THE TONGASS RAINFOREST AS ALASKA'S FIRST LINE OF CLIMATE CHANGE DEFENSE AND IMPORTANCE TO THE PARIS CLIMATE CHANGE AGREEMENTS

Dominick A. DellaSala, Ph.D.
Chief Scientist, Geos Institute (Dominick@geosinstitute.org)

photo: J. Schoen

*Executive Summary***:** the Tongass is a global champion in sequestering (absorbing) atmospheric carbon and storing it long-term in its ancient trees, productive soils, and dense rainforest foliage. Because it is one of the world's last relatively intact temperate rainforests, and it has a maritime climate, the Tongass is Alaska's first line of climate change defense and a climate refuge for its world-class salmon and wildlife populations. Logging of the Tongass rainforest produces greenhouse gas emissions that damages the region's contribution to a safe climate. Recognizing the critical need to reduce greenhouse gas emissions to keep global warming temperatures below a dangerous 2º C (~4º F) anticipated increase, a climate change agreement was reached in Paris by 195 members of the Conference of Parties (COP 21 also known as the 2015 Paris Climate Conference), including the USA. Articles of the agreement called for forests to be managed as a global "sink" for carbon. Therefore, protecting carbon sinks and reducing forestry emissions are pivotal steps to ensure a safe climate for Alaskans and for future generations.

Given the global importance of the Tongass as a carbon sink, we wanted to: (1) determine if the Tongass Draft Forest Plan Amendment (preferred alternative) was generally consistent with the Paris articles regarding managing forests as a carbon sink; (2) consistent with the Obama Administration's policies on climate change; and (3) whether the timeline for the proposed transition out of old-growth logging was consistent with efforts to end global deforestation under global forest and climate change agreements (e.g., COP 2, NY Forest Declaration). Thus, we estimated CO_2 emissions anticipated from logging old growth and young-growth forests as proposed by the Forest Service on the Tongass over the next 25 and 100 years and compared them to emissions under a conservation alternative designed to speed up the transition by relying mostly on soon-to-be-ready-for logging young growth as a replacement for old-growth logging.

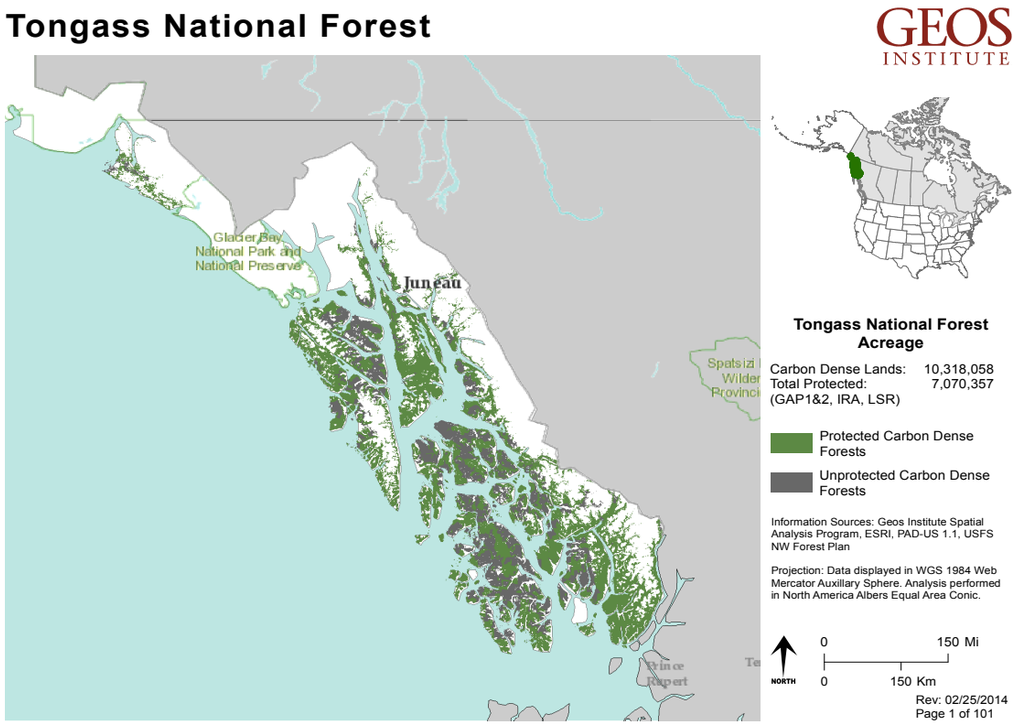
Key Findings (for 100 years):

