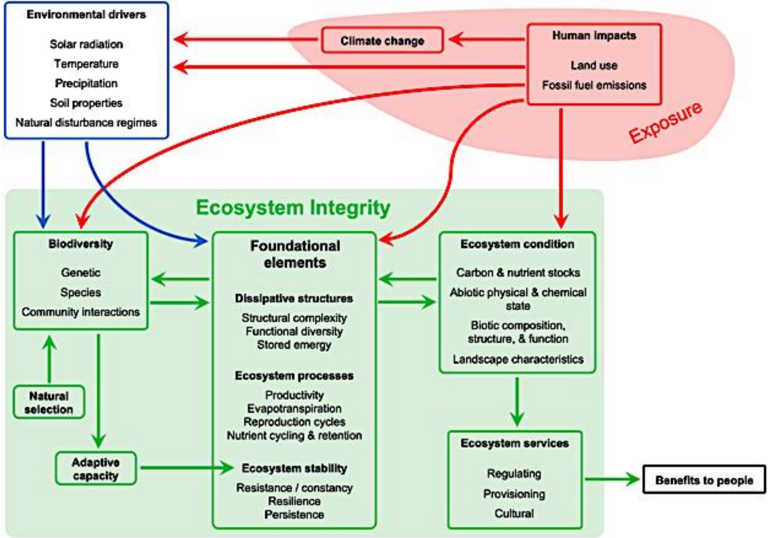


FIGURE 1

Figure 1 (Rogers et al. 2022). Conceptual framework of ecosystem integrity. Integrity is based on foundational elements including dissipative structures, ecosystem processes, and ecosystem stability. These are underpinned by biodiversity, natural selection, and adaptive capacity, and in turn generate a given ecosystem condition and benefits to people. Ecosystem integrity is impacted by environmental drivers and human impacts, including land use and climate change.

> "Ecosystem condition is measured in terms of variables that reflect the state, processes, and changes in the ecosystem, including (i) carbon and nutrient stocks, (ii) abiotic physical and chemical states such as water quantity and quality; (iii) biotic composition, structure, and function; and (iv) landscape diversity and connectivity. Indicators of condition are derived when variables are transformed by assessment against a reference condition. For a given biome and prevailing environmental conditions, these state variables are optimized by the foundational elements of ecosystem integrity and biodiversity."

And this section is particularly relevant in terms of how land use degradation impacts ecological condition and integrity (Rogers et al. 2022):

> "Comparison of risks from land use degradation - Human land use pressures on forests generally result in both direct environmental impacts as well as further, often unplanned, **degradation** or deforestation that accumulates spatially and temporally. This is exemplified by the fact that smaller fragments of primary forest have an elevated likelihood of loss (Hansen M. C. et al., 2020). New roads are the primary driver of further degradation as a result of their construction, use, and continued access (e.g., Trombulak and Frissell, 2000; Wilkie et al., 2000; Laurance et al., 2009; Laurance and Balmford, 2013; Ibisch et al., 2016; Alamgir et al., 2017; Venier et al., 2018; Maxwell et al., 2019). Roads render the surrounding forests much more susceptible to agricultural conversion (Asner et al., 2006; Boakes et al., 2010; Gibbs et al., 2010; Laurance et al., 2014; Kormos et al., 2018), logging (Laurance et al., 2009; Barber et al., 2014), and expanded networks of secondary and tertiary roads (Arima et al., 2008, 2016; Ahmed et al., 2014). Logging and transportation can also lead to severe erosion and nutrient runoff, impacting downstream water quality and quantity (Carignan et al., 2000; Hartanto et al., 2003; Foley et al., 2007), and damage the surrounding forest." (citations available from the original publication by Rogers et al)

We conclude this section with our quick read on the Forest Service's old-growth threat assessment "Introductory Report" noting that it shows in Figure 2 that fire, insects, disease together account for 2.8% loss of old growth nationally but those losses are offset by a 3.8% gain in old growth, so a net +1%. The report concludes, "despite the threats highlighted in this analysis, the RPA assessment predicted an increasing trend in the amount of mature and old-growth forests on NFS and BLM lands until at least mid-century."

NWFP AS A GLOBAL MODEL IN ECOSYSTEM MANAGEMENT AND BIODIVERSITY CONSERVATION (THE SCIENCE OF THE TIMES THEN AND NOW)

The history of the NWFP must not be lost in this revision as herein summarized.

On April 2, 1993, President Bill Clinton, Vice President Al Gore, and relevant cabinet secretaries attended the "Forest Conference" in Portland following up on the president's pledge to transform the conflict over logging in the Pacific Northwest. At the conference, President Clinton stated, "*our efforts must be insofar as we are wise enough to know it, scientifically sound, ecologically credible, and legally responsible*." The land-use allocations and standards and guidelines in the NWFP were informed by an interagency team of scientists *to be scientifically sound, and ecologically credible* (Forest Ecosystem Management Assessment Team [FEMAT]). The current multi-stakeholder FACA team is lacking expertise in spotted owl, marbled murrelet, and salmonid recovery needs; carbon accounting and carbon life cycle analysis; watershed ecology; wildfire and disturbance ecology (not active management but a central biodiversity focus); population viability of threatened and MOG-associated species ("survey and manage"); species of conservation concern; and reserve design. The omission of the very scientific fabric that underlies the original NWFP has created the appearance of a clear departure from the best available science inherent in FEMAT that stands to this day. This raises concerns about whether all the necessary expertise was included in the FACA team to ensure proper development of conservation alternatives.

FEMAT was originally tasked with meeting the population viability standard of the National Forest Management Act cited in Judge Dwyer's historic decision (*i.e.*, *legally responsible*). That gave FEMAT the direction needed to formulate a range of alternatives (options) rooted in **the reserve network, Aquatic Conservation Strategy ("coarse filter"), and protections outside reserves (e.g., "fine filter," "survey and manage").** The "probable sale quantity (PSQ)" was estimated **as a byproduct of the conservation framework** and not some sort of "broken promise" to deliver a specified timber volume to industry (probable means probable and not necessarily actual). Timber volume in Option 9 was anticipated based on many factors in the plans' standards and guidelines. However, most of the region has since moved on from federal logs and the agency no longer has a social license to log MOG even in the matrix that has been repeatedly challenged by conservation groups (legally indefensible). Today's timber industry is heavily automated, highly dependent on market fluctuations (e.g., housing, overseas), and is geared more toward export with minimal processing. In other words, job losses are largely from their own changes and much less so from a reduction in federal logs (Power 2006) (abstract only, paywall protected).

Thanks to FEMAT's solid scientific approach at the time, the reserve network of the NWFP still stands three decades later as the best science given that it is grounded in efforts to ensure the viability of >1,000 species associated with MOG within the range of the northern spotted owl (DellaSala et al. 2015a). The NWFP amendment now needs to build on the FEMAT science support for the reserves to remain scientifically sound, ecologically credible, and legally responsible as noted in our conservation alternative request. That means continuing the progress toward an intact and fully functional MOG (high ecosystem integrity) ecosystem grounded in the redundant, fixed, large, interconnected and well-distributed reserve network. The reserve network should now include **all remaining MOG** to contribute uniquely toward making the ecosystem whole again within the 100-year timeline of the NWFP.

We cannot overstate the importance of the coarse- (reserves, ACS) and fine-filter (survey and manage) conservation biology approach of the NWFP. In prior science reviews, the network of reserves was reaffirmed, including with climate change and barred owls as increasing threats to spotted owls (DellaSala et al. 2015a for prior review). And the reserve network importance was reaffirmed in the Northern Spotted Owl Recovery Plan of 2012. It is most concerning to us that the Forest Service may relax protections and even eliminate reserves in the dry forests based on its controversial and biased science synthesis and bioregional assessments (we originally critiqued this in 2017).

There is absolutely no peer-reviewed conservation science for rolling back reserve protections (or large tree protections) that are otherwise widely supported globally and in this region (Noss et al. 2012, Lindenmayer et al. 2012, Watson et al. 2014, DellaSala et al. 2015a, Dinerstein et al. 2017, Buotte et al. 2020, Carroll and Ray 2021, Law et al. 2021, Law et al. 2022). Any attempt to undo protections goes against the prevailing scientific framework of the NWFP. Notably, even though climate change is triggering more fires (see below), this should not be justification for dismantling or reducing protections within reserves (or large trees), be they in wet or dry forests (Law et al. 2018, 2021, 2022, Buotte et al. 2020, DellaSala et al. 2022a,b). None of the documented gains in the NWFP would be happening today without restraints on logging and the reserve network's built in concepts of redundancy and connectivity (DellaSala et al. 2015a).

It would be prudent for the Forest Service, as requested herein, to build on the initial NWFP support to rural communities in furthering the transition out of MOG logging. Successful transitions are underway on the Siuslaw National Forest, early adopter of the NWFP, and the Tongass National Forest is making important strides in shifting timber supply out of MOG. These efforts need to continue across the NWFP area (and nationwide) in order to reduce conflict over MOG protections (as in EO 14008). Notably, while some forms of active management may be compatible within reserves (e.g., burning), reserves should prohibit removing any large (>20 in dbh) trees for economic value as noted in the conservation alternative.

IMPORTANCE OF CARBON AND THE NEED FOR CARBON RESERVES

The reduction in logging levels under the NWFP shifted the region from a source of carbon emissions prior to the plan to a sink for long-term carbon capture and **storage** (Krankina et al. 2012, Law et al. 2018). This constraint benefit has been repeatedly demonstrated for maintaining biodiversity, clean water, and carbon accrual and storage as trees age (e.g., Krankina et al. 2012, Law et al. 2018, Moomaw et al. 2019, Nagel et al. 2023). One such benefit is federal MOG is now considered among the most carbon dense (carbon stocks per acre) ecosystems on the planet (Smithwick et al. 2002, Keith et al. 2009, Krankina et al. 2014, Brandt et al. 2014, Law et al. 2021). In recognition of its global achievement of the NWFP, we request that the NWFP revision includes the regional contribution of MOG to climate mitigation strategies involving carbon capture and long-term stores (i.e., natural climate solutions). This includes US commitments to nationally determined contributions (NDCs) to the Paris Climate Agreement via carbon sinks and reservoirs (Article 5), the Glasgow Forest Pledge to end forest degradation, and the 30 x 30 presidential directive as noted. Managing MOG as natural climate solutions is consistent with the White House "roadmap for nature-based solutions."

By a natural climate solution, we mean the protection from logging of carbon stored within MOG (large trees - live and dead - soils, etc) and by allowing mature forests to develop old growth characteristics over time via "proforestation" (Moomaw et al. 2019). What matters most in a climate emergency, is keeping additional carbon out of the atmosphere (Mackey et al. 2013) rather than storing a small amount in short-lived (relative to MOG) wood product pools (Keith et al. 2015, Harmon 2019, Hudiburg et al. 2019). Protection is the most effective natural climate solution and best climate smart forestry option (Moomaw et. 2019, Mackey et al. 2015, Mackey et al. 2022).

This particular recognition by Mackey et al (2022) points to the flaws in net carbon accounting methods often used by the forestry industry given that what matters most is not net carbon but keeping additional emissions out of the atmosphere by protecting existing carbon stocks (sinks and reservoirs):

> "All CO_2 emissions from, and atmospheric removals into, forest ecosystem carbon stocks now matter and should be counted and credited to achieve the deep and rapid cuts in emissions needed over the coming decades. Accounting and reporting systems therefore need to show gains and losses of carbon stocks in each reservoir. Changing forest management in naturally regenerating forests to avoid emissions from harvesting and enabling forest regrowth is an effective mitigation strategy that can rapidly reduce anthropogenic emissions from the forest sector and simultaneously increase removals of CO_2 from the atmosphere."

