(carbon)plan

DEC 15 2022

Shelby Livingston
Manager, Compliance Offset Program
California Air Resources Board (by email)

RE: November 2022 workshop on the forest carbon offsets program

Dear Ms. Livingston and CARB staff,

Thank you for the opportunity to submit comments in response to CARB's recent workshop on the forest carbon offsets program.[1] A public discussion of the program and its substantial flaws is long overdue. Despite spending significant time discussing one of our research papers,[2] staff failed to provide any evidence or quantitative analysis to support their complete dismissal of our peer-reviewed findings — let alone feature any critical voices at any point during the workshop. Instead, CARB continues to engage in a well-documented pattern of engaging only political supporters and financially interested parties in public policy processes designed to promote the "integrity" of a program staff apparently feel no obligation to defend on the merits.[3]

At this point, it's hard to know what anyone could do to prompt staff to engage with criticism in good faith. We shared a preprint of our first major study documenting flaws in the forest offsets program with staff in March 2021.[4] Some twenty months later, the staff response consists only

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[1]   California Air Resources Board, <u>Discussion of U.S. Forest Projects Compliance Offset Protocol and Relevant Science, Data, and Tools</u> (Nov. 30, 2022).

[2]   Grayson Badgley et al. (2022), <u>Systematic over-crediting in California's forest carbon offsets program</u>, *Global Change Biology* 28: 1433-1445.

[3]   *See*, *e.g.*, <u>Resignation letter of Compliance Offset Protocol Task Force environmental representative Brian Nowiciki</u> (Feb. 8, 2021) (describing CARB's Compliance Offset Protocol Task Force report "a wish list of ideas for expanding and deregulating the offset program" that was written by representatives "that have a vested interest in expanding the use of offsets or have ties to industries and organizations that stand to benefit financially from offsets").

[4]   As part of an in-depth reporting project led by veteran climate journalists Lisa Song and James Temple, CarbonPlan made a preprint of its over-crediting study available to CARB, carbon offset project developers, and four independent scientists chosen by the journalists to provide independent commentary on the work. Lisa Song and James Temple, <u>The Climate Solution Adding Millions of Tons of CO_2 into the Atmosphere</u>, *ProPublica* and *MIT Technology Review* (Apr. 29, 2021). This story was subsequently selected for inclusion in an annual collection of outstanding science writing, <u>The Best American Science and Nature Writing 2022</u> (Ayana Elizabeth Johnson, ed.).

of a curated selection of email responses to journalists published on CARB's website[5] and a formal statement that outsources its argument to a press release issued by a financially conflicted market participant.[6] At no point have staff provided a quantitative critique of our findings or called for a correction with the reporting from *ProPublica* and *MIT Technology Review*.[7] Instead, staff continue to rely on rhetorical, legalistic, and *ad hominem* attacks — all of which we have addressed previously.[8]

Meanwhile, our study has been peer-reviewed and published in a widely respected ecology journal,[9] where the editors commissioned an independent perspective from a pair of scientists who encouraged policymakers to address the problems we identified.[10] Three state Senators, including the current Vice Chair of the Joint Legislative Committee on Climate Change Policies, sent a public letter to CARB raising the same concerns;[11] and the Independent Emissions Market Advisory Committee, which is charged by statute with reviewing the cap-and-trade program, included our study's criticisms in a consensus report.[12] Finally, a bill that would have required CARB to review and reform the offsets program passed the California Senate with 28 votes in the last legislative session, but fell short by just seven votes on the Assembly floor.[13]

An outside observer reading the workshop materials would not have any sense of the extent to which academics, journalists, and legislators have raised serious questions about the forest

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[5]   CARB responses to questions from ProPublica on California's Forest Offset Protocol (Apr. 29, 2021).

[6]   CARB, California's Compliance Offset Program FAQ (Oct. 27, 2021) at 6-7 (referencing a press release from the Pacific Forest Trust, which has developed projects in the offsets program).