- The agencies' preferred alternative would log 43,167 acres of old growth (OG) and 261,850 acres of young growth (YG) resulting in the equivalent emissions of ~4 million vehicles annually on Alaska roads for the next 100 years. These

estimates account for carbon stored in wood products and capture of carbon by forest regrowth.

- Logging emissions are ~175 times greater than the "reference point" for project emissions recommended by the White House's Council of Environmental Quality (CEQ). Emissions would result in a "social cost of carbon"conservatively estimated at >$100 million annually in global warming damages by the end of the century. Losses are ~10 times the projected timber revenues on the Tongass.
- A conservation alternative proposed by conservation groups (but dismissed by the Forest Service) would rely predominately on 76,000 acres of low controversy YG to support the transition with much less OG (9,125 acres over 100 years) to support specialty products. This alternative yields the equivalent emissions of over ~400,000 vehicles annually for 100 years, 16 times above CEQ emissions reference, but a tenth of the emissions from Forest Service proposed logging.
- The Tongass preferred alternative is out-of-step with efforts by the global community to reduce emissions. The conservation alternative better complies with CEQ guidelines, the Paris climate agreement, and efforts to reduce climate damages from CO_2 pollution.
- President Obama showed great interest in Alaska's already extensive climate impacts during his September 2015 Alaska visit to showcase his climate change initiatives prior to the Paris conference. Continued OG logging on the Tongass would further jeopardize Alaska's climate and is out of step with the President's climate change agenda.

NO OTHER NATIONAL FOREST STORES MORE CARBON THAN THE TONGASS (map shows concentration of Tongass forest-carbon stores)



THE TONGASS IS A NATIONAL CARBON SINK

Photo: D. DellaSala

"This is as good of a signpost as any when it comes to the impacts of climate change."
President Obama during his September 2015 tour to Alaska glaciers.

Alaska's First Line of Climate Defense–Alaska is at the front lines of climate change, experiencing higher temperature increases than any other region in the nation along with increasing floods, coastal erosion and displacement of native villages, interior wildfires, die off of certain conifers, thawing of permafrost, and glacial melting (among other changes anticipated over the coming century)[1]. If Alaska is on the front lines, then the Tongass is Alaska's first line of climate defense.

At 16.8 million acres, the Tongass National Forest in southeast Alaska is the crown jewel of the national forest system. It is the nation's largest national forest and one of the world's last relatively intact temperate rainforests and thus it has global significance[2]. Its world-class salmon runs are the backbone of a thriving subsistence, commercial fishery, and recreation-based economy[3]. The Tongass is by far the nation's champion in storing carbon long-term[4] and, in doing so, represents a unique opportunity for the Obama Administration to lead by example regarding its global commitments to the Paris climate change agreements designed to keep global warming below the dangerous 2º C (~4º F) presumed tipping point. During COP 21, the parties recognized the importance of forests as global "sinks" for storing greenhouse gases and called for steps by the global

[1]Alaska Department of Environmental Conservation. 2010. Alaska's climate change strategy: addressing impacts in Alaska. http://www.climatechange.alaska.gov
[2]DellaSala, D.A. 2011. Temperate and boreal rainforests of the world: ecology and conservation. Island Press: Washington, D.C.
[3]Crane, L.K., and J.R. Mehrkens. 2013. Indigenous and commercial uses of the natural resources of the North Pacific Rainforest with a focus on Southeast Alaska and Haida Gwaii. Pp. 89-126. In G.H. Orians & J.W. Schoen (eds.). North Pacific Temperate Rainforests. University of Washington Press, Seattle.
[4]Leighty, W.W. et al. 2006. Effects of management on carbon sequestration in forest biomass in southeast Alaska. Ecosystems 9:1051-1065

community to *conserve and enhance* forest sinks to help stabilize what may soon become run-away climate chaos.