We want to repeat our concern - net carbon uptake is the wrong indicator of the carbon importance of forests because it ignores keeping additional emissions out of the atmosphere. Forests need to age to enable carbon uptake and long-term carbon storage. Since forests take at least a decade to restart carbon capture at meaningful scales after logging, very little carbon is stored in short-lived wood product pools, and over 80% of a logged forests' carbon winds up in the atmosphere at some point, no form of logging or tree planting is "climate smart" or compensatory for the carbon debt created by logging, especially under a global climate emergency (Keith et al. 2009, Mackey et al. 2014, Moomaw et al. 2019, Harmon 2019, Mildrexler et al. 2020, Mildrexler et al. 2022, Mackey et al. 2022, Ripple et al. 2022, DellaSala et al. 2022a, DellaSala et al. 2023, Birdsey et al. 2023). That distinction is further illustrated as follows and needs to be included in the NWFP revision.

The severity of forest degradation and the extent of the carbon debt depends on what logging methods, how much biomass is removed (timber volume removed can be converted to emissions), and where removals take place (MOG vs plantations, see Law et al. 2018, Law et al. 2021, Moomaw and Law 2023, Birdsey et al. 2023, DellaSala et al. 2023, Peng et al. 2023). The greatest carbon losses occur from intense logging (clearcuts, postfire salvage) and removal of large, carbon-rich trees within MOG forests (e.g., > 20 inches dbh, Mildrexler et al. 2020, 2023, Birdsey et al. 2023). Carbon losses are not "temporary" as the carbon debt created by logging can last for decades to centuries, a luxury of time we no longer have in the climate emergency (Hudiburg et al. 2019, Moomaw and Law 2023). In sum, the carbon costs of wood harvest have been grossly underestimated, including wood substitution that is overvalued (Harmon 2019).

Removing large trees for any perceived reduction in fire risks is also unrealistic as it would require massive amounts of thinning to get to scale (this type of cost/benefit analysis is missing from agency assessments and needs to be conducted). This is because of the extremely low chance of a site encountering a fire when fuels are lowest, high levels of treatment uncertainty due to the climate signal swamping on-the-ground efforts, expansive collateral damages, and significant emissions from logging that exceed those from all natural disturbances combined (Harris et al. 2016, Schoenaggel et al. 2017, Law et al. 2018, DellaSala et al. 2022a, Moomaw and Law 2023). Carbon losses also occur whenever commercial thinning is involved and not just clearcut logging (Law et al. 2018, Mildrexler et al. 2020, 2022, Bartowitz et al. 2022). The Bartowitz et al. citation in this call-out box is exemplary of the thinning problem noted and needs to be considered in any NWFP revision that proposes thinning of large trees:

> "While prescribed fire has been shown to decrease fire risk (Kolden, 2019) and increase carbon storage (Wiedinmyer and Hurteau, 2010), removal of biomass through large-diameter tree thinning or logging produces mixed outcomes for fire risk mitigation and forest resilience (Sohn et al., 2016) and reduces forest carbon storage and sequestration for decades to centuries (Campbell et al., 2012; Bartowitz et al., 2019; Stenzel et al., 2021). The misconception that trees need to be saved from wildfire through harvest (Zinke, 2018; Infrastructure Investment and Jobs Act, 2021; Table 2) may lead to unintended consequences through increased logging. These consequences include increased fire risk, a decreased forest carbon sink, decreased forest resiliency, and loss of the forest as a natural climate solution (Hudiburg et al., 2013; Law et al., 2018; Zald and Dunn, 2018; Stephens et al., 2020).

Notably, logging contributes to the dangerous feedback with extreme fire weather (see below). Any assumptions about temporary carbon losses from "active management" that offset natural disturbances would require detailed carbon life cycle analysis and independent verification (see Law et al. 2018, Harmon 2019, Hudiburg et al. 2019). We request that a life cycle analysis of carbon leaving the forest from logging in the NWFP be conducted and verified independently (e.g., published in the peer-reviewed literature).

Additionally, we request that carbon storage in MOG becomes **a central focus** of the NWFP revision along with the co-functionality benefits that come from protecting forests with high carbon stores (i.e., biodiversity, clean drinking water, recreation; Brandt et al. 2014, Law et al. 2021).

UNCERTAINTIES IN DRY VS WET FOREST DISTINCTIONS LEAD TO INAPPROPRIATE JUSTIFICATION FOR LIFTING LARGE TREE PROTECTIONS

Clearly, forest composition and disturbance dynamics vary in relation to the climatic and topo-edaphic gradient running across the Cascades and nearby mountain ranges (the so-called "eastside" vs. "westside" forests along the Cascade Crest, elevation gradients, slope, aspect, moisture gradients, orographic factors, the "Klamath Knot," etc). That distinction has greatly complicated the classification of forests as wet vs. dry and their associated fire regimes along with wildfire condition departure, leading to an overemphasis of inappropriate "active management" in forests deemed as dry forests by compressing variability in plant communities and fire regimes (DellaSala et al. 2022b). We acknowledge the uncertainty in such classifications herein and request that the agency do the same by not overstating how much and where dry forests occur.

(1) The coarse scale of wet-dry distinctions amplifies uncertainty through classification errors and inappropriate assumptions of wildfire departure classes. The approach

lacks validation and in some cases wildfire departure classes have proven opposite of on-the-ground fire severity effects (Odion and Hanson 2006, Odion and Hanson 2008). Condition class departure estimates that include this wet-dry split have been the basis for questionable "fuels reduction" in "dry forests" rooted in classification errors and flawed assumptions (DellaSala et al. 2022b) (i.e., we do not have confidence in the classification methodologies for wet-dry delineation and associated condition departure estimates).

(2) Forests with dense canopies (high stocking densities) in some regions (e.g., Klamath-Siskiyou) have been shown to burn in lower fire severities, completely opposite of condition departure classes and fire-risk assessments (Odion et al. 2004, Odion et al. 2010; Colombaroli and Gavin 2010; Lesmeister et al. 2019, 2021, Baker et al. 2023b). Risk assessments that are not validated based on field work (predicted or modeled vs. observation) may result in the wrong treatments applied, thus, do not reflect best available science especially when evidence of classification errors is ignored.

(3) All kinds of micro-climatic gradients exist within dry-wet/fire classifications, including pockets of mesic forests in areas classified as "dry." Significant (whether subtle or not) changes in plant association groups and disturbance dynamics vary over slight changes in elevation, slope, and aspect. For example, the Klamath-Siskiyou region has exceptional plant diversity across moisture and elevation gradients, especially in combination with the ecologically beneficial landscape mosaics created by mixed-severity wildfires that include both large and small patches of high-severity effects (Odion et al. 2014a, DellaSala and Hanson 2019).

(4) Microrefugia exist within broader wet-dry classifications that may function as climate and fire refugia and which may not be represented by overly simplistic wet-dry classifications (see Olson et al. 2012 for the Klamath-Siskiyou region as an example).

(5) Fire regimes derived in part from wet-dry classifications using LANDFIRE and condition class departure as predominately low- or low-moderate in "dry" are in fact misclassified and need to acknowledge the importance of mixed-severity fire with both small and large high-severity patches (Hessburg et al. 2007, Perry et al. 2011, Odion et al. 2014a, DellaSala and Hanson 2019 - this is especially true for the Klamath-Siskiyou region and Eastern Cascades mistyped as predominately dry forests with low- to low-moderate fire regimes). Fire ecology publications over the past decade have increasingly acknowledged that most western "dry" forests are not maintained by high-frequency, low-severity fire regimes (historically or contemporarily) but rather are characterized by variable-frequency, mixed-severity fire (Odion et al. 2014a, Baker et al. 2023a,b), including as noted, along the eastern slopes of the Cascades (Hessburg et al. 2007, Perry et al. 2011) and in the Klamath-Siskiyou region (Odion et al. 2014a), two exemplary regions previously misclassified as dry forests maintained by frequent, low-severity fires.

(6) Assumptions about high-severity fire rates being out-of-bounds are equivocal and not widely supported (Odion et al. 2014, Baker 2015, Law and Waring 2015, Baker et al. 2023a,b). The uncertainty in historical vs. contemporary fire and stand density estimates used by the Forest Service to justify logging has repeatedly been falsified by these studies and under-reported by the agency.

(7) Misclassifications have led to falsifiable claims about large high-severity fire patches creating conifer regeneration failures, when, in fact, high-severity patches have been demonstrated to be within historical bounds (Baker 2015, Parks et al. 2015, Law and Waring 2015, Baker et al. 2023a,b) along with sufficient postfire regeneration in the largest patches based on a very large western dry forest dataset (DellaSala and Hanson 2019). These studies need to be addressed as evidence of high-severity fire rates within historical bounds.

We note that the widespread assumption that beetle outbreaks exacerbate subsequent wildfire severity has been refuted by numerous studies across several biogeographic regions (Bond et al. 2009, Kulankowski and Jarvis 2011 (abstract only), Kulankowski et al 2012, Black et al. 2013, Six et al. 2014, Six et al. 2018, Hart et al. 2015, Meigs et al. 2016, Sieg et al. 2017, Baker et al. 2023a,b) with any effects short-lived (Harvey et al. 2014). Importantly, the tree survivors of beetle infestations (Six et al. 2018) and the survivors of severe fires (Baker and Williams 2015) may hold important genetic adaptions to future natural disturbance events. That is to say: natural disturbance-induced regeneration can precipitate genetic adaptations that confer long-term ecological resistance and resilience, and this can never be mimicked by selective logging or post-disturbance planting of nursery seed stock.

The agency needs to analyze this literature before reaching conclusions about historical departures (beetles, drought, and fire as noted), disturbance interactions, and resilience claims behind active management. This should include providing statistical analyses of any trend data in disturbance events affecting MOG, recognizing that trend analysis must be statistically robust with confidence intervals to be valid and include publicly accessible data on MOG recruitment into the reserves and MOG maps historical (e.g., 1990s) vs contemporary.

HIGH-SEVERITY FIRE ANALYSIS FOR THE NWFP "DRY" VS "WET" ECOPROVINCES AND LSRS VS OTHER LAND USE CATEGORIES

High Severity Trends Test - While there are significant limitations/uncertainties involving the coarseness of forest classifications into a wet-dry split as noted above, for the purpose of this analysis and our comments, we broke the NWFP area into forest provinces coarsely arranged by wet/dry distinctions (Hanson et al. 2009: Table 1).[4] We that note that high-severity fire within MOG generally and LSRs specifically are a natural ecosystem process that results in high levels of biodiversity (complex early seral forests as noted) with most (98%) of the carbon postfire transferred from live to dead pools (Harmon et al. 2019). Even spotted owls are known to nest in fire refugia pockets and forage in high-severity patches in large burn complexes (Lee 2018, 2020, Bond et al. 2023). Assuming MOG recruitment in the LSRs at least keeps pace with MOG losses from natural disturbances like high-severity fire, then long-term MOG stability or expansion is likely given that the LSRs were designed to handle

---

[4] We note that Forest Service researchers responded to Hanson et al. 2009 that is posted on Forest Service research portals. However, the agency has not posted our response to Spies et al. and we refer to it here (Hanson et al. 2010) as Spies et al. was refuted.

such disturbances via built-in redundancy and distribution patterns of the reserve network (DellaSala et al. 2015). Notably, the NWFP assumed a decadal gross loss of late seral forests to natural disturbances and harvest of five percent (Davis et al. 2013).

Our analysis below is constrained by not having levels of late-seral forest recruitment repeatedly requested but not provided by the Forest Service at this time (please note that the latest OGSI data available to the public online are over a decade old and the agency is required to post 10-year status reports). Thus, our analysis described below applies to all land within specific LUAs and not just MOG. Inherently this means that differences in wildfire severity distributions that may exist between MOG and younger forests within and between LUAs and physiographic provinces are currently undetectable until the Forest Service makes available a more complete MOG dataset.