[7]   Lisa Song and James Temple, The California Air Resources Board Challenges Our Carbon Credits Investigation. We respond, *ProPublica* and *MIT Technology Review* (May 12, 2021) (noting that while CARB disputes CarbonPlan's study and their reporting, the Board "has not asked for any corrections").

[8]   Grayson Badgley et al, Systematic over-crediting of forest offsets — FAQ, CarbonPlan (May 12, 2021) (responding to each of the arguments raised by the CARB staff workshop presentation).

[9]   Grayson Badgley et al. (2022), Systematic over-crediting in California's forest carbon offsets program, *Global Change Biology* 28: 1433-1445.

[10] Kristina J. Anderson-Teixeira and Ethan P. Belair (2022), Effective forest-based climate change mitigation requires our best science, *Global Change Biology* 28: 1200-1203 (describing our study as a "a call to action to redouble efforts at integrating the latest carbon science into effective and timely policy solutions").

[11] Letter from Senators Robert Hertzberg, Josh Becker, and Bob Wieckoswski to CARB Chair Liane Randolph (Aug. 6, 2021).

[12] Independent Emissions Market Advisory Committee, 2021 Annual Report of the IEMAC (Feb 4, 2022) at 27-35. Note that one of us (Cullenward) is Vice Chair of the IEMAC. This letter does not represent the views of the IEMAC, but the 2021 Annual Report does.

[13] Senate Bill 1391 (Kamlager) (2021-2022 session). Note that one of us (Cullenward) testified in support of this bill and advised its author.

carbon offsets program.[14] Instead of responding to the specific criticisms we and others have made, staff make vague assertions about the purported conservativeness of their analytical methods[15] and incorrectly argue that state courts have insulated the offsets program from legal scrutiny.[16] There is no accountability here, no analytical rigor — only raw politics that suggest regulatory capture, not regulatory confidence.

This letter addresses three topics. First, we document how the workshop casually dismissed serious additionality concerns that have been documented by researchers, journalists, and offset market participants.[17] Second, we discuss the apparent enthusiasm for remote sensing applications as a possible replacement for on-the-ground forest carbon surveys. A shift to remote sensing risks opening up the floodgates to non-additional projects if the fundamental flaws with the program's baselines and additionality screening are not addressed first. And third, we address the proposed update to the program's buffer pool insurance program. While we thank staff for agreeing to tackle this topic in a program update, we urge CARB to impose a moratorium on new project development in high-risk areas while that work is ongoing. We identify projects-in-development that have already been hit by wildfires and will almost certainly burn again, which would only further drain the buffer pool if allowed to earn credits on the basis of the scientifically inaccurate risk factors that prevail today.

1.   CARB's workshop downplayed and ignored significant additionality concerns.

The central problem with carbon offsets is that credits are awarded to projects in relation to a counterfactual baseline scenario that describes what they *could* do (or at least what projects *say* they could do). That scenario can never be seen or verified, and must be estimated instead. In practice, CARB's program rules let projects tell unreliable stories about what they could do,

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[14]   CARB, Public Workshop Staff Presentation (Nov. 30, 2022).

[15]   *Id*. at slide 13. This response is all the more hollow because CARB does not actually quantify credit uncertainty nor implement a formal framework against which evidence can be evaluated. *See* Barbara Haya et al. (2020), Managing uncertainty in carbon offsets: insights from California's standardized approach, *Climate Policy* 20: 1112-1126.

[16]   CARB Staff Presentation, *supra* note 14 at 6 (discussing *Our Children's Earth Foundation v. California Air Resources Board* (1st Dist. 2015) 234 Cal.App.4th 870); *but see* Lisa Song and James Temple, A Nonprofit Promised to Preserve Wildlife. Then It Made Millions Claiming It Could Cut Down Trees, *ProPublica* and *MIT Technology Review* (May 10, 2021) (quoting University of San Francisco Law Professor Alice Kaswan: "If there's new scientific information that suggests serious questions about the integrity of offsets, then, arguably, CARB has an ongoing duty to consider that information and revise their protocols accordingly. The agency's obligation is to implement the law, and the law requires additionality.").