Conference of the Parties (COP 21) Twenty-First session, Paris, December 12, 2015

"Recognizes the importance of adequate and predictable financial resources, including for results-based payments, as appropriate, for the implementation of policy approaches and positive incentives for reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks; as well as alternative policy approaches, such as joint mitigation and adaptation approaches for the integral and sustainable management of forests…..

Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1(d), of the Convention, including forests."

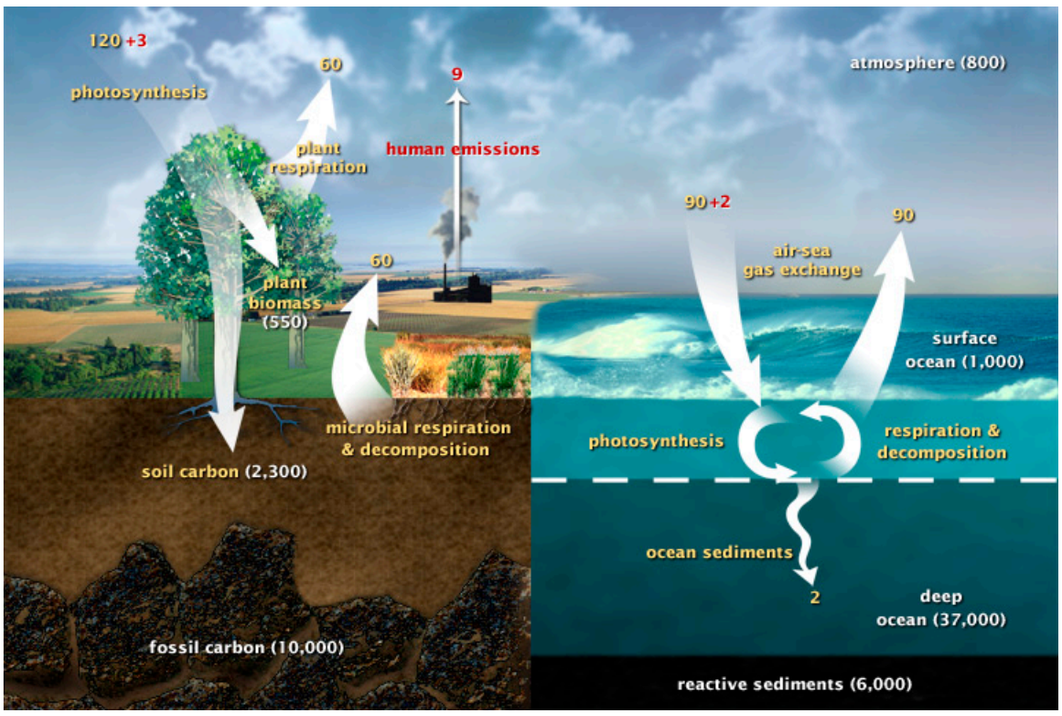
Photo: D. DellaSala

The Tongass is pivotal to the Obama Administration's climate change commitments. The region's forests not only store more carbon than any national forest,but also may function as a climate refuge (i.e., first line of defense) given maritime influences may moderate more extreme climate events anticipated for interior Alaska and temperate rainforests further south[5]. Relatively intact watersheds provide a refuge for old-growth dependent species (including many that are important to subsistence needs), and buffer salmon populations from cumulative effects of climate change and more extensive logging in the surroundings (non-federal lands)[6].

Notably, prior estimates of net carbon flux from logging scenarios on the Tongass indicate that *only a no-logging scenario* maintains carbon stores through time[4]. Carbon

[5]DellaSala, D.A. et al. 2015. Climate change may trigger broad shifts in North America's Pacific coastal rainforests. Online module – Earth Systems and Environmental Sciences – published by Science Direct
[6]For examples, see Watson, et al. 2013. Mapping vulnerability and conservation adaptation strategies under climate change. Nature Climate Change 3:989-994.

also has future economic value in terms of avoided costs from global warming pollution and development of carbon-offset markets. For instance, if carbon were stored long-term in old-growth forests instead of being released to the atmosphere by logging, the estimated annual economic value of carbon would be comparable to revenue generated from Tongass timber sales should carbon markets mature[4]. Moreover, the Interagency Working Group on Social Cost of Carbon estimated the cost of carbon in economic impacts from global warming would be $27-221 per ton by 2050[7]. Recent evidence suggests the anticipated costs maybe much higher, including large demographic displacements of human populations along coastlines[8].



