



Photo- D. DellaSala

Analysis of Carbon Storage in Roadless Areas of the Tongass National Forest

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We have reviewed the Draft Environmental Impact Statement (DEIS) for the proposed Alaska Roadless Rulemaking and, in particular, its analysis of carbon storage in the inventoried roadless areas of the Tongass National Forest. The DEIS substantially undervalues the global and national importance of old-growth trees on the Tongass for carbon storage. Research shows, for example, that primary (unlogged) forests on the Tongass store much more carbon than logged forests because of the relatively high percentage of old growth and long stable residence times of carbon stored in these forests. The DEIS incorrectly assumes the carbon emitted from logging represents a zero-sum game with carbon recapture in wood product pools and reforestation – this argument is completely false (see below).

- The Tongass is part of a global network of temperate rainforests that make up ~2.5% of the world's total forest coverage but these rainforests have exceptional carbon stores for

their relatively small spatial extent and are critically important in climate regulation collectively and individually.¹

- The Tongass is one of only 4 other temperate rainforests world-wide that is still largely intact, which is a value of global importance grossly undervalued in the DEIS.²
- The Tongass occurs within the Pacific Coastal Temperate Rainforest bioregion (extends from Coast Redwoods to Alaska) that includes temperate rainforest ecoregions and climatically distinguishable subregions (subpolar, perhumid, seasonal, warm temperate) considered globally outstanding for their biodiversity and that collectively comprise over one-third of the world's entire temperate rainforest biome based on latest rainforest mapping that should be cited and elevated in importance in the DEIS.³
- Tongass carbon stores are substantially greater than any other national forest in the US and are irreplaceable as carbon sinks.⁴
- Primary (unlogged) forests on the Tongass store much more carbon than logged forests because of the relatively high percentage of old growth and long stable residence times of carbon stored in these forests, and in fact old growth forests are accruing biomass at a rate of approximately a Teragram a year.⁵ The DEIS incorrectly assumes the carbon emitted from logging represents a zero sum game with carbon recapture in wood product pools and reforestation – this is completely false (see below).
- The Tongass may function as a climate refuge for species facing more extreme climatic conditions in the interior of Alaska and coastal rainforests further south if managed to protect old-growth forests and roadless areas, based on climate envelope modeling and downscaled climate projections for the region.⁶
- Globally, wilderness and intact areas have been declining at an accelerated rate, contain irreplaceable biodiversity and carbon stores, and these losses can be attributed to the “degazetting” (removal of protection status) globally – while roadless areas are not designated wilderness per se – the DEIS continues the alarming global trend of degazetting wild, irreplaceable places.⁷ Instead, maintaining and restoring the integrity of intact forests and wild places is an urgent global priority for conservation and

¹ DellaSala et al. 2011.

² DellaSala et al. 2011.

³ DellaSala et al. 2011.

⁴ Leighty et al. 2006; Keith et al. 2009; Buma and Thompson 2019. Also, using the dataset in Krankina et al. 2014, the Tongass is a national carbon champion.

⁵ See Leighty et al. 2006; Keith et al. 2009; Buma and Barrett 2015

⁶ DellaSala et al. 2015.

⁷ Watson et al. 2016a.

sustainability efforts designed to halt the biodiversity and climate crises.⁸ Intact areas are also much more likely to retain their native biodiversity than fragmented areas in a rapidly changing climate.⁹

- Large, old growth trees are critically important globally and scientists are calling for protecting places like the Tongass where large trees are especially concentrated to help avoid a biodiversity crisis.¹⁰
- Because of the global importance of primary (unlogged) forests and high concentration of old-growth forests on the Tongass, scientists are calling on governments to manage these forests to reach their maximum carbon potential via “proforestation” (nature-based climate solutions that allow forests to mature) in order to mitigate climate change.¹¹
- The best option for storing carbon long term on public lands is the “no harvest option” for the Tongass and all US public timberlands.¹² Forgoing timber harvest in these areas is projected to result in a net increase of 43% in carbon stores nation-wide, for instance, and an increase in sequestration potential on the national forests such as the Tongass¹². The DEIS needs to reflect these published estimates and provide a science-based assessment of carbon stored by old forests and estimated emissions from proposed logging given the national and global significance of the Tongass.

In sum, the Forest Service is responsible for stewarding arguably the most important national forest in the nation and has an ethical-moral and legal obligation to maintain remaining untrammelled areas on the Tongass as irreplaceable assets within the national forest system (as noted by 234 scientists in an October 2019 letter calling on land managers to leave the Roadless Rule in place in Alaska). These irreplaceable values need to be fully acknowledged and protected for their national and global significance.

Additionally, the Forest Service is taking unacceptable climate and biodiversity risks at a time when thousands of scientists have been calling for stricter protections as climate mitigation/adaptation strategies due to the global biodiversity and climate crises we now face.¹³ The best alternative for storing carbon long term on public lands is a “no harvest option” for the Tongass and all US public timberlands.¹⁴ Forgoing timber harvest in these areas is projected to result in a net increase of 43% in carbon stores nation-wide, for instance, and an increase in sequestration potential on national forests such as the Tongass. The DEIS needs to reflect these

⁸ Watson et al. 2017; Ripple et al. 2019.

⁹ Watson et al. 2016b.

¹⁰ Keith et al. 2009; Lindenmayer et al. 2012, 2013; Krankina et al. 2014.

¹¹ Mackey et al. 2014; Moomaw 2019.

¹² Leighty et al. 2006; Depro et al. 2008

¹³ Watson et al. 2016a,b; Ripple et al. 2017; Ripple et al. 2019.

¹⁴ Leighty et al. 2006; Depro et al. 2008.

published estimates and provide a science-based assessment of carbon stored by old forests and emitted from proposed logging given the national and global significance of the Tongass and in relation to these cited studies.

A. THE DEIS UNDERVALUES FOREST CARBON AND GROSSLY UNDERESTIMATES EMISSIONS ATTRIBUTABLE TO LOGGING.

NEPA regulations state that:

NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA.¹⁵

To ensure that the agency has taken the required “hard look,” courts hold that the agency must utilize “public comment and the best available scientific information”¹⁶ or open themselves up to lawsuits.

Further, NEPA requires agencies to explain opposing viewpoints and their rationale for choosing one viewpoint over the other.¹⁷ Federal courts have set aside NEPA analysis where the agency failed to respond to scientific analysis that calls into question the agency’s assumptions or conclusions.¹⁸

¹⁵ 40 C.F.R. § 1500.1(b).

¹⁶ *Biodiversity Cons. Alliance v. Jiron*, 762 F.3d 1036, 1086 (10th Cir. 2014) (internal citation omitted). Regulations implementing the planning provisions of National Forest Management Act (NFMA) also require the use of the best available scientific information (BASI). 36 C.F.R. § 219.3. As noted above, the proposed action includes adding 185,000 acres to the suitable timber base, which requires that the Forest Service amend the Tongass Forest Plan. The Forest Service’s planning regulations apply to Forest Plan amendments. 36 C.F.R. § 219.1. Even if they do not apply, they establish sound agency practice and comport with NEPA’s mandates regarding best available scientific information and high quality data.

¹⁷ 40 C.F.R. § 1502.9(b) (requiring agencies to disclose, discuss, and respond to “any responsible opposing view”).

¹⁸ *See Ctr. for Biological Diversity v. U.S. Forest Serv.*, 349 F.3d 1157, 1168 (9th Cir. 2003) (finding Forest Service’s failure to disclose and respond to evidence and opinions challenging EIS’s scientific assumptions violated NEPA); *Seattle Audubon Soc’y v. Moseley*, 798 F. Supp. 1473, 1482 (W.D. Wash. 1992) (“The agency’s explanation is insufficient under NEPA – not because experts disagree, but because the FEIS lacks reasoned discussion of major scientific objections.”), *aff’d sub nom. Seattle Audubon Soc’y v. Espy*, 998 F.2d 699, 704 (9th Cir. 1993) (“[i]t would not further NEPA’s aims for environmental protection to allow the Forest Service to ignore reputable scientific criticisms that have surfaced”); *High Country Conservation Advocates v. Forest Service*, 52 F. Supp. 3d 1174, 1198 (D. Colo. 2014) (finding Forest Service violated NEPA by failing to mention or respond to expert report on climate impacts).