Nonetheless, we analyzed wildfire patterns using the Monitoring Trends in Burn Severity (MTBS) annual mosaic datasets for California, Oregon, and Washington. These mosaics are based on the delta normalized burn ratio (dNBR) calculated from pre- and post-fire Landsat imagery, with further refinement from MTBS program personnel. This version of dNBR is called dNBR6 or MTBS Categorical, and it includes six severity classifications. One of these classifications is simply “High,” which we used to represent high-severity fire each year within the NWFP area. We then combined “Unburned to Low,” “Low,” “Moderate,” and “Increased Greenness” into a single low-moderate severity category. The remaining class represents areas where dNBR calculations were impossible due to cloud cover or satellite equipment malfunctions—we censored this classification from the analysis entirely.

All satellite imagery differencing methods for fire severity classifications are imperfect, but we note that dNBR generally and even the modified dNBR6 may be especially prone to misclassifying fire severity within more sparsely vegetated ecosystems, including thinned forests, especially when comparing to more densely vegetated ecosystems. DellaSala et al. (2022c) warned that remote sensing-based studies reporting a reduction in fire severity in areas that were thinned prior to wildfire often use dNBR rather than the relativized dNBR (RdNBR). RdNBR has been shown to more accurately classify fire severity in sparsely vegetated areas compared to dNBR (see Miller and Thode 2007, abstract only), yet, many studies over the last decade have continued to use dNBR, thereby under reporting high severity in thinned areas. DellaSala et al. (2022c) were the first to explore whether severity misclassification occurs differentially between dNBR, dNBR6, RdNBR, and high-resolution satellite imagery-based severity delineation within thinned forests:

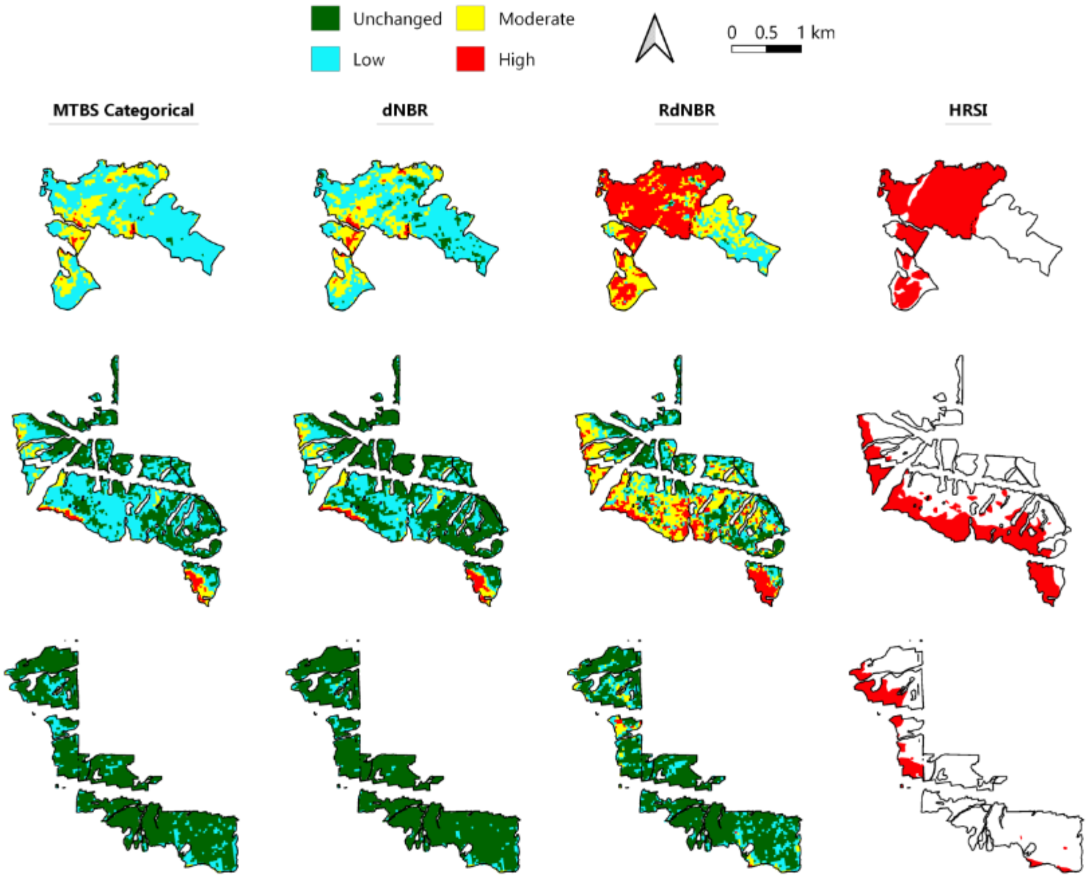


Figure S1. Fire severity distribution derived from all methods in three example thinning units within the 2011 Wallow Fire area. These units were part of the Eagar South WUI Fuels Reduction Project (top), Nutrioso WUI Fuel Reduction Project (middle), and Alpine WUI Fuels Reduction Project (bottom), all within the Apache National Forest.

Areas that were thinned tended to be classified as low to moderate severity by dNBR and dNBR6 even though the true proportion of high-severity fire was greater. More research on these differences, and methods for accurately classifying high severity fire between thinned and unthinned forests are sorely needed. This constraint is not covered in our analysis below but mentioned here as a means for identifying levels of uncertainty—or conversely poor confidence levels—in high severity studies that use this index.

We also note that whether high severity fire is increasing or not is equivocated by the lack of a statistically significant trend in most western dry forests, including the NWFP area in previous decades (Odion et al. 2014, Law and Waring 2015, Parks et al. 2015, Baker 2015, DellaSala and Hanson 2019). Although this could change with climate change producing more extreme fire weather events (heat domes, drought, high winds) that is driving the large fires that will increasingly escape containment and overwhelm on-the-ground suppression efforts, including thinning and prescribed fire (as noted in DellaSala et al. 2022c).

High Severity Rotations and Differences Between LSRs and "Other" Land Use Categories – As we are concerned about potential changes to how MOG is protected under the NWFP, especially within LSRs, we used the fire severity data described above (collected from 1984 to 2021) to calculate high-severity fire rotations at relevant spatial scales. The high-severity fire rotation is equal to the study period divided by the proportion of a study area (e.g., the NWFP area) that burned at high severity during that study period. In other words, it is the length of time that an area equal to the size of the study area will take to burn at high severity.

Across our 37-year study period, the high-severity fire rotation for the entire NWFP area was 432 years. This rotation was ~275 years in physiographic provinces typically considered "dry forest" types (i.e. Klamaths and east Cascades) and about 1,152 years in provinces considered "wet forest" types (i.e. west Cascades, Olympic Peninsula, Willamette Valley, and Washington Lowlands). We also calculated a high-severity fire rotation of 257 years in dry type LSRs (note: we combined all LSR types, including Managed LSRs, into a single LSR category for this calculation) and 1,428 years in wet type LSRs. Assuming that old-growth is experiencing high-severity rotations similar to those of these rotations calculated from areas that include both MOG and young forests, then old-growth regeneration and recruitment, and therefore long-term persistence, is still probable.

Conclusions on Fire Severity - **High-severity fires are driven largely by top down anthropogenic climate forcings generating extreme fire weather that drives large fires.** Attempts to suppress and alter this inevitably come with substantial costs that exceed any perceived benefits (DellaSala et al. 2022c). We supplemented some additional citations of relevance here on the importance of the climate signal as deterministic in large fires that escape containment. The Forest Service needs to recognize that top-down climate forcings are now overwhelming bottom-up "active management" and scaling up even more management will cause cumulative collateral ecosystem and climate damages (due to logging emissions) that will contribute to the feedback between large fires and extreme fire weather overtime (DellaSala et al. 2022c).

The figure from Coop et al. 2022 below shows that single-day spread events >1,100 ha accounted for 70% of total area burned from 2002-2020 in western forests. In particular, the number of extreme spread rates were associated with the region's aridity score (Coop et al. 2022, Figure 6 below). It is those and other climatic factors associated with large fires that are increasing and collectively will overwhelm on-the-ground suppression and active management approaches (DellaSala et al. 2022c).

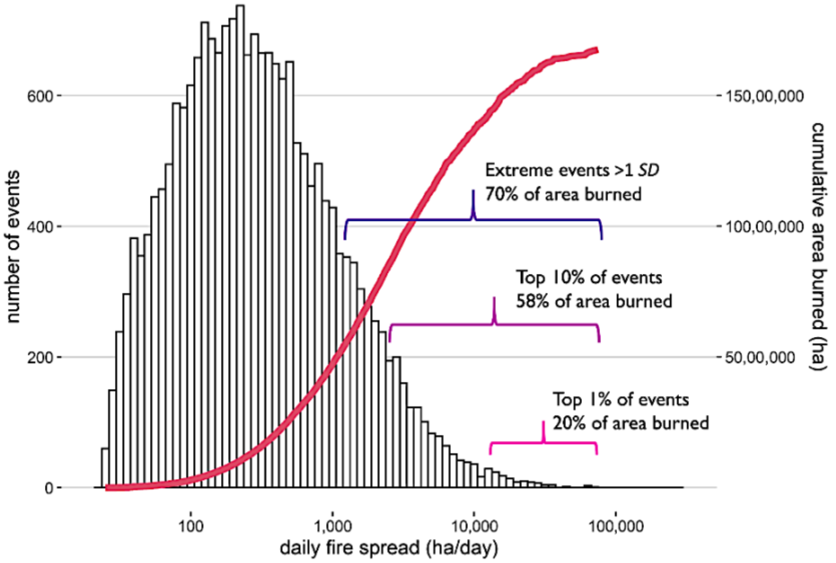
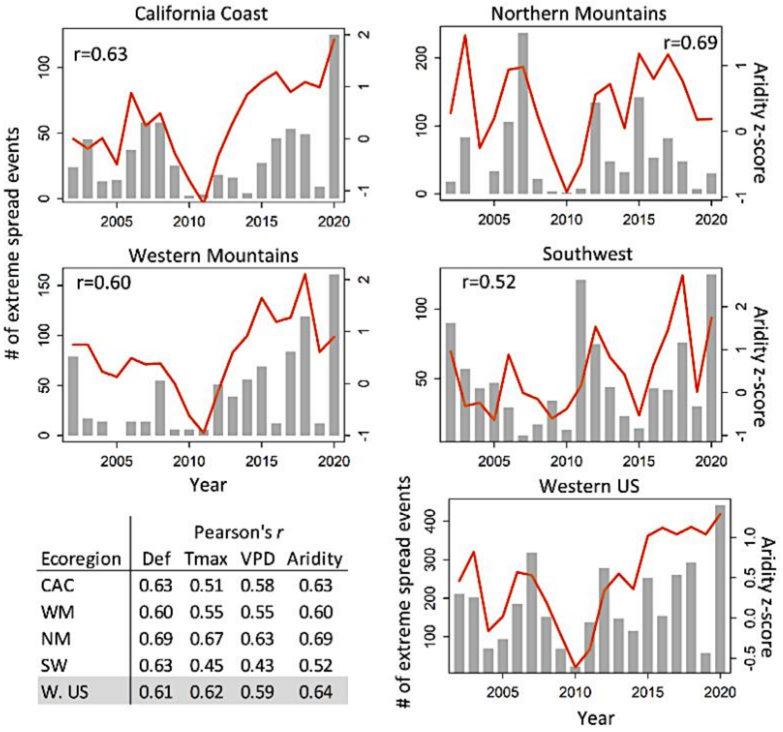


FIGURE 4 Distribution of daily fire spread events and the cumulative area burned during the 2002–2020 study period. Extreme events ≥1,100 ha (the top 16%, 1 *SD*) account for 70% of the area burned



Ecoregion	Pearson's *r* Def	Tmax	VPD	Aridity
CAC	0.63	0.51	0.58	0.63
WM	0.60	0.55	0.55	0.60
NM	0.69	0.67	0.63	0.69
SW	0.63	0.45	0.43	0.52
W. US	0.61	0.62	0.59	0.64

FIGURE 6 Plots show the annual number of extreme spread events (≥1,100 ha/day) and fire season climate (our synthetic Aridity metric); Pearson's *r* is indicated. Table (bottom left) shows Pearson's *r* for the correlation between the number of extreme spread events and metrics of fire season climate [mean climatic water deficit (Deficit), mean maximum temperature (Tmax), mean vapour pressure deficit (VPD) and Aridity (defined in the main text as the average of the other three variables)]

Additionally, [Zhuang et al. 2021](#) showed how changes in the vapor pressure deficit (VPD) have been a major factor in large fire years (they specifically mention the 2020 August Complex (Northern California Coast Range) that had an outsized influence on burning rates in the NWFP dry forests and the later timeline we analyzed. Hiraga et al. 2021 report that three main factors played a key role in the 2020 August Complex and other large fires that year: winds + VPD + soil moisture. Chiodi et al. 2021 showed that VPD, including nighttime VPD, is increasing in the western U.S. due to climate change and that will lead to more and larger fires that cannot be controlled regardless of active management and suppression forces.