Planetary carbon cycle with exchange of carbon among land, atmosphere, and oceans (billions of tons of carbon per year)[9]. Yellow numbers represent natural carbon fluxes, red are carbon dioxide emissions in billions of tons of carbon per year. White numbers show stored carbon. Note the fossil fuel related carbon stores in the diagram. Forests are integral to the earth's carbon filtration system. http://en.wikipedia.org/wiki/Carbon_cycle

Photo: D. DellaSala

Forests as a Carbon Sink – forests are a vital part of the global atmospheric carbon cycle that contribute to climate stabilization by absorbing (sequestering) and storing vast amounts of carbon dioxide (CO_2) in trees (live and dead), soils, and understory foliage. As a forest ages, it continues to sequester and store carbon, functioning as a net "sink" for centuries if undisturbed. Ongoing carbon sequestration and storage has been measured in forests >800 years old[10].

When a forest is cut down, roughly 66% to 80% of the stored carbon in the forest[11] is released overtime as CO_2 (some carbon is stored in wood products) thereby converting forests from a sink to a "source" or "emitter." The minimal storage in wood products is an accounting misstep typical of federal agency carbon

[7] Interagency Working Group on Social Cost of Carbon, United States Government. 2013. *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866*. May.
[8] Pizer et al. 2014. Using and improving the social cost of carbon. *Science* 346:1189-1190. DOI:10.1126/science.125974
[9]Reprinted from DellaSala, D.A. In 2013. The carbon cycle and global change: too much of a good thing. Reference Module in Earth Systems and Environmental Sciences, Elsevier. 3 pp. http://dx.doi.org/10.1016/B978-0-12-409548-9.05874-7
[10]Luyssaert, S. et al. 2008. Old-growth forests as global carbon sinks. Nature 455:213-215
[11]Wayburn, L.A. 2000 (several citations included). Forest carbon in the United States: opportunities and options for private lands. Pacific Forest Trust, San Francisco.

pronouncements that over value carbon in wood products[12].

Soon after logging, carbon is emitted to the atmosphere via rapid decomposition of logging slash, fossil-fuel emissions from transport and wood processing, and decay or combustion (within 40-50 years) of forest products in landfills[13]. Planting or growing young trees or storing carbon in wood products does not make up for emissions released from a logged forest. Indeed, after an old forest is clearcut, the young forest remains a net CO_2 emitter for 5 to 50 years, depending on site productivity[14].

Logging on the Tongass is global warming pollution(photo: D. DellaSala)

Globally, deforestation (8-15%) and forest degradation (6-13%) **contribute more greenhouse gas pollution than the world's entire transportation network**[15], which is why countries, including the U.S., have committed to reducing emissions and protecting forest sinks (COP 21 climate agreements). Recognizing the importance of unlogged forests as carbon sinks, scientists also have repeatedly called on countries to protect their vast forest carbon stores as integral to stabilizing global climate change[16].

[12]The White House. 2015. Climate change and the land sector: improving measurement, mitigation and resilience of our natural resources.

[13]Harmon, M.E. W.K Ferrel, J. F. Franklin. 1990. Effects on carbon storage of conversion of old –growth forests to young forests. Science 247:699-702.

[14]Law, B. E., and M.E. Harmon. 2011. Forest sector carbon management, measurement and verification, and discussion of policy related to climate change. Carbon Management 2:73-84.

[15]Estimates are conservative as they were mainly derived from the tropics where the majority of forest losses occur – boreal and temperate losses are not available at this time. Intergovernmental Panel on Climate Change. 2007. Synthesis report. An assessment of the IPCC on climate change. Houghton, R.A., B.Byers, and A.A. Nassikas. 2012. A role for tropical forests in stabilizing atmospheric CO_2. Nature Climate Change 5:1022-1023.