The DEIS does not present or consider the best available scientific information about the impact of the proposed action on forest carbon. The DEIS presents a contradictory, scientifically flawed, inappropriately scaled and biased accounting of forest carbon losses associated with suspending the national roadless conservation rule on the Tongass. Not a single forest carbon life cycle analysis is presented, yet, the Forest Service draws sweeping conclusions that undervalue the global importance of carbon stored in old growth and roadless areas (IRAs) on the Tongass, while inappropriately minimizing the emissions footprint from roadless entry at a time when overwhelming scientific consensus urges governments to avoid additional emissions from forest degradation and to store more carbon in forest ecosystems.¹⁹ Because agencies and academics have quantified and compared the carbon emissions of alternative logging proposals, the Forest Service cannot fail to undertake a similar analysis on the basis that it is too complex or complicated. Dr. DellaSala's 2016 report addressed carbon stores from wood products and concluded that logging Tongass old-growth forest under the 2016 Forest Plan would result in net annual CO₂ emissions totaling between 4.2 million tons and 4.4 million tons, depending on the time horizon chosen.²⁰ The Bureau of Land Management a decade ago completed an EIS for its Western Oregon Resource Management Plan in which that agency also predicted and quantified the net carbon emissions from its forest and other resource management programs.²¹

Opening up roadless areas and logging in old-growth forests, as the proposed rule would do, conflicts with published research showing the most effective/efficient means to maintain the enormous Tongass carbon sink is to protect all remaining old-growth forests from logging.²² The DEIS carbon assessment does not present the best scientific information, particularly in reference to the global climate emergency²³ or the importance of keeping carbon tied up in Tongass forests as recommended by scientists.²⁴ In fact, the DEIS goes as far as to boldly proclaim, without a single published scientific reference, that “the management mechanisms applied in all alternatives are consistent with internationally recognized climate change adaptation and mitigation practices identified by the IPCC (IPCC 2000, 2007).”²⁵ To the contrary, the IPCC (2018)²⁶ does not endorse roadless development as an appropriate climate mitigation/adaptation

¹⁹ Mackey et al. 2013, Mackey 2014, Mackey et al. 2016a,b, Griscom et al. 2017, Law et al. 2018, Ripple et al. 2019, Moomaw 2019.

²⁰ D. DellaSala, *The Tongass Rainforest as Alaska's First Line of Climate Change Defense and Importance to the Paris Climate Change Agreements* (2016) at 14, and available at <https://forestlegacies.org/wp-content/uploads/2016/01/tongass-report-emissions-2016-01.pdf> (last viewed Dec. 13, 2019).

²¹ See Bureau of Land Management, Western Oregon Proposed RMP Final EIS (2009) at 165-181, excerpts attached.

²² Leighty et al. 2006.

²³ Ripple et al. 2019.

²⁴ Leighty et al. 2006, DellaSala et al. 2011, Moomaw 2019.

²⁵ DEIS at 3-128.

²⁶ Given the large size of this report and the fact that the IPCC report is readily available online, we have provided only the only link and not the full pdf - https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf.

strategy. Rather, the IPCC has repeatedly recommended storing more carbon in ecosystems by avoiding additional emissions in the land sector.²⁷ The same is true for the published sources cited in these comments. We are unaware of any other research that supports the DEIS assertion that clearcutting old-growth rainforests and building roads into intact watersheds is consistent with adaptation and mitigation strategies.

Based on the recent IPCC assessment (2019), an estimated 23% of total anthropogenic greenhouse gas emissions (2007-2016) derive from agriculture, forestry, and other land use. Thus, IPCC recommends avoiding additional emissions from these sectors.

Notably from the IPCC (2019)

“Achieving land degradation neutrality will involve a balance of measures that avoid and reduce land degradation, through adoption of sustainable land management, and measures to reverse degradation through rehabilitation and restoration of degraded land. Many interventions to achieve land degradation neutrality commonly also deliver climate change adaptation and mitigation benefits. The pursuit of land degradation neutrality provides impetus to address land degradation and climate change simultaneously (high confidence).”

There are at least two fundamental flaws (inherent *biases*) in the DEIS carbon assessment: (1) undervaluing long-term carbon stored in intact watersheds and old-growth forests compared to logged areas; and (2) understating cumulative emissions from logging and road building by using an inappropriate analysis scale and by overstating wood product stores that do not comport with recent published estimates (discussed below).

The DEIS also does not sufficiently meet the Forest Service’s substantive obligation to protect Tongass resources because it: (1) proposes to enter intact watersheds that are acting as irreplaceable strongholds for fish and wildlife populations in a changing climate;²⁸ and (2) degrades intact areas containing nationally recognized carbon sinks at a time when scientists recommend avoiding entry into intact areas as critical to preventing the escalating climate and biodiversity crises underway globally.²⁹ Specifically, the DEIS should continue *to protect, preserve, manage, and restore* natural systems (roadless, old growth) on the Tongass, rather than degrade them by development, and then expecting them to somehow be miraculously restored and recovered with all emissions offset by regrowth and wood product stores – an assumption directly contradicted by the best available science (see below).

²⁷ See also Griscom et al. 2017, Moomaw 2019.

²⁸

See DellaSala et al. 2011, DellaSala et al. 2015, Watson et al. 2016a,b; 2017.

²⁹ Watson et al. 2016a,b; 2017; Ripple et al. 2019.

To assess properly the impacts of the proposed exemption on carbon emissions and sequestration, the agency must address the following key elements and information not now considered in the DEIS.

Trees accumulate carbon over their entire lifespan. While growth efficiency declines as the tree matures, corresponding increases in a tree's total leaf area overcome this slow down as the **whole-tree carbon accumulation rate increases with age and tree size** (Figure 1 – the figure below and some of the text in this section was modified from materials sent to DellaSala by M.G. Anderson, pers. comm). A study of 673,046 trees across six countries and 403 species found that at the extreme, a large old tree may sequester as much carbon in one year as growing an entire medium size tree.³⁰ At one site, large trees comprised 6 percent of the trees but 33 percent of the annual forest growth. More recent studies show the largest 1% of trees in old-growth forests worldwide store ~50% of the total stand level carbon.³¹ In the Tongass, old growth forests continue to accrue biomass and carbon at an amazing rate³². In sum, young trees grow fast, but old trees store a disproportionate amount of carbon over time given the larger leaf surface area for absorption and massive tree trunks and root wads that represent centuries of accumulated carbon.

Quoting directly from the abstract in Lutz et al. (2018):