[17]   We also refer staff to detailed comments we filed with the Washington Department of Ecology, which are included here as Appendix 2.

without any apparent concern for whether these scenarios represent what projects *would* do in the absence of the billions of dollars' worth of credits CARB has issued to date.

Our over-crediting study documented how the bulk of credits in the forest offsets program are issued upfront to projects based on the difference between their current carbon stocks and so-called "common practice" baselines. CARB's calculation of common practice is critical to the program's integrity because the program rules allow projects to claim that they would harvest timber down to these levels in their baseline scenarios. Nearly all projects make this claim. Using official project data — including all of the "logical management unit" information CARB claims will prevent cherry-picking[18] — we showed that projects preferentially cluster in areas where trees are naturally more carbon-rich than the program's coarse assumptions about average regional carbon stocks. Projects earn credits based on that false difference.

As a result, our study concluded that "nearly a third of all credits we analyzed do not reflect real climate benefits and are, instead, the consequence of methodological shortcomings."[19] We also documented several examples where project developers appear to have preferentially selected lands that earned spurious, non-additional credits due to these methodological shortcomings.

But you don't have to take our word for it. Multiple program participants have publicly confirmed that they or others are exploiting weaknesses in the program's rules. For example, Lisa Song and James Temple reported that:

> "Zack Parisa, chief executive of the carbon offsets company SilviaTerra, previously consulted for project developers and landowners enrolling forests in California's system. But he said he stopped out of frustration, after seeing the ways it was regularly being gamed, including the cherry-picking techniques CarbonPlan highlighted."[20]

Similarly, Jim Hourdequin, the CEO of Lyme Timber, has also indicated that CARB's program rules allow projects to claim unrealistic baseline scenarios — including his own. He explains that while baseline scenarios are technically feasible and conform with the program's legal and financial rules, those scenarios are often commercially unrealistic and therefore unlikely to happen. In a public presentation at a major forestry conference, Mr. Hourdequin argued that:

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[18]   CARB Staff Presentation, *supra* note 14 at slide 31; *see also* Badgley et al., *supra* note 8 (FAQ #04).

[19]   Badgley et al. (2022), *supra* note 2 at 1442.

[20]   Song and Temple, *supra* note 4.

"[H]arvest reductions determined under the protocol are largely theoretical, and on many of the properties [enrolled in the program] it would be difficult to materially reduce standing timber to the level of common practice baselines."[21]

In other words, many practices being credited are non-additional and do not lead to increased carbon storage, despite earning carbon credits that increase pollution in the cap-and-trade program. Mr. Hourdequin discussed in detail how these concerns could manifest across his own company's portfolio, such that California's protocol would allow Lyme Timber to earn more than twice the number of credits it should be given on the basis of its typical forest management practices.[22] These non-additional credits are the result of the difference between what the protocol allows projects to say they *could* do in the absence of carbon incentives, and what Mr. Hourdequin's expert analysis indicates such a timber owner *would* do under commercially reasonable conditions.

Mr. Hourdequin has also come forward with a truly mind-boggling story about a California forest offset project on his company's land, CAR582.[23] Although the parcel in question was subject to a conservation easement at the time it was developed for the California program, with onerous terms that precluded timber harvesting going forward, Lyme Timber was able to claim, for the purposes of the baseline scenario, that it would aggressively harvest this land. While most non-additional harvest claims result from the difference between *could* and *would*, this example is particularly egregious because the baseline scenario the project submitted to CARB is actually prohibited by law. Nevertheless, the 2011 and 2014 forest protocols contain a loophole that enables projects to skip the usual requirement that baseline scenarios account for all legally binding requirements and thus generate obviously non-additional credits.