[16]MackeyB., et al. 2014. Policy options for the world's primary forests in multilateral environmental agreements. Conservation Letters 8:139-147 DOI: 10.1111/conl.12120. Also letters sent to the Forest Service and USDA in 2015 signed by 7 scientific societies and hundreds of the nation's leading natural resource scientists calling on the Administration to protect the Tongass old-growth rainforest sink.

Photo: The Big Thorne logging operation on Prince of Wales Island converted Tongass old-growth rainforest from a carbon sink to a source of emissions (S. Ballhorn)

"The Tongass National Forest is a national treasure. Today, I am outlining a series of actions by USDA and the Forest Service that will protect the old-growth forests of the Tongass while preserving forest jobs in southeast Alaska. I am asking the Forest Service to immediately begin planning for the transition to harvesting second growth timber while reducing old-growth harvesting over time." July 3, 2013 Press Release, USDA Secretary Tom Vilsack.

Tongass Is Transitioning But Not Soon Enough – Agriculture Secretary Tom Vilsack announced in July 2013 that a transition away from old-growth logging would need to occur rapidly on the Tongass National Forest while maintaining a viable timber industry. In November 2015, the Forest Service released a Draft Environmental Impact Statement (DEIS) Plan Amendment to transition the Tongass from predominately old growth to predominately young-growth logging with the preferred alternative adopting recommendations of a multi-stakeholder Tongass Advisory Committee that incorporated years of additional old growth volume as "bridge timber" to accommodate the transition. Here, we compare the Forest Service preferred alternative to a conservation alternative prematurely dismissed by the Forest Service as not producing enough volume. The agencies' decision to dismiss this alternative occurred before completion of independent field inventories that now show sufficient volume from young growth can accommodate a more rapid transition with minimal old growth (Appendix I, report in preparation).

In conducting theTongass logging emissions analysis, we compared the following:

- *Forest Service Preferred Alternative* – proposes logging 43,167 acres of old growth and 261,850 acres of young growth over 100 years with extensive road building (road building was not calculated in emissions scenarios although it certainly contributes to emissions).

- *Conservation Alternative* – proposed by conservation groups to accelerate the transition while meeting timber demand targets of the Forest Service using much less old growth (OG) to transition. Young growth (YG) estimates were provided by Mater Engineering (Appendix I) from field-verified 55-year old pre-commercially thinned (PCT) YG sampled from a land base of 76,000 acres of relatively low controversy areas (i.e., areas not considered environmentally sensitive based on a suite of attributes, manuscript in preparation). An additional 9,125 acres of old growth was estimated for specialty wood products over 100 years (Appendix I).

We estimated carbon stored in young and old forests by interpolating data from prior estimates on the Tongass[4] for above ground biomass, which was higher than estimates used by the Forest Service for live tree carbon only. We projected logging emissions of the two alternatives over 25- and 100-year increments. We then converted logging emissions to equivalent emissions from vehicles using EPAs equivalencies calculator and compared these projected emissions to CEQ's draft "reference point" for minimizing emissions of federal actions. CEQ directs agencies to adopt projects with low emission using a reference of 25,000 metric tons of $CO_2(e)$[17] on an annual basis[18]. We used the CEQ reference for two reasons: (1) to determine if the preferred alternative is generally consistent with the Obama Administration's global warming commitments (COP 21, Paris agreements); and (2) to provide an appropriate regional comparison of logging emissions that is based on easy to understand emissions comparable. Notably, the Forest Service based logging emissions projections on comparisons to the entire U.S. annual greenhouse gas emissions (the wrong scale of comparison), masking the severity of regionally specific climateimpacts.

ESTIMATING LOGGING EMISSIONS USING VEHICLE EQUIVALENTS

Photo: Juneauempire.com

Forest Service Preferred Alternative – In general, the agencies' preferred alternative to log substantially more OG and YG than proposed by the conservation alternative is estimated to generate **annual** emissions that are:

- equivalent to 4 million vehicles annually for 100-years (Appendix II); and
- 175 times > the CEQ emissions reference.

Conservation Alternative – the transition proposed by the conservation alternative uses much less OG and is estimated to generate **annual** emissions that are:

- equivalent to 419,535 vehicles annually (Appendix II); and
- 16 times > the CEQ emissions reference.