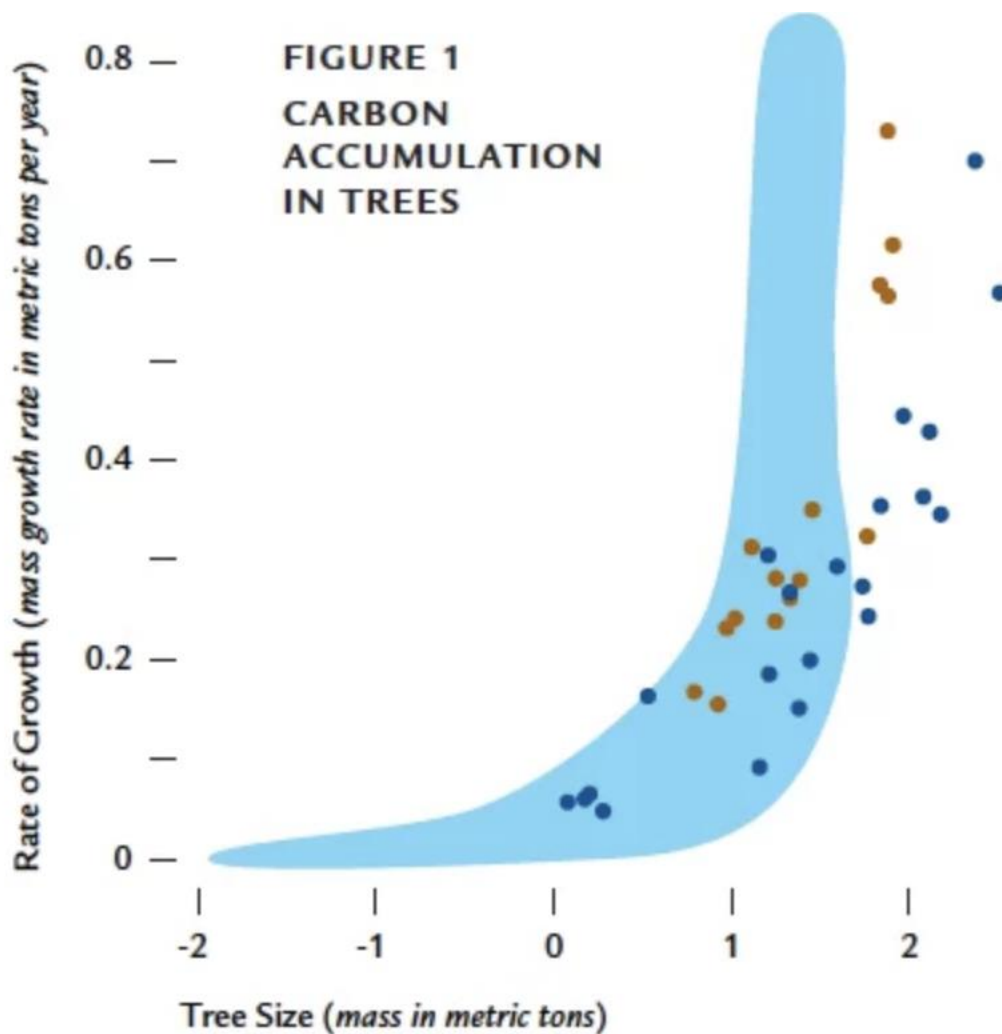
Main conclusions: Because large-diameter trees constitute roughly half of the mature forest biomass worldwide, their dynamics and sensitivities to environmental change represent potentially large controls on global forest carbon cycling. We recommend managing forests for conservation of existing large-diameter trees or those that can soon reach large diameters as a simple way to conserve and potentially enhance ecosystem services.³³

³⁰ Stephenson et al. 2014.

³¹ Lutz et al. 2018.

³² Buma and Barrett 2015

³³ Lutz et al. 2018



Aboveground mass growth rates for 58 species (shaded area) juxtaposed with two of the most massive tree species on earth: Swamp Gum (*Eucalyptus regnans*—brown dots) and Coast Redwood (*Sequoia sempervirens*—blue dots). Mass growth rate equals the total mass accumulated each year after accounting for respiration. The mass of a tree is primarily carbon, so the figure shows that annual carbon accumulation increases with the size of the tree. (Adapted from Stephenson et al. 2014.)

Old forests accumulate carbon and contain vast quantities of it. Although individual trees experience an increasing rate of carbon sequestration, forest stands experience an “S-curve” of net sequestration rates (e.g. slow, rapid, slow).³² The expected decline in older stands is due to

Lutz et al. 2018.

tree growth balanced by mortality and decomposition. For instance, an international team of scientists reviewed 519 published forest carbon-flux estimates from stands 15 to 800 years old and found that, in fact, net carbon storage was positive for 75 percent of the stands over 180 years old and the chance of finding an old-growth forest that was carbon neutral was less than 1 in 10.³³ They concluded that old-growth forests are substantial carbon sinks, steadily accumulating carbon over centuries and containing vast quantities of it in relatively stable form.

Old forests accumulate carbon in soils. Soil organic carbon levels in old forests are generally thought to be in a steady state. However, as Alaska’s climate increasingly overheats (twice the rate of the rest of the US), soils will be exposed to increased drying and reduced snowpack, and this will lead to methane release. Notably, Tongass soils store >50% of the carbon in the already incredibly dense ecosystem³³. Moreover, protecting remaining unlogged forests provides for more stable microclimates (with less desiccation and lower temperatures). In fact, recent research shows that old-growth forests may act as a climate buffer as studies comparing logged vs. old growth in the Oregon Cascades found that old growth reduced maximum spring and summer air temperatures as much as 2.5 degrees C.³⁴ Thus, scientists have repeatedly acknowledged the superior climate benefits inherent to old-growth forests that are irreplaceable in human lifetimes.

Forests share carbon among tree species. Trees compete for sunlight and soil resources, and competition for resources is commonly considered the predominant tree species interactions in forests. However, recent research on carbon isotope labeling has shown that trees interact in more complex ways, including substantial exchange and sharing of carbon below ground. Aided by mycorrhiza networks, interspecific transfer among trees accounts for 40% of the fine root carbon: totally ~280 kg ha⁻¹ per year tree-to-tree transfer.³⁵ Morrien et al. (2017), found that mycorrhiza soil networks become more connected and take up more carbon as forest succession progresses even without major changes in dominant species composition. Notably, old-growth forests compared to young growth contain more complex below-ground processes that connect trees at the subsurface level.³⁶ Thus, the Forest Service needs to provide information on the impacts of logging on soil microbial and mycorrhizae carbon exchange before concluding it is insignificant. Failure to include such information would violate NEPA’s hard look and BASI mandates.

Primary forest carbon can help slow climate change. Griscom et al. (2017) systematically evaluated 20 conservation, restoration, and improved land management actions that increase carbon storage and avoid greenhouse gas emissions. They found that the maximum potential of natural climate solutions was ~2.4 Pg of carbon per-year while safeguarding food security and

1. 2018

³³ McNicol et al. 2019

³³ Luyssaert et al. 2014.

³⁴ Frey et al. 2016.

³⁵ Klein et al. 2016.

³⁶ Morrien et al. 2017.

biodiversity.³⁷ To put the Tongass in this perspective – total Tongass stores = 2.8 Pg carbon with 16%-23% of that in IRAs – additionally, by maximizing carbon in IRAs and old growth (the scientifically recommended climate strategy) – the entire national forest benefits through the maintenance of linked ecosystem services and biodiversity (i.e., multifunctionality of forests maintained via carbon management).³⁸ New research (see below) suggests this strategy is the most cost-feasible option by a large margin³⁹ (also see below) and it should receive highest priority as a policy consideration⁴⁰ especially on the Tongass.⁴¹ In addition to carbon, old forests also build soil, cycle nutrients, mitigate pollution, purify water, release oxygen, and provide habitat for wildlife at levels far superior than logged forests.⁴²

Primary (unlogged) forests are far superior to logged forests in climate mitigation and biodiversity benefits. Globally, primary forests store 30-50% more carbon than logged forests (which is similar to the estimates provided in the DEIS on mature vs. logged Tongass forest stores⁴³) and up to half of the carbon stored in a forest is represented by the largest/oldest 1% of trees at the stand level as noted.⁴⁴ As stated, logging primary forests results in a net carbon debt and other irreplaceable losses that are not made up for via reforestation or wood product stores as the carbon present in primary forests and soils takes centuries to accumulate compared to much shorter-lived wood products that represent only a fraction of the original forest store.

In part because the DEIS analysis fails adequately to account for this basic scientific information relevant to an assessment of the impact of the proposed exemption on carbon and climate impacts, the DEIS is flawed in at least the specific ways described herein.