The extent to which this exemption plainly and facially violates the additionality standard likely explains why Washington's Department of Ecology, which adopted California's forest carbon offset protocols for use in its forthcoming cap-and-trade program, carefully excised this loophole from its regulatory approval.[24] Given how closely regulators in California and Washington collaborated on the Washington rulemaking, we believe it is implausible that CARB

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[21]   Jim Hourdequin, <u>You Get What You Pay For: A TIMO Perspective</u>, World Forestry Center 2021 Conference, Who Will Own the Forest? (Oct. 26, 2021) (discussion beginning at 07:15).

[22]   *Id*. (discussion beginning at 11:58).

[23]   Ben Elgin, <u>This Timber Company Sold Millions of Dollars of Useless Carbon Offsets</u>, *Bloomberg* (Mar. 17, 2022).

[24]   <u>WAC 173-446-505</u> § 3(b)(ii)(J) (eliminating the loophole in CARB's 2014 forest protocol); *id*. at § 3(b)(iii)(N) (eliminating the loophole in CARB's 2011 forest protocol).

staff are not aware of this outcome. Nonetheless, staff make no mention of this error nor offer any discussion of potential remedies to address the use of facially non-additional credits.[25]

For the sake of argument, however, let's assume that none of the above concerns are valid. At the end of the day, we can still ask: is the program increasing carbon sequestration on participating lands? New peer-reviewed research from a team based at the University of California, Irvine, set out to answer this question using satellite data to compare outcomes across California forests that participate in the offsets program and similar in-state forests that do not.[26] As the study's lead authors put it in a recent summary, "we found that carbon isn't increasing in the state's 37 offset project sites any more than in other areas, and timber companies aren't logging less than they did before."[27]

In other words, even if the program's methodology is robust to our criticisms, it isn't delivering additional carbon benefits on the ground — yet it produces carbon credits that have justified substantially higher climate pollution in the cap-and-trade program.[28] And even though the study's authors shared their paper with CARB before publication and also wrote a prominent op-ed in *The Los Angeles Times* that called on the workshop to explore program updates,[29] CARB staff did not acknowledge or engage with this evidence during the workshop.

These are not simple criticisms that can be ignored or easily resolved through minor program updates. They require acknowledgement and rigorous, evidence-based engagement from staff. Instead, the workshop fell into a longstanding pattern in which staff promoted the views of market participants and allied organizations that support their work, while ignoring and dismissing any critical evidence. As a result, the state's multi-billion-dollar carbon offsets market is completely insulated from accountability despite failing to deliver meaningful climate benefits.

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[25]   CAR582 was an early action project that transitioned into the compliance period under a separate OPR ID of CAR1130. Regulated emitters in the cap-and-trade program have surrendered credits from both listings for compliance purposes (see CAR582 and CAR1130 for a list of compliance users).

[26]   Shane Coffield et al. (2022), Using remote sensing to quantify the additional climate benefits of California forest carbon offset projects, *Global Change Biology* 28: 6789-6806.

[27]   Shane Coffield and James Randerson, Satellites detect no real climate benefit from 10 years of forest carbon offsets in California, *The Conversation* (Dec. 1, 2022).

[28]   Cap-and-trade compliance entities have surrendered almost 128 million forest offset credits to comply with program regulations and hold over 47 million more forest offset credits in private accounts. CARB, Q3 2022 Compliance Instrument Report (Oct. 5, 2022).

[29]   Shane Coffield and James Randerson, Op-Ed: California's carbon-offset forests aren't trapping much carbon. Here's how to do better, *The Los Angeles Times* (Nov. 29, 2022).

2. Remote sensing technologies hold significant potential, but could lead to algorithmic gaming and widespread non-additional crediting in the absence of comprehensive program reforms.

Rather than provide a comprehensive response to extensive criticism about non-additional crediting outcomes, staff instead prompted participants to provide forward-looking guidance on how new science and measurements might lower costs and further expand the program.[30] During the public comment period, there was an especially vocal contingent of project developers, verifiers, and industry groups advocating for future program revisions to allow remotely derived estimates of carbon storage, instead of the current reliance on relatively expensive on-the-ground forest surveys.