The bottom line here is you cannot reduce fire spread rates, fire intensity, or even contain fires burning in extreme fire weather caused by anthropogenic climate factors that overwhelm on-the-ground efforts. Active management that removes significant amounts of forest biomass to reduce fire intensity (e.g., flame lengths to 4 feet) will either be futile in these climatic conditions that are increasingly evident in the NWFP and/or result in ecosystem type conversions to novel forest-climate associations at the expense of ecosystem integrity, carbon emissions, and MOG forests relative status as climate and fire refugia (Lesmeister et al. 2019, 2021). A paradigm shift in the relationship to fire is being increasingly called upon by the scientific community recognizing the futility of this effort (Schoenaggel et al. 2017, DellaSala et al. 2022, Calkin et al. 2023, Law et al. 2023).

OVEREMPHASIS ON EFFICACY OF “ACTIVE MANAGEMENT” AND UNDER-REPORTING ON COLLATERAL DAMAGES

Active management can take on many forms; however, the Forest Service seems to be wedded mainly to logging/thinning as the predominant methodology in practice. To achieve restoration and “resilience,” a comprehensive approach is needed that emphasizes removing anthropogenic stressors (active or passive) that are individually and cumulatively degrading ecosystem integrity (see Hanson et al. 2009, Hanson et al. 2010, Odion et al. 2014b, DellaSala et al. 2022b). The Forest Service cannot claim it is doing “ecological restoration” or “ecologically appropriate timber harvest” without addressing cumulative impacts (e.g., roads, livestock grazing, invasives, large trees removals, aquatic water quality impacts, etc). This should include a detailed life cycle analysis of carbon removed from treatments as noted. Any temporary set-backs in MOG recovery or carbon losses from thinning to achieve some perceived reduction in fire severity must include the countervailing evidence (Hanson et al. 2009, Odion et al. 2014b, DellaSala et al. 2022, Baker et al. 2023a,b) along with impacts to spotted owls from large-tree removals (Raphael et al. 2013, Odion et al. 2014b, Bond et al. 2022).

Based on best available science, we request that you give prioritization to these management objectives that are consistent with ecological integrity objectives:

(1) Cultural and prescribed burning within MOG where ecologically appropriate.
(2) Retain representative native plant understories compared to reference conditions and provide representative levels of small tree densities and native species composition that may have adaptive traits to the emerging climate (Baker 2015).

(3) Retain **all** large (e.g., >20 in-dbh) overstory trees to prevent excessive soil drying and wind penetrance related to fire spread rates. Large tree removals—even of large grand firs—are not warranted (Mildrexler et al. 2020, 2022). In some cases, shade tolerant trees can be killed and left on site to create snags or tipped into streams for aquatic habitat. To reduce fire transfer into the crowns during the 1-3-year period when dead trees still have needles, the lower branches could be pruned and dropped to the ground and burned or lopped and scattered.

(4) Analyze and reduce management impacts to soils and mycorrhizae (Delavaux et al. 2023) to maintain carbon below-ground along with below-ground processes essential to forest integrity. Soil damages come from repeat entry logging, machinery, intense pile burning, roads, cattle, and ORVs that should be avoided.

The following active management practices should be avoided as they constitute degradation:

(1) Thinning large trees does not reduce fire intensity especially in extreme fire-weather, thus, attempting to reduce flame lengths (e.g., 4 feet lengths) by taking out large, carbon-dense, wildlife valuable trees will result in type conversions to open, weed infested, areas (e.g., type conversion to savannahs) and far more emissions than wildfires (Harris et al. 2016, Bartowitz et al. 2022, Moomaw and Law 2023). The agency also needs to account for tree mortality caused by thinning itself before it concludes any fire intersecting thinned areas resulted in reduced tree mortality (see Baker and Hanson 2022, Hanson 2022). Thinning of overstory trees increases wind penetration, leads to extensive soil desiccation and can increase fire intensity even if slash is removed - making stands less wind firm - leading to faster moving fires.

(2) The chance of a fire hitting a stand where thinning has occurred based on empirical evidence is very low (e.g., <1%). Scaling up to improve the odds amplifies cumulative forest degradation. This has led some scientists to call for working with fire for ecosystem benefits and focusing on home/structure protections (Cohen 2000, Schoennagel et al. 2017, Calkin et al. 2023).

(3) The chance of fire spilling over into urban areas is much greater on private lands where forest degradation is much higher and the contribution of logging levels on nonfederal lands needs to be acknowledged as a major source of fire risks (Downing et al. 2022).

(4) Thinning large trees (canopy reductions) in spotted owl habitat below 60% canopy closure is degrading to long-term owl habitat maintenance (Odion et al. 2014b, Raphael et al. 2016). Most documented northern spotted owl territory abandonment is associated with repeat logging (and barred owls in logged territories) rather than fires (Lee 2018, Lee 2020, Hanson 2021, Bond et al. 2023).

LINKING EXTREME WILDFIRE TO ANTHROPOGENIC CLIMATE CHANGE (ACC)

We underscore the ecological importance of mixed-severity fires, including large and small high-severity patches within or outside MOG, as natural disturbances ostensibly operating within historical bounds (e.g., on centuries-long fire rotations at the landscape scale, see above). However, there have been recent increases in acres burning, but not in the amount of high-severity fire, proportion of fire complexes, or large high-severity patch sizes (Odion et al. 2014, Waring and Law 2015, Baker 2015, DellaSala and Hanson 2019).

The NWFP amendment also should take into consideration recent advancements in climate attribution science showing how large fires are increasingly due to anthropogenic climate change (ACC) that is overriding on-the-ground fuel reduction. The **root cause** of fire increases in this case is coming from the burning of fossil fuels (all sectors) along with logging emissions that contribute to rates of global overheating and related climate changes. Notably, the main emission source that the agency can actually control is from logging (see Harris et al. 2016, Bartowitz et al. 2022, Moomaw and Law 2023). Climatic factors are reflected in this section below and we request that the Forest Service address how it cannot possibly keep pace with the rate of fire increases attributed to ACC and will further degrade ecosystems, the climate, and nearby communities by scaling up treatments and their associated impacts (DellaSala et al. 2022b). We request that you acknowledge the significant costs to ecosystems and the climate by putting more emissions into the atmosphere during the climate emergency via logging and road building.

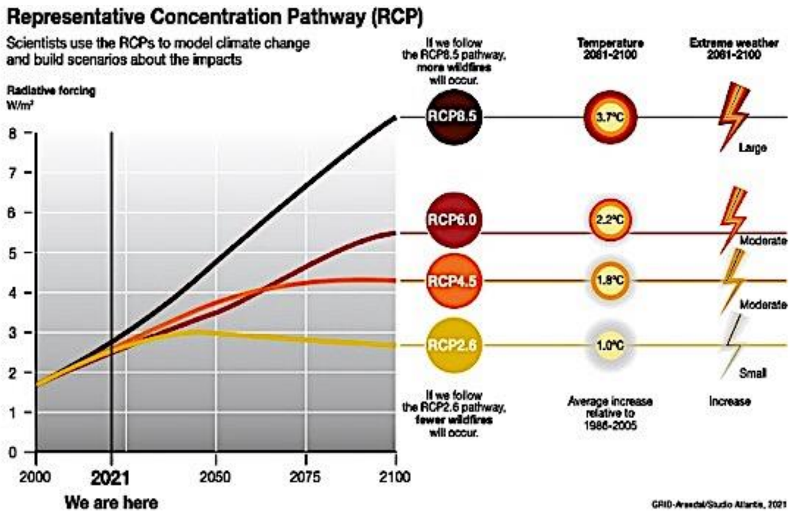
Extreme fire-weather such as the Oregon Labor Day fires of 2020 was unlike anything in recorded history. Such events have been increasing due to ACC caused primarily by burning fossil fuels with substantial contributions from the land-use sector, including forestry. Oregon’s summer of 2021 was impacted by an unprecedented (White et al. 2023) heat wave and drought, conditions likely to increase as global temperature records are shattered. We note the following:

- The World Meteorological Organisation (WMO) indicates there is now a 66% chance that global temperature increases will breach the critical 1.5°C threshold as soon as 2027 with increasing catastrophic consequences for all of society. Indicative of the speed at which climate change is proceeding, are unprecedented oceanic temperatures and annual heat records (each year is a new record). Many extreme events draw excess energy from oceanic temperature increases that are exceedingly a challenge to slow or reverse with excessively long lag times (centuries) in biosphere-atmosphere response rates. That is there is a lot of carbon in the atmospheric pipeline with very long atmospheric “hang times.” The carbon put in the atmosphere today will be around for decades-centuries and the Forest Service can and should be part of the global and regional solution instead of the problem by shifting logging out of MOG.
- Overshooting the temperature threshold will contribute to even more wildfires and overall weakening of natural land carbon sinks. According to the AR6 climate report, the temperature overshoot would increase land sector emissions from diminished land sinks, making temperature reversal even more problematic (medium confidence). The 1.5°C threshold is a well-documented global “safety net” beyond which impacts from

ACC will increasingly become catastrophic. Protecting forests, especially MOG, is our best natural solutions strategy (along with GHG reductions across all sectors) (Law et al. 2018, 2021, 2022, DellaSala et al 2022a, DellaSala et al. 2023).

- The global climate assessment (AR6) report concluded that as ACC accelerates, **“compound extreme events include increases in the frequency of concurrent heatwaves and droughts (high confidence); fire weather in some regions (medium confidence); and compound flooding in some locations (medium confidence)” (emphasis added)**. GHG emissions have created a dangerous feedback loop with extreme wildfire events. That feedback is overriding on-the-ground fire suppression efforts, which is why the agency keeps spending at unprecedented levels to “contain fires” that, in turn, are increasing in area burned despite these efforts. You are focused on the effects of climate change rather than the root causes (DellaSala et al. 2022b).
- The United Nations Environment Programme Report, authored by 52 international scientists, linked global spread of **landscape-scale wildfires to planet-wide overheating**. The Forest Service can never achieve scale with on-the-ground treatments and even if they could, the costs to ecosystems and damages to the climate are extreme in a global emergency (DellaSala et al. 2022b).

This figure from the UN report shows the current global and projected relationship between **radiative forcings (ACC) and wildfires** – without major emissions reductions (including forestry), society is currently on the worse case (RCP8.5) trajectory (top of the figure), meaning even more wildfire activity and carbon will be in the atmospheric pipeline.