Tongass carbon stores need to be prioritized as globally and nationally significant climate mitigation/adaptation strategies to be protected, preserved, and managed as unique ecological communities. Old-growth forests, in general, store massive amounts of carbon in trees, foliage, and soils. Pacific coastal rainforests, in particular, are global champions in this regard.⁴⁵ Of relevance, temperate rainforests in Alaska store >2.8 Petagrams (Pg) C (1 Pg = 1 billion tonnes) in biomass and soils, the equivalent of >8% of the carbon in all contiguous US forests, most of which is on the Tongass.⁴⁶ Based on FIA datasets, Tongass roadless areas represent ~16% to 23% of total carbon on the Tongass forest depending on categories used

³⁷ Griscom et al. 2017.

³⁸ See Brandt et al. 2014.

³⁹ Moomaw et al. 2019.

⁴⁰ McKinley et al. 2011.

⁴¹ Leighty et al. 2006; Buma and Thompson 2019

⁴² Mackey et al. 2014, Brandt et al. 2014.

⁴³ DEIS at 3-124.

⁴⁴ Lutz et al. 2018.

⁴⁵ Leighty et al. 2006, Keith et al. 2009, Krankina et al. 2014.

⁴⁶ Leighty et al. 2006; Buma and Thompson 2019; McNicol et al. 2019

(Table 1, 2). Thus, roadless areas – especially those with old-growth forests – are uniquely valuable as a long-term stable carbon sink compared to logged areas that emit most of their carbon (see below).

The Tongass stores a massive amount of carbon--the total carbon stored in Tongass roadless areas are equivalent to annual emissions of ~128, 550-watt coal-fired power plants.⁴⁷ Keeping carbon in forests is a fundamental climate mitigation strategy directly responsive to the climate emergency⁴⁸ and essential to offsetting some of the emissions from the energy sector. The Tongass stores a massive amount of carbon in its old growth forests, at levels that if emitted into the atmosphere would approach the emission equivalents of coal-fired power plants. At a time when the world is looking for leadership on cutting emissions at all scales, removing protection for this carbon storage is unsupportable. Table 1 provides a breakdown of Tongass old-growth roadless carbon values (including congressionally withdrawn areas), Table 2 just the IRA carbon values, and Figure 1 shows the spatial distribution of carbon stores on Tongass IRAs. Table 3 shows that Alternative 6 will place at risk **71.5%** of the carbon stored in old-growth forests and soils, with most of that carbon emitted to the atmosphere (see Leighty et al. 2006). Table 4 provides an economic estimate of the carbon value at risk to logging on the Tongass under Alternative 6 (>\$234 million), which may far exceed timber values. Additionally, if the Forest Service enters all roadless areas in this century >\$2.2 billion in carbon assets will be squandered away, should an offset market develop. All these data were available to the Forest Service (Forest Inventory Assessment - FIA) and they need to be fully analyzed in the DEIS to provide reliable estimates of carbon assets and their relative (to timber), tradeoffs involved, and the economic importance on the Tongass of carbon, along with reliable estimates of emissions from logging. Disclosing these tradeoffs is especially relevant at a time when the IPCC (2018, 2019) and other reports (Ripple et al. 2017, 2019) have warned that we have about 10 years before severe climate impacts are locked in with irreversible consequences to biodiversity and the planet's life-giving systems.

⁴⁷ https://www.oregonlive.com/business/2010/12/pges_coal-fired_boardman_plant.html.

⁴⁸ See Moomaw 2019, Ripple et al. 2019.

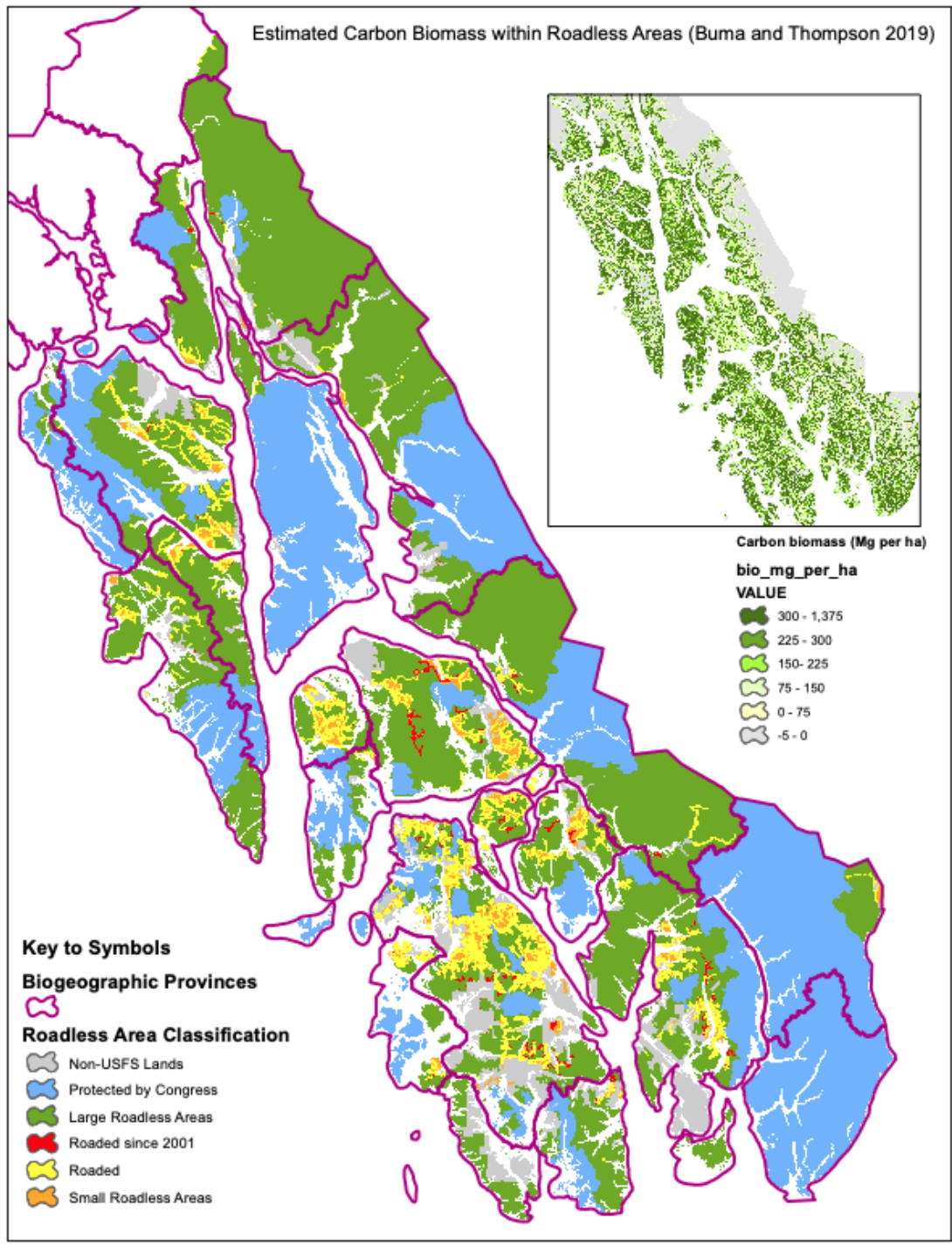
Table 1. Estimated carbon biomass in old-growth forest among categories of roadless areas on the Tongass NF

| OwnerType_2019 | USDA FOREST SERVICE | | | | | |
|--|----------------------------|----------------------------|---------------------|--|---------------------------------|--------------------|
| POG | OG Only | | | | | |
| | low estimate | high estimate | Total area | | Estimate C in OG forest biomass | |
| Row Labels | Average of Carbon_ratio 58 | Average of Carbon_ratio 46 | Sum of GIS_Hectares | | (low estimage in Mg) | (high est. in Mg) |
| Roadless in 2001 Rule | 264.7 | 333.7 | 999,179 | | 264,443,913 | 333,444,106 |
| Lg. Roadless Areas not in Small Rdls Areas | 257.1 | 324.1 | 76,166 | | 19,580,156 | 24,689,023 |
| Roaded-Roadless | 242.4 | 305.6 | 58,329 | | 14,139,031 | 17,828,070 |
| Roaded Areas | 249.3 | 314.4 | 14,357 | | 3,579,634 | 4,513,860 |
| Wilderness or NM | 263.3 | 332 | 156,023 | | 41,076,507 | 51,794,893 |
| Non-USFS Lands | 247.7 | 312.3 | 662,496 | | 164,101,837 | 206,915,638 |
| Unknown | 261.5 | 329.8 | 4,171 | | 1,090,861 | 1,375,453 |
| Unknown | 187.5 | 236.5 | 982 | | 184,209 | 232,273 |
| Grand Total | 255.6 | 322.3 | 1,971,704 | | 503,969,209 | 635,467,036 |