While we appreciate the potential for these technologies to facilitate carbon measurement going forward, we are concerned that the premature adoption of remote sensing techniques could exacerbate non-additional crediting outcomes. We believe that the current cost of project development has effectively limited developers from exploiting smaller-scale arbitrage opportunities, where local forest conditions deviate from the program's coarse common practice calculations. Allowing low-cost, high-spatial-resolution carbon measurements to reduce or replace on-the-ground measurements could suddenly make smaller-scale carbon arbitrage opportunities financially attractive, taking further advantage of the weaknesses in current program rules. While we are open to proposals for using remote sensing techniques to improve current measurement requirements, any such changes should only be considered *after* reforms are adopted to address widespread additionality problems.

Absent wholesale reform, it's easy to imagine how projects could exploit known problems with the program rules using remote sensing technologies. For example, a well-financed project developer who knows that tanoak occurs in great abundance along the divide between the Northern California and Southern Cascades supersections could commission an extensive aerial LiDAR survey of the region. After building a detailed carbon map, the developer might then intersect their carbon data with a land ownership database[31] to identify large properties with above-common-practice carbon stocks and a preponderance of tanoak — a carbon-dense species that lacks commercial value and therefore is not at any plausible risk of harvest. The developer could then propose turnkey carbon projects with tanoak owners that require no changes to current management practices.

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[30]   CARB Staff Presentation, *supra* note 14 at slides 36-37.

[31]   For example, a developer might take advantage of the publicly available CalLands database. Luke Macaulay and Van Butsic (2017), <u>Ownership Characteristics and Crop Selection in California Cropland</u>, *California Agriculture* 71: 221–30.

The developer could then run proprietary baseline optimization software, generating a legally permissible (even if commercially implausible) scenario for liquidating landowners' standing trees.[32] The financial feasibility of these scenarios could be demonstrated by pointing to any of the timber harvest plans already used to justify the financial feasibility of other tanoak-dominated projects (such as CAR1339 or ACR378), even though tanoak lacks any meaningful commercial market. After programmatically generating baseline scenarios and going through third-party verification, a wave of non-additional credits could flood the market, earning the developer (and their investors) a hefty return at the expense of the atmosphere and overburdened communities throughout California.

Similarly lucrative carbon prospecting opportunities likely exist elsewhere, especially in coastal Alaska, where large Sitka spruce are averaged together with more diminutive trees like cottonwood and paper birch.[33] These measurement-enabled arbitrage opportunities emerge directly from the protocol's calculation of common practice, which averages together a wide diversity of tree species (assessment areas) over large geographic areas (supersections).

As the staff workshop presentation acknowledged, "[a]ny method of defining boundaries for Assessment Areas is imperfect and regional averages will never represent every location accurately."[34] As a result, any attempt to incorporate remote sensing into CARB's forest offsets protocol must include strong safeguards to ensure that those inevitable imperfections are not exploited by low-cost, high-spatial-resolution carbon measurements — which could facilitate the adverse selection of particular localities where conditions depart from regional averages.

To be clear, our objection isn't to the potential for remote sensing to reliably measure carbon, nor specifically to any measurement cost reductions remote sensing might facilitate. What we are concerned about is the potential of these technologies to facilitate algorithmic gaming of weak protocol rules. Those rules are already being gamed through much more manual and

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[32] Song and Temple, *supra* note 16 (reporting that a Bluesource marketing and communications manager, Emily Six, confirmed that Bluesource uses optimization software to generate profit-maximizing baseline scenarios); *see also* Badgley et al. (2022), *supra* note 2 at 1442 (discussing how project documentation for ACR373 acknowledges similar optimization techniques). While CARB argues that our observation that nearly all projects submit baseline scenarios that reach the minimum common practice numbers allowed under program rules is a sign of the methodology's strength, rather than its weakness — *see* CARB Staff Presentation, *supra* note 14 at 28 — the fact that developers are using optimization software to generate those outcomes illustrates that developers are not actually trying to project realistic harvest conditions but rather earn the most credits that the rules allow. It also substantiates the risk that developers might use optimization techniques to exploit any new opportunities for adverse selection.