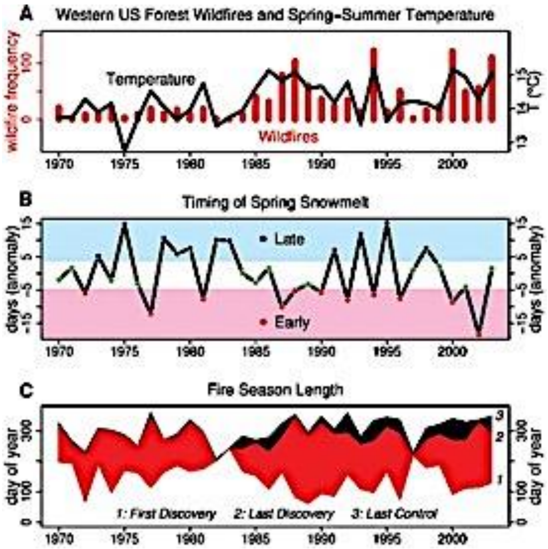


GRID-Arendal/Studio Atlantis, 2021

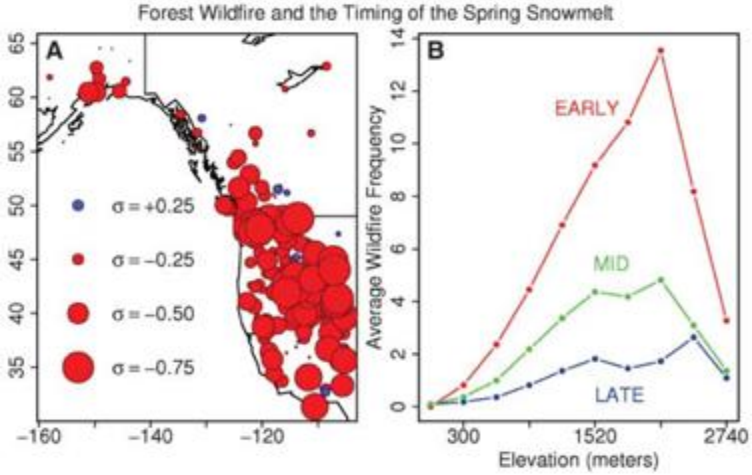
Figure 2.6. Representative Concentration Pathway(s) (RCPs) are trajectories of greenhouse gas concentrations used for climate modelling in the IPCC Fifth Assessment Report (IPCC 2013). The numerical values of the RCPs (i.e., 2.6, 4.5, 6.0 and 8.5) refer to the possible range of radiative forcing values in the year 2100. RCPs are used to build future climate scenarios based on greenhouse gas emissions from human activities, depending on the efforts taken to limit greenhouse gas emissions (high efforts taken under RCP2.6, low efforts under RCP8.5). RCP2.6 is the scenario that will likely keep global warming below 2°C by 2100 – this alone will have a significant impact on reducing wildfire occurrence (see also Figure 2.8).

- The Oregon Climate Assessment (6th Assessment, available online) indicates total acres burned each year in Oregon has increased over the past 35 years. The number of days with extreme wildfire danger have also more than doubled since 1979 along with frequent droughts, reductions in humidity, and declining snowpack, all of which are **attributed to GHGs**. The report concluded that particulate pollution from smoke could double or triple by the end of the century, increasing human health and socio-economic impacts.

- The Oregon Global Warming Commission, which is responsible for tracking and evaluating impacts of climate change, released its 2023 report (online) to the legislature stating that: Oregon's average annual temperature has increased by around 2.2 degrees F over the past century. Without significant reductions in greenhouse gas emissions, Oregon's annual temperate is projected to increase by 5 degrees F by mid-century and by 8.2 degrees F by the 2080s." Meaning there will be more fires regardless of what the agency does and by increasing the scale and pace of "fuels removal" will only worsen the problem by putting emissions into the atmosphere, contributing to the feedback to wildfires. Thus, **as global temperatures increase, wildfires are expected to become larger and fire seasons increasingly extreme in Oregon and across the West**.
- Recent advances in attribute risk assessments (online), climate tracking satellites, long-term trend analyses, and computer simulation models demonstrate a statistically robust association between specific climate variables related to **ACC and wildfire activity globally**. Extreme event attribution (online) is one of the fastest developing climate assessment fields (hundreds of publications). Again, this underscores the underlying root causes of fire increases that swamp on-the-ground containment or risk reduction efforts.
- Rigorous peer-reviewed studies and meta-analyses (synthesis studies) show a consistent pattern of **increased wildfire activity in the West linked to specific climate variables associated with ACC**. All of the studies above and below apply to the NWFP.
- Westerling et al. (2006) published in the prestigious journal *Science* a comprehensive time series of 1166 large (>20,000 acres) forest wildfires for 1970 to 2003 and compared fire data to corresponding hydroclimatic and land surface variables noting that the incidence of wildfires increased in the mid-1980s in forested areas. Increases were **strongly associated with rising temperatures during spring and summer**. The length of the wildfire season also increased by 78 days **all due to ACC**. Note the link between wildfire frequency and temperature in the top graph.

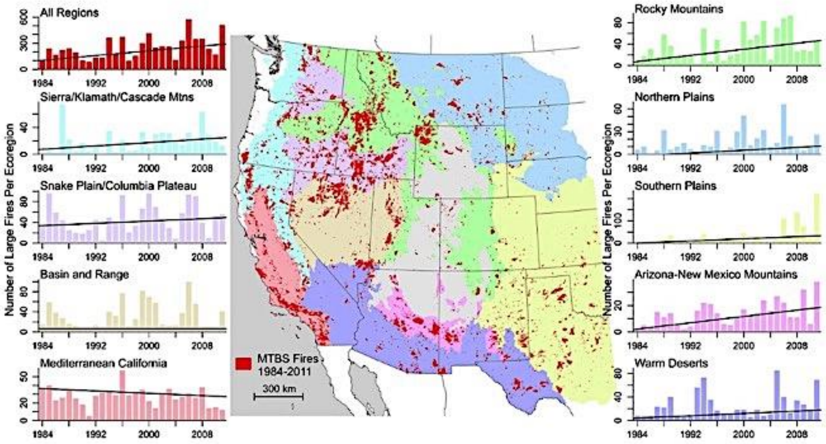


Also, this study noted the relationship between **wildfires and timing of spring snowmelt, influenced by ACC**, is statistically strong in the NWFP area (large circles denote higher confidence in the below figure on the left).



- [Dennison et al. (2014)](#) reported increasing wildfire activity across the West was attributed to **warmer and drier summer conditions (drought severity)**. For all ecoregions, large fires increased at a rate of seven per year, while total fire area increased at a rate of 355 km^2 per year (see figure below). The relationship below for the Cascades is particularly revealing (light blue bar graph upper left).

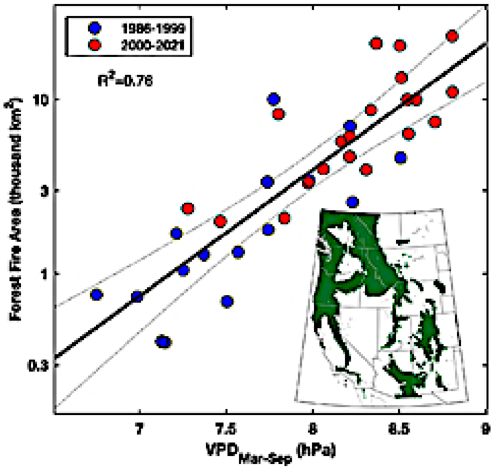
Large wildfire trends in the western United States, 1984–2011



- Westerling (2016) reaffirmed the tight association between wildfire activity and the relatively high cumulative warm-season actual evapotranspiration and early spring snow melt. Notably, **there was a +1000% increase in wildfire activity from 2003-2012 and the increase was attributed again to spring and summer temperature increases**.
- Abatzoglou and Williams (2016) noted that anthropogenic increases in **temperature and vapor pressure deficit** significantly enhanced fuel aridity across western forests during 2000–2015, **contributing to 75% more forested area experiencing high fire-season fuel aridity** and an average of 9 additional days per year of high fire potential. **ACC accounted for ~55% of observed increases in fuel aridity and wildfire potential in recent decades**.
- Holden et al. 2017 showed how **declines in summer precipitation and rain days associated with GHG increases are the primary driver of increases** in wildfire area in the West. Their findings are consistent with further decreases anticipated in summer precipitation and longer dry periods between rain events and are very similar to the vapor pressure deficit as a key indicator of wildfire activity.
- Abatzoglou et al. (2021) reported that the 2020 Labor Day fires in Oregon exceeded the area burned in any single year for at least the past 120 years, contributing to hazardous air quality and massive smoke plumes. **Unusually warm conditions with limited precipitation occurred in the 60-days prior to the fires**. **Exceptionally strong winds and dry air drove rapid rates of fire spread.** The concurrence of these drivers created conditions unmatched in the observational record.
- Mass et al. 2021 reported that the Labor Day fires of 2020 were **driven by strong easterly and northeasterly highly unusual winds**. Wildfires produced dense smoke that initially moved westward over the Willamette Valley and eventually covered the entire region. Air quality rapidly degraded to hazardous levels, representing the worst levels in recent decades (see below).

- [Hawkins et al. (2021)](#) – noted that **ACC factors (fuel aridity, warmer temperatures during dry wind events) increased fuel aridity and likelihood of extreme fire weather by 40% in northern California and Oregon**.
- [Dahl et al. (2023)](#) linked increases in burned forest area across the West and southwestern Canada to **the vapor pressure deficit, meaning drier atmospheric conditions produced drought-stressed plants and soils that readily burned**. They used a robust global energy balance carbon-cycle model and a suite of downscaled climate models to attribute emissions to vapor pressure deficit from 1901–2021 and cumulative forest fire area from 1986–2021. **Emissions were responsible for 48% of long-term rise in vapor pressure deficit and, correspondingly, 37% of the cumulative area burned. Emissions also contributed to nearly half the increase in drought- and fire-danger since 1901**.

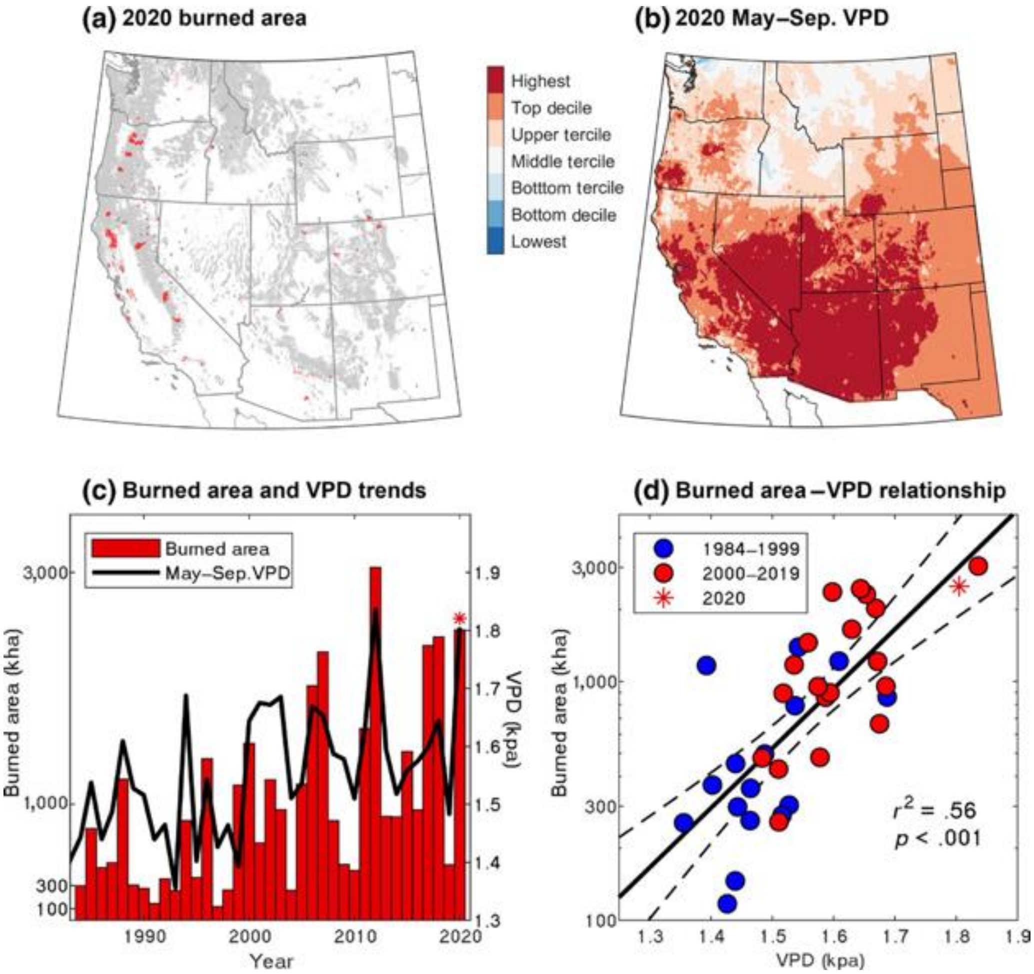
The figure below from Dahl et al represents a statistically significant relationship between forest area burned and the vapor pressure deficit in western states and southwestern BC.