Table 2. Carbon stored in roadless area categories on the Tongass.

| Large Roadless Areas | "Roaded Roadless" | | Small Rdls Areas | | Roaded Areas | | Protected by Congress | | Non-USFS Lands | | Total Average Mg per ha | Total Total Mg Carbon | |
|----------------------|-------------------|-----------------|-------------------|-----------------|-------------------|-----------------|-----------------------|-----------------|-------------------|-----------------|-------------------------|-----------------------|-------------|
| | Average Mg per ha | Total Mg Carbon | Average Mg per ha | Total Mg Carbon | Average Mg per ha | Total Mg Carbon | Average Mg per ha | Total Mg Carbon | Average Mg per ha | Total Mg Carbon | | | |
| 242.5 | 47,208,8 | 274.7 | 98,058 | 313.89 | 1,867,886 | 361.48 | 10,026,227 | 207.71 | 66,457,805 | 263.80 | 5,436,143 | 260.64 | 131,094,140 |
| 245.92 | 2,081,610 | | | | | 317.13 | 83,671 | 224.49 | 36,976,406 | 205.86 | 248,378 | 224.82 | 39,390,064 |
| 224.39 | 7,939,491 | 248.04 | 7,679 | 361.21 | 317,926 | 374.39 | 1,469,914 | 179.03 | 2,579,177 | 277.13 | 198,836 | 277.09 | 12,513,023 |
| 255.70 | 18,610,022 | 295.11 | 85,792 | 305.53 | 1,322,520 | 356.44 | 6,423,528 | 210.15 | 11,972,020 | 286.92 | 3,550,567 | 278.05 | 41,964,449 |
| 231.40 | 17,172,289 | 226.63 | 4,587 | 304.03 | 227,439 | 371.92 | 2,025,237 | 144.80 | 7,123,632 | 252.95 | 1,407,175 | 261.84 | 27,960,360 |
| 190.38 | 1,404,610 | | | | | 234.51 | 23,876 | 185.47 | 7,806,570 | 228.97 | 31,187 | 192.89 | 9,266,244 |
| 232.20 | 58,182,471 | 262.79 | 1,429,232 | 261.26 | 4,248,583 | 303.66 | 15,895,643 | 196.32 | 22,381,595 | 253.61 | 11,984,173 | 249.11 | 114,121,697 |
| 236.71 | 9,363,695 | 232.25 | 279,800 | 213.54 | 756,243 | 291.33 | 3,979,300 | 167.72 | 2,705,767 | 252.31 | 1,048,227 | 244.24 | 18,133,031 |
| 248.42 | 4,621,788 | | | 282.27 | 61,790 | 345.31 | 264,235 | 231.39 | 6,290,381 | 200.47 | 149,533 | 246.54 | 11,387,728 |

| | | | | | | | | | | | | | |
|--------------|----------------|--------------|---------------|-------------|---------------|-------------|---------------|--------------|----------------|-------------|---------------|-------------|--------------------|
| 201.6 | 14,044, | 240.7 | 675,8 | 236. | 1,737, | 276. | 4,000, | 199.1 | 2,694,6 | 216. | 3,418, | 225. | |
| 3 | 010 | 8 | 71 | 58 | 670 | 70 | 336 | 6 | 88 | 69 | 960 | 90 | 26,571,535 |
| 289.3 | 4,013,7 | 317.0 | | 337. | 1,008, | 340. | 3,176, | 284.3 | 1,032,3 | 291. | 521,09 | 311. | |
| 9 | 21 | 4 | 8,473 | 44 | 771 | 32 | 035 | 1 | 43 | 65 | 0 | 71 | 9,760,434 |
| 237.9 | 26,139, | 301.0 | 465,0 | 286. | 684,1 | 320. | 4,475, | 177.9 | 9,658,4 | 268. | 6,846, | 254. | |
| 6 | 257 | 6 | 88 | 21 | 09 | 59 | 736 | 3 | 16 | 36 | 362 | 25 | 48,268,969 |
| 229.9 | 31,318, | 247.6 | 892,2 | 238. | 2,941, | 290. | 16,874 | 239.8 | 16,293, | 268. | 21,060 | 255. | |
| 6 | 111 | 6 | 78 | 48 | 262 | 26 | ,911 | 6 | 468 | 92 | ,394 | 37 | 89,380,425 |
| 264.7 | 5,634,5 | | | 226. | | 356. | | | | 265. | 3,679, | 266. | |
| 3 | 63 | | | 80 | 397 | 33 | 2,846 | | | 96 | 426 | 56 | 9,317,233 |
| 219.8 | 15,720, | 244.8 | 775,4 | 234. | 2,586, | 287. | 15,078 | 258.0 | 7,425,9 | 261. | 14,491 | 252. | |
| 8 | 049 | 1 | 92 | 97 | 253 | 67 | ,975 | 7 | 74 | 59 | ,136 | 13 | 56,077,879 |
| 281.1 | 2,088,0 | 230.6 | 21,44 | 251. | 236,8 | 294. | 1,465, | 196.9 | 4,999,4 | 315. | 468,65 | 278. | |
| 0 | 47 | 7 | 3 | 59 | 29 | 96 | 398 | 9 | 43 | 98 | 2 | 44 | 9,279,811 |
| 231.4 | 7,875,4 | 293.1 | 95,34 | 284. | 117,7 | 322. | 327,69 | 192.5 | 3,868,0 | 296. | 2,421, | 256. | |
| 9 | 51 | 4 | 3 | 60 | 83 | 67 | 2 | 6 | 51 | 39 | 180 | 94 | 14,705,501 |
| 186.1 | 53,884, | 336.7 | 287,4 | 333. | 595,5 | 312. | 2,942, | 149.4 | 66,534, | 259. | 5,757, | 213. | |
| 3 | 796 | 8 | 12 | 72 | 65 | 46 | 711 | 4 | 550 | 89 | 139 | 28 | 130,002,173 |
| 192.5 | 11,619, | 369.3 | 120,6 | 327. | 275,9 | 313. | 861,29 | 118.5 | 3,208,9 | 268. | 1,822, | 235. | |
| 6 | 409 | 4 | 27 | 18 | 72 | 76 | 5 | 7 | 27 | 13 | 554 | 07 | 17,908,784 |
| | 1,228,3 | | | 368. | 96,49 | 136. | | 159.8 | 18,154, | 284. | | 168. | |
| 62.94 | 45 | | | 10 | 0 | 68 | 78,974 | 4 | 192 | 05 | 46,875 | 06 | 19,604,876 |
| | | | | | | 123. | | 181.0 | 31,003, | 148. | | 179. | |
| | | | | | | 88 | 45 | 2 | 210 | 94 | 170 | 52 | 31,003,425 |
| 187.6 | 21,671, | 288.4 | 136,4 | 309. | 31,94 | 325. | 1,478, | 118.4 | 7,974,9 | 260. | 721,35 | 212. | |
| 2 | 798 | 9 | 81 | 91 | 3 | 86 | 419 | 1 | 12 | 51 | 8 | 07 | 32,014,912 |
| 192.0 | 19,365, | 314.3 | 30,30 | 440. | 191,1 | 322. | 523,97 | 118.6 | 6,193,3 | 251. | 3,166, | 215. | |
| 2 | 243 | 3 | 4 | 91 | 61 | 72 | 8 | 7 | 09 | 30 | 182 | 24 | 29,470,176 |
| 225.3 | 190,59 | 264.3 | 2,706, | 265. | 9,653, | 312. | 45,739 | 196.0 | 171,66 | 263. | 44,237 | 247. | |
| 2 | 3,399 | 8 | 980 | 82 | 295 | 40 | ,492 | 9 | 7,419 | 11 | ,849 | 37 | 464,598,434 |