[33] Badgley et al. (2022), *supra* note 2 at 1439-40.

[34] CARB Staff Presentation, *supra* note 14 at slide 28.

labor-intensive strategies today, and could be gamed much more cost-effectively on the basis of remote sensing technologies in the future.

Given the robust evidence that project developers have already gamed baselines via adverse selection and the use of optimization software to design baseline scenarios to maximize credit issuance, CARB should anticipate that any proposed adoption of remote sensing measurement options could facilitate accelerated gaming in the future.

3. **CARB should implement a moratorium on high-risk project development while it completes an update to its buffer pool risk factors.**

We welcome the news that staff plan to revise the buffer pool's reversal risk factors that dictate the number of credits set aside to cover unintentional reversals. Until those revisions take place, however, CARB should impose a moratorium on new project development in fire-prone areas. We also offer suggestions for how CARB could address the deep uncertainty facing any effort to predict future forest disturbance rates.

Allowing the continued development of exceptionally fire-prone projects threatens to further undermine the already-fragile buffer pool.[35] CAR1614 provides a clear example of why a moratorium must be put in place. CAR1614 is a "listed" project that is currently under development, spanning almost 130,000 acres of semi-arid mixed California conifer forest in Siskiyou and Jackson counties. Although the project is still eligible to change its final project boundaries, the proposed project area[36] was partially burned by two large wildfires in 2022, the McKinney (~60,000 acres) and the Mountain (~13,000 acres) fires. The listed project area was also affected by the 2014 Beaver fire (~34,000 acres), the 2016 Gap fire (~33,000 acres), and the 2018 Klamathon fire (~38,000 acres). Given the frequency and size of these events, it simply is not credible to assert that the project's actual wildfire reversal risk approaches anything as low as 4 percent.

Similarly, Sierra Pacific Industries has a lot of land in the development pipeline. Many of these projects, like CAR1384,[37] hug the arid foothills of the Sierra, which are especially fire-prone and ill-suited for long-term carbon storage. In fact, part of the proposed boundary for CAR1384 intersects the footprint of the 2018 Camp fire, the 150,000-acre megafire that devastated the town of Paradise. We know that residential fire insurance markets are collapsing in these areas,

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[35] Grayson Badgley et al. (2022), <u>California's forest carbon offsets buffer pool is severely undercapitalized</u>, *Frontiers in Forests and Global Change* 5: 930426.

[36] Climate Action Reserve, <u>Klamath Forest Carbon Offset Project (CAR1614)</u>, Attachment E (July 2022).

[37] Climate Action Reserve, <u>Mosquito 2019 (CAR1384)</u>.

contributing to substantial community displacement[38] — yet the buffer pool continues to allow projects to socialize future wildfire losses based on scientifically invalid risk factors.

Forest projects that have burned during project development have a poor track record with wildfires after they enter the California offsets program. Both ACR255 (Colville) and ACR260 (Warm Springs) burned during project development and later experienced large unintentional reversals from severe wildfire events. While in development, part of ACR255's proposed project area was incinerated by the North Star megafire, which ultimately consumed over 200,000 acres. The final project area has burned several times since, including the 2019 Williams Flat and the 2021 Summit Trail fires. Those events resulted in pending reversals of 3.74 million offset credits.[39] Like ACR255, ACR260 also burned during project development, when the Bear Butte fire burned part of the project's listed area. Despite the clear demonstration of fire risk, ACR260 was enrolled in California's forest offsets program — only to have a significant portion of the project area burn in the 2020 Lionshead fire.[40]

Development in fire-prone areas threatens the program's buffer pool. CARB has appropriately recognized the need to revise its outdated risk factor assumptions, but needs to issue an immediate moratorium on projects in high-risk areas until those risk factors can be properly calibrated to the reality facing forests in the American West.