The conservation alternative, while also exceeding CEQ's reference, yields 10 times less emissions in the long-term compared to the agencies' preferred alternative and therefore should have been kept in the DEIS as a reasonable alternative under NEPA. The agencies' preferred alternative is generally inconsistent with the COP 21 climate agreements

[17]Carbon dioxide equivalents (CO_2e) are an internationally accepted term for comparing different greenhouse gas emissions using a common (standardized) unit of analysis.

[18]CEQ 2014. Draft published for public review and comment Dec. 2014. White House.https://www.whitehouse.gov/sites/default/files/docs/nepa_revised_draft_ghg_guidance_searchable.pdf

(Article 4 on greenhouse sinks) to conserve forests as a sink for atmospheric carbon and is well above the CEQ emissions reference.

SOCIAL COSTS OF CARBON
Photo: S. Ballhorn

Executive Order 12866 requires federal agencies to "*assess both the costs and benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that benefits of the intended regulation justify its costs*."

We provide an estimate of the social cost of carbon (SCC) derived from relevant published sources as a means for costing emissions in a regional context and to illustrate how the Forest Service could achieve compliance with the Executive Order by documenting climate costs of logging and the benefits of maintaining the Tongass carbon sink.

In any cost-benefit analysis, it is imperative to incorporate the *benefits* (or cost savings) of avoiding damages to the environment, or, in this case, the climate, so as to level the economic playing field (although many ecosystem services critical to properly functioning forests are difficult to quantify). In this case, SCC is expressed as monetized damages associated with incremental increases in emissions, including, but not limited to changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. An Interagency Working Group on SCC estimated the **annual** cost of releasing emissions to be $27-221 per ton of carbon using 2050 projections. For this analysis, we used the lower bound of $27 per metric ton of CO_2(e) to estimate potential costs of logging emissions recognizing costs will escalate overtime as a result of the accumulation of regional and global emissions under status quo emissions scenarios.

Forest Service Preferred Alternative - CO_2 (e) released from logging would contribute to:

- ~$108 million annually in global warming costs over 100 years. Estimated costs are 10 times greater than the $8-10 million in annual wood products value anticipated by the Forest Service (DEIS Table 3.22-16).

Conservation Alternative - CO_2(e) released from logging would contribute to:

- ~$11 million annually in global warming costs, a tenth as costly as the Forest Service alternative.

Thus, the conservation alternative represents a cost savings to the foreseeable future climate compared to the Forest Service's preferred alternative that would result in much higher costs due to greater logging emissions and this should have been included in the agencies' NEPA analysis. It should be noted that *only a no-logging alternative* results in maximizing carbon sinks and generating apositive SCC. This is because removing carbon from a forest always results in some costs to the climate (costs are based on the combination of regional logging intensity and global emissions contributions).

LIMITATIONS, UNCERTAINTIES, AND THE FUTURE CLIMATE

Photo: A. DellaSala

Follow Up Research and Monitoring – accurately estimating carbon in regional forest assessments requires the use of new carbon assessment tools and improved inventories (including soils) along with inclusion of sequestration rates (e.g., Net Ecosystem Productivity). Carbon assessments are costly but necessary to develop proper carbon flux estimates from logging and to evaluate SCC as a multiple-use objective. In this case, we approximated emissions from published sources, published estimates of carbon stored in wood products (using conversion factors), and published estimates of carbon capture via forest regrowth (using nationally recognized online carbon tools).

Without the benefit of a comparable analysis, however, the Forest Service claims that logging old-growth forests could result in *either a net loss or gain* of carbon depending on logging practices even though clearcut logging (a substantial emissions source) is the method of choice on the Tongass (some young tree retentions and small (<10 ac) clearcuts are proposed in young forests within Old Growth Reserves and Beach buffers by the agency). Our findings are meant to provide a better estimate of emissions than the DEIS. Moreover, we used an appropriate scale of analysis that tiers to CEQ emissions guidelines and used comparable emission sources (e.g., vehicle equivalents that are locally applicable) to evaluate the magnitude of regional impacts. Follow up work, ideally conducted by the Forest Service in collaboration with scientists, is needed to improve upon these estimates and address uncertainties.