**Table 3.
Estimated
Mg of forest
and soil
carbon on
lands
suitable for
old-growth
logging
under DEIS
Alternatives**

| Forest & Soil Carbon Estimates | Alternatives | | | | | |
|---|---------------------|------------|------------|-------------|-------------|-------------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Suitable Acres (with Data) | 229,564 | 249,888 | 307,778 | 387,941 | 394,997 | 394,997 |
| Net Change from Alt 1 (acres) | 0 | 20,325 | 78,214 | 158,377 | 165,433 | 165,433 |
| Suitable Hectares (w/data) | 92,901 | 101,126 | 124,554 | 156,994 | 159,850 | 159,850 |
| Net Change from Alt 1 (hectares) | 0 | 8,225 | 31,652 | 64,093 | 66,948 | 66,948 |
| Total Forest C (low est) | 23,625,799 | 25,643,535 | 31,591,558 | 39,655,731 | 40,508,557 | 40,508,557 |
| % Increase from Alt 1 (low est) | 0.0% | 8.5% | 33.7% | 67.8% | 71.5% | 71.5% |
| Total Forest C (high est) | 29,790,661 | 32,334,884 | 39,834,901 | 50,003,261 | 51,078,589 | 51,078,589 |
| % Increase from Alt 1 (high est) | 0.0% | 8.5% | 33.7% | 67.8% | 71.5% | 71.5% |
| Total Soil C | 34,284,875 | 37,153,086 | 45,699,226 | 56,497,163 | 57,468,262 | 57,468,262 |
| % increase from Alt 1 (soil) | 0.0% | 8.4% | 33.3% | 64.8% | 67.6% | 67.6% |
| Forest + Soil C (low) | 57,910,675 | 62,796,621 | 77,290,783 | 96,152,894 | 97,976,819 | 97,976,819 |
| Forest + Soil C (high) | 64,075,536 | 69,487,970 | 85,534,126 | 106,500,424 | 108,546,851 | 108,546,851 |

% Increase from Alt 1 (high) 0.0% 8.4% 33.5% 66.2% 69.4% 69.4%

Table 4. Economic value of at-risk carbon (Alternative 6 plus all suitable)

| | Alt 6 suitable timber at-risk | All suitable timber at-risk |
|---|--|-----------------------------|
| Acres | 42,500 | 394,997 |
| Low est total carbon | 40,508,577 | 40,508,577 |
| CO2 (carbon x 3.67) | 148,666,478 | 148,666,478 |
| Value of CO2 at-risk in suitable timber base* at \$15/ton CO2 | \$240,839,694 40% logged in first decade = \$96.3 million | \$2.2 billion |

*Suitable timber base = 10.8% of at-risk carbon under Alt 6, 100% at risk under all suitable acres

Carbon emissions assessment by the Forest Service provides a misleading comparison to other emissions and fails to include a social cost analysis. The DEIS is woefully inadequate as it compares emissions (prior and current logging) on the Tongass to gross emissions from the **entire US electric power sector in 2012 and all US emissions in 2017**.⁴⁹ Federal courts have rejected this kind of skewed comparisons.⁵⁰ This arbitrary baseline ignores the incremental nature of carbon emissions and impacts and is inconsistent with recommendations of the IPCC (2018) to avoid additional emissions, and with the broader scientific consensus of fully protecting carbon sinks like the Tongass.⁵¹ To comply with NEPA, the Forest Service must, at a minimum, explain why it is choosing to ignore these expert conclusions. The global community also has signaled its intent to protect carbon sinks under Article 5 of the Paris Climate

⁴⁹ DEIS at 3-124.

⁵⁰ See *High Country*, 52 F. Supp. 3d at 1190 (“Beyond quantifying the amount of emissions relative to state and national emissions and giving general discussion to the impacts of global climate change, [the agencies] did not discuss the impacts caused by these emissions.”); *Mont. Env’tl. Info. Ctr. v. U.S. Office of Surface Mining*, 274 F. Supp. 3d 1074, 1096–99 (D. Mont. 2017) (rejecting the argument that the agency “reasonably considered the impact of greenhouse gas emissions by quantifying the emissions which would be released if the [coal] mine expansion is approved, and comparing that amount to the net emissions of the United States”); *WildEarth Guardians v. Zinke*, 368 F. Supp. 3d 41, 76-78 (D.D.C. 2019) (holding BLM’s conclusion that the emissions from oil and gas leases “represent an incremental contribution to the total regional and global GHG emissions level” was arbitrary and capricious because it was not supported by any data).

⁵¹ Keith et al. 2009, DellaSala et al. 2011, Stephenson et al. 2014, Mackey et al. 2014, Law et al. 2018, Moomaw et al. 2019.

Agreement. While the US is irresponsibly withdrawing from the agreement, it is also irresponsible for the Forest Service to downplay the substantial regional emissions from Tongass roadless and old growth logging when the rest of the world is looking for ways to reduce and avoid emissions **at all scales**. Instead, the agency should choose the alternative with the least emissions – no action – and compare alternatives against no action with respect to reliable and accurate direct, indirect, and cumulative emissions. This also needs to be expressed in carbon dioxide equivalents to estimate the socio-economic cost of carbon. Additionally, the emissions need to be expressed at an appropriate **regionally specific scale**, as for instance, coal-fired power plant equivalents as mentioned above so that the public understands the true regional climate consequences of opening roadless areas to logging and development.

Further, the DEIS falsely asserts that “it is difficult and highly uncertain to ascertain the indirect effects of emissions resulting from these alternatives on global climate.”⁵² The Forest Service could easily express the indirect impacts of climate emissions by quantifying or estimating climate pollution volumes by alternative (as noted above in our analysis) and then using the social cost of carbon (SCC) to assess and compare the significance of the effects on global climate. The very purpose of the SCC is to assist decisionmakers in (conservatively) estimating the marginal damages from each additional ton of greenhouse gas emissions. To avoid this analysis irresponsibly kicks the emissions can down the road.

The DEIS incorrectly states that most of the carbon in trees after logging will be recovered via reforestation and stored in wood products for buildings instead of stored in forest ecosystems and this is completely false. As noted, a substantial portion of the total forest carbon is contained in foliage, branches and bark, root wads and soils.⁵³ Because much of the carbon in logs hauled to mills becomes waste, only a relatively minor portion of the total tree carbon ultimately ends up in wood products.⁵⁴ Up to 40% of the harvested material does not become forest products and is burned or decomposes quickly on site, and a majority of manufacturing waste is burned for heat. One study found that 65% of the carbon from West Coast forests logged over the past 100 years is still in the atmosphere with just 19% stored in long-lived products; the remainder is in landfills.⁵⁵ Additionally, Leighty et al. (2006) reported that a century of Tongass logging has emitted 6.4-17.2 Tg C that is still in the atmosphere (again – it matters most what the atmosphere “sees” more than what is stored in wood products). Further, Hudiburg et al. (2019) note that state and federal reporting of emissions has erroneously excluded some product-related emissions, resulting in 25-55% underestimation of total CO₂ emissions from logging. Thus, the Forest Service needs to fully disclose and provide reliable estimates on how much carbon is emitted by clearcutting given the substantial fall down and problems with underestimating emissions as noted. Large amounts of logs, stumps, root wads and slash are left on the ground after clearcutting and soils are noticeably disturbed by heavy equipment. This cannot be simply dismissed as an insignificant impact in the DEIS.

⁵² DEIS at 3-127

⁵³ Campbell et al. 2007.

⁵⁴ See, e.g., Harmon et al. 1990, Harmon et al. 1996, Ingerson 2008, Law et al. 2018, Harmon 2019.