- [MacDonald et al. 2023](#) synthesized the literature on climate-wildfire attribution studies finding that there was a “striking increase” in annual area burned in the West related to **increasing temperatures and the atmospheric vapor pressure deficit**. **ACC was the main driver behind wildfire activity**, in addition to influencing other climate-related factors such as compression of the winter wet season. **This trend is projected to increase without reductions in GHGs, the pathway the world is currently on**.
- [Turco et al. 2023](#) used the latest simulations for climate change attribution and detection studies showing that nearly **all observed increases in burned area in California over the past half-century was attributed to ACC alone** (summer temperature increases, dryness). Model simulations using ACC factors alone accounted for 172% (range 84 to 310%) more area burned than simulations with natural processes only (no ACC in the model). **Their results indicate that observed**

> **increases in burned area was primarily due to greater fuel aridity (from drying and summer temperatures).**

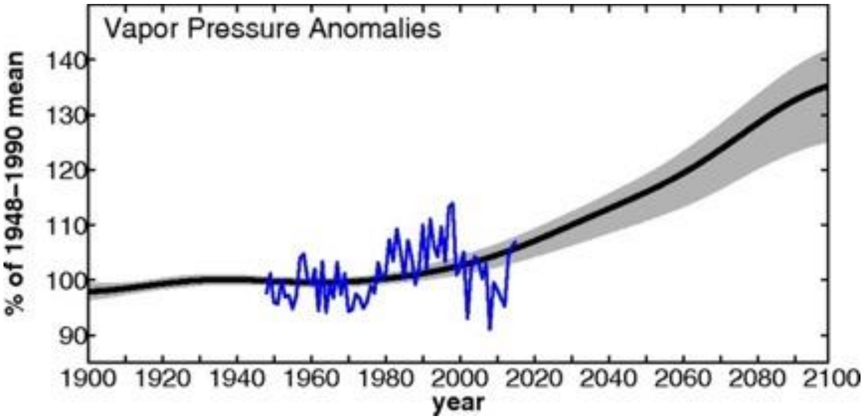
Notably, this particular study by Higuera and Abatzoglou (2020) further demonstrates the connection between the **record-setting heat wave in the western U.S. and "extraordinary 2020 fire season."** Accordingly, in just a few days, >1.9 million acres burned in Oregon and Washington with millions enduring hazardous air, thousands of smoke-related deaths, over 10,000 structures damaged or destroyed, and dozens of lives lost. Extreme fire activity was attributed to the **vapor pressure deficit as dry atmospheric air increased fuel aridity and dry fuels facilitated ignitions and rapid-fire spread**, which is most problematic to fire containment. Like the studies noted above, the relationship between area burned and vapor pressure deficit is quite strong, and will continue to rise in importance governing fire behavior and overwhelming anything the agency does on the ground.



The authors conclusion is directly relevant to the situation in the NWFP area:

> “Projected increases in fuel aridity in the coming decades make it unlikely that records from 2020 will stand for long. As a result, fire will increasingly become a driver of global change, catalyzing ecosystem shifts as landscapes adjust to a changing climate, and altering ecosystem services including carbon storage (Coop et al., 2020). Paramount for minimizing the negative human impacts of wildfires **is addressing the root causes of anthropogenic climate change.”**

- Timing, extent, and severity of wildfires in the West are strongly influenced (Westerling 2016) by specific **ACC factors (root causes)** related to vapor pressure deficit and hotter summer temperatures documented repeatedly in the above facts and supporting material. Other ACC factors also contribute to increasing wildfire activity, including unusually strong winds (Higuera and Abatzoglou 2020), a higher incidence of lightning, longer fire seasons, and decreased snowpack.
- Importantly, the vapor pressure deficit and summer temperatures are likely to further increase in the decades ahead based on projected emissions scenarios, meaning even more extreme wildfire events are forecasted as corroborated by the UN report (online) for global increases in wildfire activity. This figure shows the projected increase in vapor pressure deficit associated with increasing GHGs (**again this is the root cause and will overwhelm fuel reduction unless emissions are drastically cut across all sectors, including forestry**).



- Since 2000 alone, there’s been only 1 year (2006) that Oregon has not been locked into at least moderate drought conditions (online), and only four of these years did it not have severe drought. Drought conditions are linked to rising temperatures along with winters warming faster than summers, declining snowpack, and earlier snow melt – **the exact conditions that are associated with large wildfires.**
- Large (>40,000 acres) fires in Oregon were very costly from 2020-2022 based on data obtained from the National Interagency Fire Center (NIFC). For the 3-year period, suppression totaled $512.5M, large fire duration averaged 55.6 days, and ~1.9 million acres burned. The important point here is by throwing more money via wildfire suppression (including thinning) you are not addressing the root-cause of the fire

problem (DellaSala et al. 2022b) that is not a fire problem per se but a fire-urban problem (Calkin et al. 2023).

- Based on the AR6 report (online), global net anthropogenic GHG emissions were about 12% higher than in 2010 and 54% higher than in 1990, with the largest share and growth in gross GHG emissions in CO_2 from fossil fuels combustion and industrial processes (high confidence). Releasing more emissions from “fuels reduction” is adding to the feedback to large wildfires.

CONCLUSIONS AND REQUESTS

We summarily conclude these core issues along with associated analyses requested as they pertain to plan revision.

(1) Analyze a conservation alternative based on protection of MOG from all forms of extraction logging on NWFP land-use designations to avoid forest degradation. The conservation alternative should build on the NWFP reserves by addition, comply with 30 x 30, address the Glasgow Forest Pledge regarding forest degradation, and the Paris Climate Agreement (Article 5) regarding sinks and reservoirs of carbon within MOG. This alternative should add to the redundant pattern of reserves, well distributed, large, and interconnected along with the protection of all large (≥20 inches dbh, or ≥80 years) trees within reserves.

(2) Prescribed fire and cultural burning should be the preferred treatment in MOG where ecologically appropriate and no wood products of economic value removed.

(3) Despite recent increases in wildfire activity, there is no agreement in the scientific community that fire severity is increasing in high severity acreage, proportion of high severity within large fire complexes, and high severity patch sizes. The same is true for beetle-drought mortality factors as noted (Baker et al. 2023b). We note that resistance to drought is highest in forest stands with structural complexity (e.g., canopy layering, Ma et al. 2023). Therefore, reducing the overstory canopy, degrades structural complexity, and can increase drought susceptibility (Ma et al. 2023).

(4) Industrially logged landscapes have higher rates of high-severity fire, especially when under extreme fire weather, when such fires are most likely to spill over into urban areas from nonfederal lands where logging is most intense (Bradley et al. 2016, Zald and Dunn 2018, Downing et al. 2023).

(5) Fire risk reduction needs to concentrate closest to homes and in heavily logged areas. This should include seasonal road closures and road obliteration to reduce unwanted human-caused ignitions. Importantly, camping and road access areas should be closed to public access during heat domes, severe drought, and high wind conditions (i.e., extreme fire weather). Thus, the agency needs a transportation and national forest access plan that is designed to reduce human-caused ignitions, which is absent in most fire-risk reduction approaches. This should allow for greater use of natural wildfire ignitions for ecosystem benefits that will reduce far more fuels than “active management,” and that can be carried out safely in low-moderate fire weather.

(6) The vapor pressure deficit and summer temperature increases (related factors include early spring snow melt, reduced snow pack, longer fire seasons along with more human-caused ignitions) are primary drivers behind recent fire increases that override fire suppression and mechanical treatments. This fact needs to be acknowledged as significant limitations/constraints on “active management” treatments that involve thinning (DellaSala et al. 2022b).

(7) Attempting to reduce fire intensity by scaling up logging/thinning (especially large fire-resistant trees) will result in cumulative forest degradation, including emissions that exceed those of wildfires, thereby contributing to the root cause of the problem you seek to resolve.

(8) Uncertainty in wet-dry classifications and high error rates in condition class departure has led to misclassifying fire regimes and inappropriate treatments. Field validation and model sensitivity analysis and validation are needed.

(9) Under certain conditions (low fire weather), all large trees retained, representative understories (see above), and prescribed or cultural burning, fire line intensity can be reduced but climatic factors are overtaking on-the-ground efforts (acknowledge the limitations).

(10) Collateral damages are seriously under-estimated and thinning overstated in fire-risk reduction. This has resulted in substantial conflict, public mistrust, ignoring evidence that contradicts agency treatment assumptions, and most importantly, cumulative damages to ecosystems, the climate, and nearby communities by failing to consider root causes (DellaSala et al. 2023a).

As further evidence and a reminder of the importance of MOG (wet and dry forest) as a climate and wildfire buffer, we underscore these two abstracts that include Forest Service researchers:

From Lesmeister et al. (2019):

Abstract. The frequency, extent, and severity of wildfire strongly influence the structure and function of ecosystems. Mixed-severity fire regimes are the most complex and least understood fire regimes, and variability of fire severity can occur at fine spatial and temporal scales, depending on previous disturbance history, topography, fuel continuity, vegetation type, and weather. During high fire weather in 2013, a complex of mixed-severity wildfires burned across multiple ownerships within the Klamath-Siskiyou ecoregion of southwestern Oregon where northern spotted owl (Strix occidentalis caurina) demographics were studied since 1990. A year prior to these wildfires, high-resolution, remotely sensed forest structural information derived from light detection and ranging (lidar) data was acquired for an area that fully covered the extent of these fires. To quantify wildfire impact on northern spotted owl nesting/roosting habitat, we fit a relative habitat suitability model based on pre-fire locations used for nesting and roosting, and forest structure variables developed from 2012 lidar data. Our pre-fire habitat suitability model predicted nesting/roosting locations well, and variable response functions followed known resource selection patterns. These forests had typical characteristics of old-growth forest, with high density of large live trees, high canopy cover, and complex structure in canopy height. We projected the pre-fire model onto lidar data collected two months post-fire to produce a post-fire suitability map, which indicated that >93% of pre-fire habitat that burned at high severity was no longer suitable forest for nesting and roosting. We also quantified the probability that pre-fire nesting/roosting habitat would burn at each severity class (unburned/low, low, moderate, high). Pre-fire nesting/roosting habitat had lower probability of burning at moderate or high severity compared to other forest types under high burning conditions. Our results indicate that northern spotted owl habitat can buffer the negative effects of climate change by enhancing biodiversity and resistance to high-severity fires, which are predicted to increase in frequency and extent with climate change. Within this region, protecting large blocks of old forests could be an integral component of management plans that successfully maintain variability of forests in this mixed-ownership and mixed severity fire regime landscape and enhance conservation of many species.