Climate Shift Happens – Notably, the effects of climate change on forest productivity represents additional uncertainties. As the climate warms in Alaska, other vegetation types may replace conifer forests that evolved under a cooler climate[3]. For instance, during the Miocene millions of years ago Alaska was a much warmer place dominated by hardwood forests. As climate change now accelerates, it could lower carbon storage in conifer forests as the climate conducive to hardwoods gradually replaces conifers and some conifers die off from climate change effects (thereby releasing CO_2 as is currently

happening with an extensive die-off of Alaska yellow cedar[19]). However, the maritime climate of the Tongass might ameliorate some of these shifts compared to more extreme changes anticipated for interior Alaska and temperate rainforests to the south[3].
Photo: A. DellaSala

ALASKA'S FIRST LINE OF CLIMATE CHANGE DEFENSE AT RISK: CONCLUSIONS

Although the Obama Administration took a leadership position during the climate negotiations in Paris, its global commitments to lower emissions and end deforestation ostensibly do not extend to Alaska's globally significant Tongass rainforest carbon sink.

The Administration has a unique opportunity to demonstrate to the world that it takes its climate change commitments seriously by quickening the pace of transition without relying on controversial timber sales that will cost more in future economic losses from climate change than the revenues generated by logging. The Forest Service has not conducted a logging emissions analysis as directed by CEQ. It has not conducted a cost-benefit analysis of the SCC implications of more OG logging and is out of compliance with Executive Order 12866. The feasibility of an accelerated transition was demonstrated in the conservation alternative summarily dismissed by the agency but which uses much less OG and generates far less emissions over time.

A robust analysis using carbon life cycle accounting is needed to more fully assess the social cost of carbon using advancements in forest carbon accounting as declared in recent climate change policies of the White House[11]. The Tongass is a known carbon sink, yet land-use emissions[11]references the importance of climate resilience best achieved through ecosystem and landscape conservation. Ecosystem resilience, and therefore the Tongass carbon sink, will decline on the Tongass with another 100 years of OG logging and road building. Proposed logging will be occurring at a time when the climate is changing the likelihood that the Tongass can function as a climate refuge[3].

"I loved Alaska and met so many inspiring people. Have to keep up the fight on climate change for their sake—and ours." President Obama on his September visit

The international community clearly spoke up in Paris about the strategic value of forest sinks in keeping global warming below the dangerous 2º C threshold. Choosing a climate responsible alternative for the Tongass would allow the Obama Administration to live up to its commitments to safeguard Alaska's climate, comply with the COP 21 climate agreements and its pledge to end global deforestation.

[19]Hennon P.E.et al. 2012. Shifting climate, altered niche, and a dynamic conservation strategy for yellow-cedar in the North PacificCoastal Rainforest. Bioscience 62: 147–158.

"We share the vision of slowing, halting, and reversing global forest loss while simultaneously enhancing food security for all. Reducing emissions from deforestation and increasing forest restoration will be extremely important in limiting global warming to 2°C." United Nations Climate Summit New York Declaration on Forests (agreed to by 157 governments, including the U.S, indigenous groups, corporations, NGOs, and others)

APPENDIX I. YOUNG GROWTH LOGGING LEVELS NEEDED TO HIT TIMBER DEMAND THRESHOLDS OF THE FOREST SERVICE CALCULATED FROM MATER 2015 PHASE II CRUISE RESULTS (IN PUBLICATION PREPARATION).

	Estimated Avg Length of Tree Residual for PCT Stands When Harvest at 55 yrs Based on 2015 Cruise Results *(lineal ft from top of merchantable log to tree top)*		
	Trees producing *two* 34' logs (ft)	**Trees producing *one and a half* 34' logs (ft)**	**Trees producing *only one* 34' log (ft)**
2020	**36**	**27.4**	**40.86**
2025	**38.7**	**41.1**	**45.23**
2030	**33.4**	**31.9**	**39.39**

		Conservation Alternative • With 80% merchantable volume growth every 5 yrs per 2015 cruise results • Focus on *one and a half* log-producing trees
		Annual mbf harvested 2020-2024
		33,074
		Annual mbf harvested starting 2025
Industry Demand (DEIS)	**46,000**	46,000
	Public Law 113-291	
Total acres harvested; first 10 years	**15,000 ac max**	13,272 ac
Annual acres harvested; first 5 years	**3,000 ac max**	1,696 ac
Annual acres harvested; next 5 years	**3,000 ac max**	958 ac
Total acres harvested overall	**50,000 ac max**	44,636 ac
Acres harvested per year after 10 years	**5,000 ac max**	697 ac
Total acres harvested: 25 years		23,727
Total acres harvested: 100 years		76,002 (44,636 before re-harvest)