⁵⁵ Hudiburg et al. 2019.

It is also wrong for the Forest Service to assert that carbon stored in Tongass saw logs (wood product pools) compensates for carbon emitted by logging long-lived (hundreds of years) trees in the Tongass old-growth carbon sink.⁵⁶ The carbon debt created by expansive clearcut logging (past, present, future) must be calculated using reliable and accurate estimates via a carbon life cycle analysis that accounts for how long carbon remains in the atmosphere (after all, it's what the atmosphere "sees" that matters most in the long run). Thus, at a minimum, NEPA requires that the Forest Service conduct a carbon life cycle analysis using published sources and the Forest Service should use FIA/timber stand data on estimated carbon uptake and stores in old growth vs. young growth to calculate age-related differences in carbon stores and associated emissions from logging (e.g., using the carbon values for Tongass old growth and IRAs in our comments) at the regional scale. The following analysis components should be included in the DEIS:

- In-boundary emissions – at the stand and landscape level, this includes carbon entering the atmosphere from the substantial “fall down” and defect of uneconomical logs, slash, and stumps – based on Tongass timber stand inventory data (2016-18) fall down alone (uneconomical material) may be as high as 70% of felled trees (carbon emitted directly to the atmosphere) with old-growth defect at least 30%.
- Out-of-boundary emissions – this includes: (1) carbon emitted via wood processing waste at the mill (see Law et al. 2018 for example); (2) fossil fuels used in transport and manufacture of wood products, including emissions from log exports sent to China and then exported for distribution as products, the lower 48 states and elsewhere (note - transport emissions are easily obtained from the Alaska Department of Environmental Conservation Division of Air Quality (greenhouse gas emission inventory⁵⁷; and (3) estimated emissions from road building.⁵⁸
- Use more recent studies on wood product substitution estimates – Harmon (2019), for instance, re-examined substitution assumptions questioning their *reliability* in life cycle analysis and concluding that any benefits depend on duration of fossil carbon displacement, longevity of buildings being assumed, and nature of the forest supplying building materials (also see below):

“Substitution of wood for more fossil carbon intensive building materials has been projected to result in major climate mitigation benefits often exceeding those of the forests themselves. A reexamination of the fundamental assumptions underlying these projections indicates long-term mitigation benefits related to product substitution may have been overestimated 2- to 100-fold (*emphasis added*). This suggests that while

⁵⁶ See, e.g., DEIS at 3-127.

⁵⁷ See <https://dec.alaska.gov/air/anpms/projects-reports/greenhouse-gas-inventory>

⁵⁸ See Loeffler et al. 2008 for how to estimate this -note – this is a Forest Service publication easily accessible to the agency.

product substitution has limited climate mitigation benefits, to be effective the value and duration of the fossil carbon displacement, the longevity of buildings, and the nature of the forest supplying building materials must be considered.”⁵⁹ Failure to address this scientific study would violate NEPA’s and NFMA’s mandate that the Forest Service use the best available science and that the agency explain why its approach differs from that of experts.

- The need for reliable published references to estimate wood product stores— Researchers report most carbon is emitted to the atmosphere when old trees are logged, accounting for wood product stores is only a fraction of the carbon pool (e.g., ~35% of the live carbon is rapidly emitted when an old-growth forest is logged with another 30% emitted at the mill and even more in transportation).⁶⁰
- The reference to an albedo effect in the DEIS (at 3-123) is unreliable, cannot be verified, is inconsistent with the BASI requirement, and should be dropped. The DEIS provides no citation or support for its unsubstantiated albedo assumption, which likely was extrapolated from the boreal regions where albedo has been reported as having a potential cooling affect because of the reflectance properties of snow. The Forest Service cannot make this same claim for the Tongass given that low-elevation temperate rainforests experience relatively little snow (and therefore have low albedo/reflectance properties), especially in a changing climate (as noted in the DEIS). Without a life cycle analysis that first estimates logging emissions and then compares emissions to whatever insignificant albedo effect is anticipated in temperate regions with little snow, the albedo cooling assumption is falsified and cannot be used for disclosing climate impacts of Tongass logging. In sum, large regional and ecosystem type variations have been observed in albedo and one cannot compare albedo from one region to another or one forest type to another.

In this regard, the DEIS echoes unsupportable claims and assumptions by the wood products industry that substituting wood for concrete and steel reduces the overall carbon footprint of buildings and thus is unreliable and inaccurate. The agencies’ wood production substitution claim has been refuted by recent analyses that reveal forest industries have been using unrealistic and erroneous assumptions in their models, overestimating the long-term mitigation benefits of substitution by 2- to 100-fold.⁶¹ An additional recent analysis concluded that the carbon footprint of wood is 6% higher than concrete (Stiebert et al. 2019), and that assessment did not include the reduced forest carbon sequestration and storage caused by forest losses as discussed. Importantly, a very recent breakthrough in solar energy production will soon make it possible to dramatically reduce the carbon footprint of concrete and steel even further.⁶² Additionally,

⁵⁹ Harmon 2019. –

⁶⁰ See Harmon et al. 1990, Harmon et al. 1996, Law et al. 2018, Harmon 2019.

⁶¹ As discussed, Law et al. 2018, Harmon 2019.

⁶² <https://www.cnn.com/2019/11/19/business/heliogen-solar-energy-bill-gates/index.html>.

regarding the noted problems with exaggerated wood substitution benefits,⁶³ there is no assurance that concrete and steel replaced by wood will not be used in application somewhere else (i.e., leakage from using steel/concrete used elsewhere). For the substitution benefit to accrue, an equivalent amount of concrete or steel would need to not be produced and used in construction; otherwise, substitution is purely speculative (not best science) and unreliable. Further, the DEIS did not account for the high recycled content in most steel or recent/future anticipated advances in reducing the carbon footprint of concrete. For instance, changing manufacturing methods impact embodied energy, as for example, if fly ash is added to concrete it could yield 22-38% reductions in embodied energy required in manufacturing processes, thereby reducing the displacement value of wood.⁶⁴ Using clean, renewable energy instead of coal in concrete and steel manufacturing also can lower the substitution value and is part of the mix of energy sources being expand upon by the global community (i.e., over the next few decades new energy sources and processing efficiencies will emerge to reduce concrete/steel emissions and this needs to be factored into a “best case scenario” for energy efficiency upgrades in the DEIS). This change is already underway.⁶⁵

To construct a proper life cycle analysis that provides a science-based assessment of carbon stocks and flows on the Tongass, the DEIS should adopt a method similar to the approach used by Hudiburg et al. in their 2019 life cycle analysis of emissions from logging. The following abstract summarizes their methodologies:

Abstract

Atmospheric greenhouse gases (GHGs) must be reduced to avoid an unsustainable climate. Because carbon dioxide is removed from the atmosphere and sequestered in forests and wood products, mitigation strategies to sustain and increase forest carbon sequestration are being developed. These strategies require full accounting of forest sector GHG budgets. Here, we describe a rigorous approach using over one million observations from forest inventory data and a regionally calibrated life-cycle assessment for calculating cradle-to-grave forest sector emissions and sequestration. We find that Western US forests are net sinks because there is a positive net balance of forest carbon uptake exceeding losses due to harvesting, wood product use, and combustion by wildfire. However, over 100 years of wood product usage is reducing the potential annual sink by an average of 21%, suggesting forest carbon storage can become more effective in climate mitigation through reduction in harvest, longer rotations, or more efficient wood product usage (emphasis added). Of the ~10,700 million metric tonnes of carbon dioxide equivalents removed from west coast forests since 1900, 81% of it has been returned to the atmosphere or deposited in landfills (emphasis added). Moreover, state

⁶³ See DEIS at 3-123.

⁶⁴ Harmon 2019.