From Lesmeister et al. (2021):

Background: The northern spotted owl (Strix occidentalis caurina) is an Endangered Species Act-listed subspecies that requires coniferous forests with structurally complex and closed-canopy old-growth characteristics for nesting. With climate change, large wildfires are expected to become more common within the subspecies' range and an increasing threat to these types of forests. Understanding fire severity patterns related to suitable nesting forest will be important to inform forest management that affects conservation and recovery. We examined the relationship between fire severity and suitable nesting forest in 472 large wildfires (> 200 ha) that occurred in the northern spotted owl range during 1987–2017. We mapped fire severities (unburned-low, moderate, high) within each fire using relative differenced normalized burn ratios and quantified differences in severity between pre-fire suitable nesting forest (edge and interior) and non-nesting forest. We also quantified these relationships within areas of three fire regimes (low severity, very frequent; mixed severity, frequent; high severity, infrequent).

Results: Averaged over all fires, the interior nesting forest burned at lower severity than edge or non-nesting forest. These relationships were consistent within the low severity, very frequent, and mixed severity, frequent fire regime areas. All forest types burned at similar severity within the high severity, infrequent fire regime. During two of the most active wildfire years that also had the largest wildfires occurring in rare and extreme weather conditions, we found a bimodal distribution of fire severity in all forest types. In those years, a higher amount—and proportion— of all forest types burned at high severity. Over the 30-year study, we found a strong positive trend in the proportion of wildfires that burned at high severity in the non-nesting forests, but not in the suitable nesting forest types.

Conclusions: Under most wildfire conditions, the microclimate of interior patches of suitable nesting forests likely mitigated fire severity and thus functioned as fire refugia (i.e., burning at lower severity than the surrounding landscape). With changing climate, the future of interior forest as fire refugia is unknown, but trends suggest older forests can dampen the effect of increased wildfire activity and be an important component of landscapes with fire resiliency.

In closing, the Forest Service can best solve for root causes of forest degradation by: (a) protecting all remaining MOG from logging to maintain climate and wildfire refugia, carbon stores, wildlife habitat, clean water, and recreational benefits; (b) greatly reducing anthropogenic stressors that accumulate spatially and temporarily (logging, roads, invasives, mining, ORVs, grazing etc); and (c) the judicious use of active management and natural wildfire ignitions compatible with ecosystem integrity as noted. We underscore the need to protect from logging all remaining MOG by placing these irreplaceable forests within the reserve network. This is a unique moment in Forest Service history to leave a conservation legacy important to the climate, biodiversity, drinking water, recreation, forest stability and recovery, and future generations that will increasingly need these forests in a radically changing climate. All forest plan alternatives need to build on the success story of the NWFP by additions to protections and the reserves, and not by subtractions.

Appendix A: Determining Threats and Conservation Needs for Mature-Old Growth (MOG) Forests (Note - this section is also submitted as part of our national MOG comments)

Purpose and Need

President Joe Biden's Executive Order 14072 directed federal agencies to inventory MOG for "*conservation purposes*." While conservation was not clearly defined in the EO, and the only "threats" singled out were natural disturbances (e.g., fire and insects) and climate change, the field of conservation biology includes specific definitions, methods, and criteria for identifying threats and assigning risk factors applicable to the NWFP in the context of biodiversity, climate resilience, and ecological integrity. Importantly, anthropogenic and natural disturbances should never be grouped together on the same summary graph as in the Federal Register Notice for the Advanced Notice for Proposed Rule Making for national MOG (see below). This is because there are major differences in spatial extent, frequency, duration, magnitude, and cumulative effects from anthropogenic disturbances vs. natural ones. As noted herein, native species have many adaptations that confer resilience to natural disturbances, but many species cannot adapt quick enough to cumulative anthropogenic disturbances that act more like threats than do natural processes. This clear distinction between anthropogenic vs. natural disturbances in assigning risk factors needs to be recognized in the MOG threat assessment. Rather than using a literature cited section, all citations in this white paper are hyperlinked to the original source as noted above.

Using Pulse vs. Press Disturbances to Help Define Threats

Pulse disturbances - As the name implies, a pulse disturbance is short-lived change agent that most species are readily adapted and resilient to and that are important determinants of ecosystem community structure and function. Many species thrive in the pulse disturbance environment like large wildfires of mixed-severity effects on plant and wildlife communities (i.e., the pyrodiversity begets biodiversity hypothesis; DellaSala and Hanson 2015, online) An example in this case is a severe fire that passes through a mature stand killing most trees and creates a pulse of biological legacies (dead and surviving trees, seed propagules, shrubs, burrowing mammals, mycorrhizae that escape the heat, etc) (DellaSala 2019). That pulse sustains coarse woody debris and snag/log requirements for decades and it is ecologically beneficial with high levels of biodiversity associated with the ensuing regenerating, complex early seral forest (Swanson et al. 2010, DellaSala and Hanson 2015, DellaSala et al. 2017). Severe fires also provide a pulse of nutrients to aquatic systems that in turn support invertebrate and nutrient productivity spikes within years following the disturbance that are especially beneficial when there are fire-free and logging-free refugia present (Minshall 2003 (paywall download only), Jager et al. 2021). Pulse disturbances are not thought of as “threats” per se to species or ecosystems when operating within evolutionary bounds. Out of bounds, they can shift to press or chronic disturbances especially if compounded by anthropogenic disturbances (see Paine et al. 1998).

Press disturbances - as the name also implies, are long-lasting, creating a disturbance “echo” that reverberates through ecosystems for many decades-centuries. An example is postfire logging after a severe fire damages soil horizons (pile burning), natural conifer regeneration is retarded from logs dragged uphill, biological legacies needed to jump-start natural succession are removed, and hazardous fuels remain on the ground that then primes the next fire (Lindenmayer et al. 2008, online). Typically, press disturbances accumulate spatially and temporally and operate outside the adaptive capacity of species and resilient ecosystem properties. They can lead to compounded ecological surprises (Paine 1998). This figure from Paine et al. (1998) is instructive on how press disturbances may push ecosystems beyond disturbance thresholds.

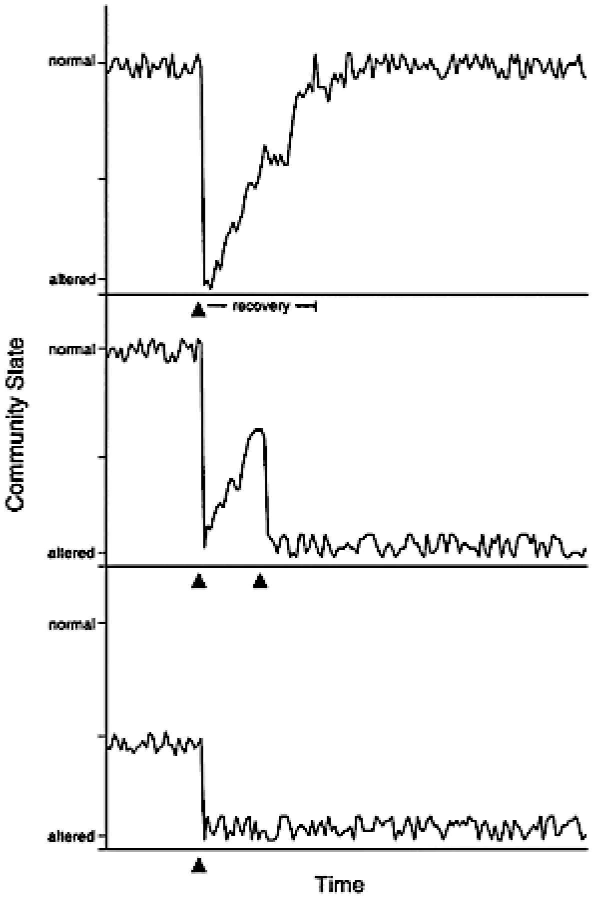
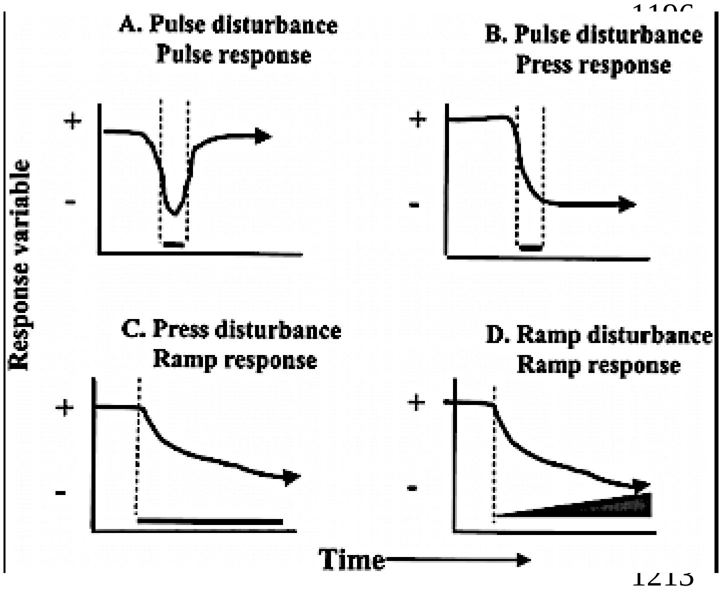


Figure 1. Schematic representation of the effects of large, infrequent disturbances (LIDs) on community state. Top, A normal community is subjected to a single LID and subsequently recovers. Middle, A normal community undergoes a second (or multiple) disturbance(s) before recovery from the first is completed; the combined effects lead to long-term alteration in community state. Bottom, A major disturbance is superimposed on an assemblage already altered by anthropogenic processes or disease; again the combination of stresses leads to long term alteration of community state. Arrowheads mark the disturbances.



This figure from [Lake (2000)](#) (paywall download only) also illustrates the difference in ecosystem response variables between pulse (natural) vs. press (chronic anthropogenic) disturbance dynamics.

Another example of a press disturbance that accumulates over large areas and across timescales is a site(s) that has been repeatedly logged (e.g., thinned, postfire logged), is accessed by roads with additional or “temporary” ones built that then funnel sediment into streams, and the area is invaded by weeds due to logging machinery, ORVs, and livestock acting as vectors of spread (see DellaSala 2019 for additional examples). Logging, roads, defective culverts, especially on steep fragile soils, also can lead to mass-wasting events during storms. Thus, press disturbances are clear and present dangers to MOG ecosystems and are distinguishable from pulse disturbances.

Threats - based on the above distinction of pulse and press disturbances, we define a "threat" as

> any anthropogenic driver(s) of ecosystem change that causes direct, indirect, and cumulative impacts to ecosystem integrity (i.e., native species populations, spatial distributions, ecosystem processes, and functions). This includes human disturbances that accumulate in overall extent, frequency, distribution, and magnitude that push species/ecosystems beyond thresholds/tipping points and create landscape traps (see Lindenmayer et al. 2011) that type convert ecosystems to degraded states. The degree of such impacts should be assessed relative to reference sites/reference conditions (comparable natural areas lacking press disturbances). If pulse disturbances shift to press disturbances, they need to be assessed within the context of anthropogenic causalities and such root causes treated first and foremost (e.g., by removing the stressors).

Notably, logging is often used by land managers mistakenly to mimic natural disturbances but there are major differences that need to be addressed in this assumption. For instance, most natural disturbances generate long-lasting legacies that perform vital ecosystem functions, whereas most forms of logging remove or damage legacies and associated processes. Logging does not mimic pulse disturbances and instead can tip ecosystems beyond thresholds especially when accumulating across time and spatial scales.