APPENDIX II: ESTIMATED LOGGING EMISSIONS UNDER THE FOREST SERVICE PREFERRED ALTERNATIVE (DEIS) VS. A CONSERVATION ALTERNATIVE IN 25- AND 100-YEAR INCREMENTS AND IN RELATION TO CEQ'S EMISSIONS GUIDELINES (25,000 METRIC TONS CO2 (E) ANNUALLY)

	DEIS • Comply with PL 113-291 (harvest below CMAI) on 14% of acres • Harvest above CMAI on 86% of acres • Harvest above stated FS demand volume (46 mmbf/yr)	Conservation Alternative • Comply with PL 113-291 (harvest below CMAI) on 100% of acres • Harvest capped at FS demand volume (46 mmbf/yr)
Acres to be harvested first 25 years	• 37,390 ac SG below CMAI (@65 yrs) • 23,223 ac OG (@ 120 yrs)	• 23,727 ac SG below CMAI (@55 yrs) • 3,500 ac OG (@ 120 yrs)
Acres to be harvested next 75 years	• 224,460 ac SG above CMAI (@120 yrs) • 19,944 ac OG (@ 120 yrs)	• 52,273 ac SG below CMAI (@55 yrs) • 5,625 ac OG (@ 120 yrs)
	After initial harvest, re-growth, and (where applicable) re-harvest:	
Total CO2(e) emissions	In 25 years	In 25 years
	105,347,668 tons (4,213,907 tons/yr)	36,576,407 tons (1,463,056 tons/yr)
	In 100 years	In 100 years
	441,068,733 tons (4,410,733 tons/yr)	41,953,532 tons (419,535 tons/yr)
Multiplier above CEQ annual CO2(e) emissions limit of 25,000/yr	In 25 years	In 25 years
	x 168	x 58
	In 100 years	In 100 years
	x 175	x 16

Calculation Notes (all other calculations will be posted online):

- Carbon values interpolated from Leighty et al. 2006 Fig. 2 for age classes as follows: 55 years (494 tons per ac), 65 years (585 tons per acre), 120 years (776 tons per acre).
- Emissions adjusted to account for wood products stores using published estimates in footnote 10 and then multiplied by 3.67 to convert to metric tons CO_2 (e).
- Logging emissions are equivalent to passenger vehicle emissions http://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.
- CEQ reference = 25,000 metric tons CO_2 (e): https://www.federalregister.gov/articles/2014/12/24/2014-30035/revised-draft-guidance-for-federal-departments-and-agencies-on-consideration-of-greenhouse-gas
- PL 113-291 requires: no more than 50,000 acres of initial YG (not including re-harvest acres) logging; total YG logging in first ten years cannot exceed 15,000 ac; 3,000 ac annual acres in first five years; 3,000 acres annual in 6-10 yrs; and 5,000 YG acres annual after 10 years. If the timber volume goal is 46 mmbf/yr and compliance with PL113-291, the conservation alternative would log: 8,480 acres YG in 2020-2024 (1,696 ac/yr @ 13mbf/ac with a 1.5 multiplier for long log to short log recovery factor) producing 33 mmbf/yr.; not enough pre-commercially thinned 55-yr old stands are available at this time to meet the timber target exclusively from YG); 4,790 acres in 2025-2029(958 ac/yr @ 32mbf/ac with a 1.5 multiplier for long log to short log recovery factor meets that target); 697 acres YG annual logging beginning in 2030 (1.5 multiplier for long log to short log recovery factor producing 46 mmbf/yr @ 44 mbf/ac). See Appendix Ifor Mater 2015 YG numbers plus specialty OG products (e.g., 3 mmbf/yr = 75 ac OG logged per year using a mid point of 40,000 board feet per acre Class 6 old growth (Tongass DEIS: 3-295) to back calculate to acres logged).