⁶⁵ See J. Gillis, The Steel Mill That Helped Build the American West Goes Green, The New York Times (Oct. 16, 2019) (describing Colorado steel mill’s decision to manufacture steel using only renewable energy), available at <https://www.nytimes.com/2019/10/16/opinion/solar-colorado-steel-mill.html> (last viewed Dec. 13, 2019).

and federal reporting have erroneously excluded some product-related emissions, resulting in 25%–55% underestimation of state total CO₂ emissions. For states seeking to reach GHG reduction mandates by 2030, it is important that state CO₂ budgets are effectively determined or claimed reductions will be insufficient to mitigate climate change.⁶⁶

Logging involves transportation of trucks and machinery across long distances between the forest, the mill, and point of distribution and the DEIS needs to properly disclose these emission sources. For every ton of carbon emitted from logging, an additional ~17% is estimated from fossil fuel consumption to support transportation, extraction, and processing of wood⁶⁷, not including the significant emissions from building roads.⁶⁸ There is no indication that this was even accounted for in the DEIS.⁶⁹ As noted, the Forest Service should consult with state emissions data to obtain reliable estimates of emissions from transport and manufacturing of wood products, particularly the incredibly long hauling distances involved with exporting logs to China and the burning of fossil fuels to get them there (plus when manufactured products are shipped again to retail and distribution areas). In the Tongass this is an especially valid concern given the remote location, no road access (necessitating saltwater barges), and weather which requires extensive and long transportation chains.

The DEIS does not account for the reduction in carbon sequestration and storage potential in forests due to logging-caused soil compaction and nutrient loss. This is despite the fact that these combined impacts can reduce forest carbon storage potential contributing to an overall carbon debt not explained or assessed in the DEIS. We note that this debt is not trivial because ~60% of the carbon lost through logging since 1700s has not yet been recovered by the land sector⁷⁰ and 81% of carbon previously stored in West Coast forests has been returned to the atmosphere via logging since 1900.⁷¹ These are centuries-long atmospheric carbon emissions coming at a time when we are in a climate emergency.⁷² This is why scientists are calling for policies that avoid emissions and store more carbon in forests compared to wood product pools.⁷³

⁶⁶ Hudiburg et al. 2019.

⁶⁷ Ingerson 2008.

⁶⁸ See Loeffler et al. 2008.

⁶⁹ The DEIS at 3-127 includes “transporting wood products” in a laundry list of potential cumulative impacts to consider in its climate analysis, but provides no analysis at all of the scale or nature of that impact, violating NEPA’s hard look mandate.

⁷⁰ McKinley et al. 2011.

⁷¹ Hudiburg et al. 2019.

⁷² Ripple et al. 2019.

⁷³ Hamon et al. 1990, 1996, Leighty et al. 2006, McKinley et al. 2011, Mackey et al. 2016a,b, Law et al. 2018, Moomaw 2019.

Additionally, there are other greenhouse gas effects such as methane and nitrous oxide emissions from soil impacts that will impact the climate from logging.⁷⁴

In sum, the DEIS fails to include peer-reviewed science on forest carbon and emissions that shows: (1) primary (unlogged) forests are far superior to logged forests at carbon uptake and storage long term; (2) trees accumulate carbon over their entire lifespan; older trees capture and store far more carbon than young trees; (3) old, primary forests accumulate far more carbon than they lose through decomposition and respiration, thus acting as net carbon sinks; (4) logged forests are an emission source for at least the first decade and never fully recapture the emitted carbon stored in the pre-logged old-growth forest due to short rotation harvests and carbon losses throughout the wood product distribution chain; and (5) the superior carbon benefits of old forests are especially evident when taking into account the role of undisturbed soils (which may contain ~50% of carbon stores⁷⁵.) and below ground carbon exchange losses from logging and climate change impacts.

B. DEIS CLAIMS ABOUT TEMPERATE RAINFORESTS AND FOREST MANAGEMENT ARE NOT BASED ON BEST AVAILABLE SCIENCE

In addition to failing to analyze important information about the Tongass and its value for climate and carbon storage, the DEIS fails to analyze important information about the value of temperate rainforests.

- **Temperate rainforest amount reported in the DEIS is incorrect** – The DEIS grossly underestimates the global importance of coastal temperate rainforests, including the Tongass, for carbon regulation (0.5% global cover; no citation given).⁷⁶ DellaSala et al. (2011) provided the first computer generated map of all the world’s temperate rainforests reporting that the total area for this rainforest biome is actually 2.5% of all forests globally (5 times that reported in the DEIS). The Pacific Coastal rainforests (California Coast Redwoods to Alaska) are globally significant as they represent over one-third of all temperate rainforests world-wide and because the Tongass is one of only 4 other relatively intact temperate rainforests (Great Bear – BC; Valdivia – Chile; Russian Far East; Southern Siberia). Thus, even though the overall global footprint of this rainforest biome is relatively small, the climate regulation properties of these forests – because of their enormous carbon stores – along with their myriad biodiversity and ecosystem benefits⁷⁷ – are globally significant and irreplaceable.⁷⁸ The Forest Service therefore has a national and global responsibility to maintain the intactness of this region and opening up roadless areas will have global ramifications contributing to the pace and scale of forest degradation globally. This is why 234 scientists signed a letter urging the Forest

⁷⁴ McKinley et al. 2011.

⁷⁵ Campbell et al. 2007. McNicol et al. 2019

⁷⁶ DEIS at 3-122.

⁷⁷ Brandt et al. 2014.

⁷⁸ DellaSala et al. 2011.

Service to protect the region’s roadless areas (attached). The decision to open up roadless areas therefore is not based on best available science. At an absolute minimum, the Forest Service must correct its evaluation of the global importance of the Tongass’s temperate rain forests and respond to these expert reports.

- **Unsubstantiated claims are made about management activities approximating and promoting natural processes** – The Forest Service states, without a single citation, that logging and prescribed fire tend to approximate and promote natural processes and that such actions can result in long-term carbon uptake and storage that somehow increases resilience.⁷⁹ We note that prescribed fire is not even relevant on the Tongass rainforest and has no purpose in this DEIS. The statement overall also has no basis in the ecological literature, and certainly none for the Tongass’s temperate rainforest, and seems to imply that forest degradation is a net gain in carbon and ecosystem processes even though the IPCC (2018, 2019) and numerous scientific studies indicate otherwise.⁸⁰ As discussed, the Forest Service needs to provide a reliable life cycle analysis and evidence-based review of the literature to back assertions that clearcut logging and road building somehow resemble natural disturbance processes – including effects on biodiversity (e.g., deer, wolves, murrelets and other old growth species). The statement, in fact, is reflective of old-school forestry ideologies long dismissed in the ecological literature and even by many foresters. Notably, given the lack of fire on the Tongass, primary disturbance agents are blow down from wind storms (canopy gap, stand, landscape level), landslides (watershed-landscape level), and tree mortality (stand level – canopy gaps – and watershed-landscape yellow cedar death from climate impacts). In no way do clearcuts, roads, mines, dams, etc. resemble any of these natural disturbances as natural disturbances leave prodigious amounts of biological legacies⁸¹ that “life-boat” a forest through successional stages while these developments in old growth and IRAs will remove nearly all biological legacies. The long return interval of natural disturbances allows for old growth to develop over centuries, whereas, logged areas can be logged again in <100 years; this is insufficient time for forests to recoup carbon emitted from logging and to reach their maximum carbon potential.⁸² We note that Public Law 113-291 (2014) allows up to 15,000 acres of young growth to be logged from 2016-2025 in stands < 95% CMAI and there is flexibility in NFMA to allow a continuation of harvesting at young ages beyond 2025 – thus, the carbon debt from re-logging these forests on a sustained yield basis is never recaptured and remains in the atmosphere for over a century at a time when we are in a climate emergency. The Forest Service needs to properly account for this carbon debt in the DEIS.

⁷⁹ DEIS at 3-123.

⁸⁰ See e.g., Harmon et al. 1990, Harmon et al. 1996, Mackey et al. 2014, Law et al. 2018, Moomaw 2019.

⁸¹ DellaSala 2019; Buma et al. 2019.

⁸² Moomaw 2019.