In a global analysis of threats, Bowler et al. (2020) concluded that climate change and anthropogenic drivers of biodiversity loss are present worldwide but are unequal in distribution, with several that overlap in the same place (cumulative). Additionally, according to Bowler et al. (2020), "climate change, habitat change, exploitation, pollution and invasive alien species have been recognized as the most important and widespread direct anthropogenic causes of biodiversity change (IPBES, **2019**; IPCC, **2013**; Pereira, Navarro, & Martins, **2012**). These five main drivers have been linked with changes in multiple dimensions of biodiversity, including genetic diversity, species' population sizes, community richness and ecosystem functioning (Pereira et al., **2012**). The impacts of anthropogenic drivers on a biological community in any given region critically depend on the *amount of exposure to each driver*, which is described by its local magnitude or change (such as the strength of climate change or intensity magnitude, and frequency of land-use). An important, but so far underexplored, step towards understanding the global patterns of biodiversity change is *characterizing the exposure patterns of biological communities to different types of environmental change*." In this case, researchers did not consider natural disturbances as a formidable threat.

Several other researchers have defined threats as human activities that reshape biological communities and ecosystem functions and they are increasing globally, triggering the sixth great extinction spasm (Barnosky et al. 2011, Dornelas et al. 2014, Bowler et al. 2020).

Likewise, global threat assessments (e.g., ecological or human footprint analyses) are anthropogenically focused and do not consider natural disturbances a threat per se. Importantly, meeting the global challenge of conservation (and in this case the conservation of MOG) requires not only quantifying biodiversity loss but also identifying the root causes of such loss, which in the case of MOG is historical and ongoing (albeit lower federal levels) logging (DellaSala et al. 2022a), the only disturbance that land managers can realistically control at scale.

In sum, wildfires and insects need to be considered pulse disturbances and unequivocal evidence provided when they are not operating within evolutionary bounds. We note that the evidence on fire being a press disturbance is indeed equivocal. While some researchers contend contemporary large wildfires ("megafires") are operating out of bounds (e.g., Miller and Safford 2012, Hessburg et al. 2021), others have provided evidence where it is not (e.g., Law and Waring 2015, Parks et al. 2015, Baker 2015, DellaSala and Hanson 2019). This is particularly true for mesic mixed conifer forests (Jaffe et al 2023, paywall download only) and dry mixed conifer and pine forests (Odion et al. 2014a, DellaSala and Hanson 2019) that have been shown to be quite resilient to high-severity fires (e.g., postfire "seed rains" are more than enough for pioneer species to jump start succession).

Much of the differences in interpretation of high-severity fire effects are due, in part, to an overreliance on fire return intervals derived from limited fire-scar sampling extrapolated over large areas, which has been shown to be biased and unreliable (Baker 2017), the omission of multiple lines of evidence that show otherwise (Baker et al. 2023), plot sampling problems (Hanson and Chi 2021), and failure to account for tree mortality from thinning itself (Hanson 2022).

LANDFIRE departure classes also have been used to assess fire risks, which likewise has been shown to over-estimate high-severity fire due to differences between predictions and observations on the ground following fires (Odion and Hanson 2008). Importantly, high-severity fire rotations are still on the order of centuries, providing ample opportunity for naturally disturbed forests to succeed to old-growth conditions, including with projected climate change related increases in fire severity overtime (e.g., Odion et al. 2014ab). And at least one study has shown that high-severity fire patches have not increased in area or proportion of mixed severity fire mosaics since the 1990s (DellaSala and Hanson 2019).

Finally, the tree survivors of beetle infestations carry important survival traits that may resist the next infestation but are often removed in logging operations (Six et al. 2014, 2018). Like fire, insect infestations are pulse disturbances that are increasing in frequency and magnitude in places, becoming press disturbances, due predominately to climate change and homogenization of landscapes from logging (Black et al. 2013). In such cases, treating the root causes - climate change and logging - are the best ways to effectively ameliorate the threat.

Establishing the Baseline for Threat Assessments

Establishing a reference condition or baseline in threat assessments is fundamental. For MOG specifically, there is only one historical map prior that Greeley (1925) (online) published to estimate "virgin" forests before European colonization. Other methods for back casting have often been used in regional studies of primary or MOG forests via potential vegetation mapping that can be used in areas with long-intervals between disturbances.

It is also important to avoid a shifting baseline perspective (Alleway et al. 2023) in threat assessments that occurs when the baseline is inappropriately moved to a more recent period and called "historical." For instance, placing too high a risk on contemporary fire in MOG (mainly high severity) by using a more recent historical timeline fails to take notice of the early 1900s when fire activity was much greater. Instead of the 1900s historical baseline a more recent one - usually the 1980s - is used to track wildfire activity mainly because this is the period when MTBS began tracking high-severity fire. Consequently, the baseline is inappropriately shifted to the 1980s instead of a longer and more ecologically relevant historical timeline. Another factor that affects the baseline is back-burning that is often done in burn-out operations and can overestimate high-severity fire that could have been triggered by the backburn itself (this is hard to determine given inaccuracies in fire perimeter estimates and incomplete reporting on backburning). Fire severity estimates are also often skewed by using RAVG (which uses the difference between a pre-fire satellite image and an immediate postfire satellite image to estimate severity) that has been shown to overestimate high-severity fire given some conifers are known to flush needles postfire when they were incorrectly classified as "dead" (Hanson and North 2009, DellaSala et al. 2022a: supplemental).

Conservation purposes - we define conservation as protection of MOG from press disturbances originating from anthopogenic sources. The main restoration treatment in this case is simply remove or greatly contain/restrict the anthropogenic stressors. Some examples include ending commercial logging of MOG that would begin restoring the extent of MOG writ-large. In other cases, it could mean active restoration also to remove the stressor(s) like road ripping (Hanson et al. 2009). While most land managers think of active restoration as some form of logging ('active management'), there are many interventions that are compatible with ecosystem integrity maintenance and restoration that do not involve logging, including upgrading culverts, rewilding landscapes, contributing to recovery of imperiled species, invasive weed containment, etc.

Notably, most assessments of biodiversity loss focus on rank ordering threats to species and ecosystems from anthropogenic factors that are then used to develop robust reserve and connectivity proposals to achieve conservation objectives (e.g., 30 x 30). A relevant example is the chronic loss of MOG nationwide has resulted in numerous, Red-listed ecosystems and Species, many of which are also listed under the US Endangered Species Act (DellaSala et al. 2022a). The conservation imperative in this case (supported by the evidence) is to protect MOG from the main anthropogenic stressors (logging, roads) by designing a robust reserve strategy (e.g., the NW Forest Plan reserves, carbon reserves, Law et al. 2022).

Some examples of large-scale map-based assessments of press disturbances are also available for reference as “ecological footprint analyses” (Sanderson et al. 2002, Venter et al. 2016) and many are specific to the USA, including forest fragmentation assessments that include road densities and logging (Heilman et al. 2002). The MOG threat team needs to incorporate ecological footprint analysis into its threat assessment to show cumulative losses that far exceed perceived losses from natural disturbances.

Conclusions

Based on the above, we strongly advise that you clearly distinguish anthropogenic from natural disturbances in scale, distribution, frequency, magnitude and effect on ecosystem integrity and biodiversity, and that you do not group them all under the “disturbance” or “threat” section of the assessment. For instance, by using a stacked histogram, this figure from the ANPRM assumes all 3 disturbances have equivalent effects on ecosystems, clearly, they do not.

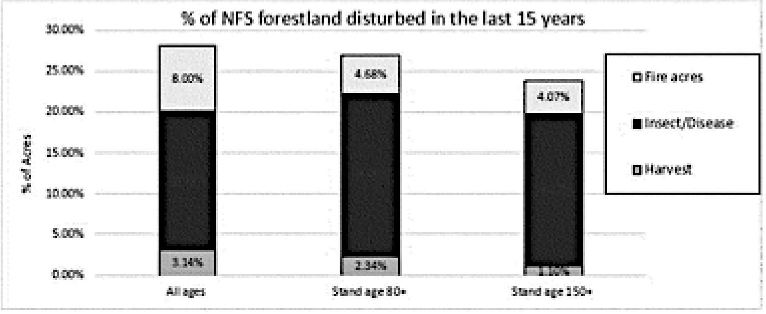


Figure 2. National Forest disturbance has increased over the past fifteen years driven primarily by overstocked forests that are susceptible to insects, disease and wildfire. Forests are also disturbed by timber harvest (these figures include harvest for ecological restoration and fire risk reduction). Most forest disturbances result in different plants, animals, and fungi colonizing an area due to the shift of environmental factors in the area of disturbance.

We request that you provide where possible spatially and temporally explicit (map based) assessments of the amount, type, and rate of MOG logging over time and split this out by land ownership while comparing how much of the federal MOG is in the GAP land-use designations (GAP1-4).

A split analysis of natural disturbance processes (fire, insects) vs. anthropogenic is needed to clearly distinguish species and ecosystem responses and adaptations/resilience potential - i.e., there are winners and losers in natural disturbances and MOG species have numerous adaptations, including at the genome level as the survivors of natural disturbances often contain highly varied gene pools (Baker and Williams 2015, Six et al. 2018). This is not the case for press disturbances that routinely degrade ecosystem integrity and push ecosystems and species to their limits.

We request that you include a MOG patch size and distribution fragmentation/footprint analysis region by region, including a discussion of habitat fragmentation and edge effects from logging and roads. We also recommend that you include a broad sweep of the literature on the ecological importance of mixed and high-severity fires and insect outbreaks in regenerating ecosystems and jump-starting natural succession. Federal agencies have a tendency to look only at the negative effects. Logging is often used to reduce fire severity but is most detrimental to MOG functionality and will not work in a changing climate (DellaSala et al. 2022b).

Finally, we are greatly concerned about the consistent misreporting on the role of forest carbon sinks in a changing climate. The latest misinformation was posted in ClimateWire (and Scientific American) and included extensive comments by Lynn Riley (American Forest Foundation) about a USDA forest report on carbon that are not based on best available science of carbon accounting.

The article and USDA report is misinformed for the following reasons and this needs to be considered in the MOG assessment:

1. There is simply no substitute for MOG as long-term carbon sinks. While carbon capture slows as forests mature at the *stand level*, the most important issue is to retain carbon stored for centuries in large trees, foliage, and soils by not logging them (see Mackey et al. 2013 for importance of long-term stores). Cutting down "some" MOG and replacing with young trees is counterproductive and damaging to the climate and ecosystems (Moomaw and Law 2023). It would violate the intent of EO 14072 - to "conserve" MOG.
2. At the *tree level*, the rate of carbon accumulation increases continuously with tree size (Stephenson et al. 2014; Mildrexler et al. 2020; Mildrexler et al. 2023) and thus large trees of all species can be thought of as carbon banks (Birdsey et al. 2023).
3. Logging results in emitting >80% of the carbon stored in forests overtime (Law et al. 2018; Hudiburg et al. 2019), which is far greater than all natural disturbances combined at scale (Harris et al. 2016; Merrill et al. 2018).
4. The carbon costs of global wood harvests and wood substitution costs are far greater than previously estimated (Harmon 2019; Peng et al. 2023); meaning, storing some carbon in wood products is a lose-lose situation and planting young trees is no substitute for the carbon debt created by cutting down MOG (Law et al. 2018; Moomaw and Law 2023).
5. Allowing forests to mature - a process called proforestation (Moomaw et al. 2019), along with protecting existing mature and old-growth forests as carbon reserves (Law et al. 2022, DellaSala et al. 2022a) is the best natural climate solution.
6. Even if forests do switch to a net carbon source from increased climate-related tree mortality, logging them will only exacerbate the rate of carbon released to the atmosphere. This is because nearly all of the carbon in naturally severely disturbed forests transfers from live to dead pools and soils. For instance, nearly all the carbon present in large trees before the Rim and Creek fires in the Sierra Nevada was still present in those trees after these severe burns (Harmon et al. 2022). And carbon in dead pools would slowly (decades-centuries) decompose, much of it would be retained in soils, and new growth would quickly compensate for losses provided those forests are not postfire logged.