We are also encouraged that staff have already engaged with leading experts studying forest disturbance dynamics, as evidenced by the inclusion of wildfire risk experts like Dr. Karin Riley as a speaker at the workshop.[41] We anticipate that a number of other experts will submit comments and hope CARB staff will consider what the research community has to say about the unprecedented level of disturbance they are observing in American forests.

As you review the risks facing forests participating in California's offsets program, we want to make two points. First, any update needs to reflect the deep uncertainty surrounding the future evolution of forested ecosystems in the United States. Second, in light of substantial scientific uncertainty, it is essential that the analytical assumptions and risk management framework underlying whatever future risk factors are adopted be transparent and completely documented in public. Because the current risk factors were not based on any traceable evidence or

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[38]   Pauline Bartalone, Their Home Survived The Camp Fire — But Their Insurance Did Not, NPR Weekend Edition (Feb. 17, 2019).

[39]   Grayson Badgley and Danny Cullenward, California forest carbon buffer pool update, CarbonPlan (Dec. 1, 2022)

[40]   Claudia Herbert et al., Carbon offsets burning, CarbonPlan (Sept. 17, 2020).

[41]   Karin Riley, Opportunities for updating forest offset protocols: tree-level model of CONUS and fire risk modeling, CARB workshop presentation (Nov. 30, 2022); see also U.S .Forest Service, Wildfire Risk to Communities.

analysis, it has proven difficult to have a robust conversation about whether or not the risk factors are adequate in the face of observed evidence.

Going forward, it will be essential for policymakers and the research community to be able to monitor, evaluate, and update the risk management framework CARB adopts. This is particularly important in light of surprises, which continue to mount. For example, U.S. Forest Service researchers recently announced massive and unexpected losses of fir trees across Southern Oregon and Northern California, which they termed "firmaggedon."[42] This event has a direct bearing on the forest offsets program, as white fir (*Abies concolor*) embody a significant fraction of the credited carbon in several offset projects throughout the region. To list a few examples, white fir constitutes approximately 70 percent of the basal area of CAR1066, 20 percent of ACR274, 14 percent of ACR273, and 21 percent of CAR1614, a listed project that has yet to receive credits.

Because this particular mortality vector was not anticipated, it is important that any risk management framework be able to respond to and account for the all-but-inevitable surprises that lie ahead.[43] To help assist CARB in its work, we include an incomplete list of studies that help frame the substantial uncertainty facing future forest disturbance risks in an appendix.[44]

Thank you for the opportunity to submit comments.

Danny Cullenward
Policy Director
danny@carbonplan.org

Grayson Badgley
Research Scientist
grayson@carbonplan.org

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[42]   Nathan Gilles, Record Number of Firs Dying in Oregon, Washington in What Experts Call 'Firmageddon', *The Oregonian* (Nov. 25, 2022).

[43]   Richard J. Hobbs et al. (2009), Novel ecosystems: implications for conservation and restoration, *Trends in Ecology & Evolution* 24: 599-605.

[44]   See Appendix 1 to this letter.

Appendix 1 — Studies documenting deep uncertainty in forest disturbance risks

- William R.L. Anderegg et al. (2022), <u>A climate risk analysis of Earth's forests in the 21st century</u>, *Science* 377: 1099-1103.

- Songlin Fei et al. (2019), <u>Biomass losses resulting from insect and disease invasions in US forests</u>, *Proceedings of the National Academy of Sciences* 116: 17371-17376.

- William M. Hammond et al. (2022), <u>Global field observations of tree die-off reveal hotter-drought fingerprint for Earth's forests</u>, *Nature Communications* 13: 1-11.

- Henrik Hartmann et al. (2022), <u>Climate change risks to global forest health: emergence of unexpected events of elevated tree mortality worldwide</u>, *Annual Review of Plant Biology* 73: 673-702.

- Rupert Seidl et al. (2017), <u>Forest disturbances under climate change</u>, *Nature Climate Change* 7: 395-402.

- Anna T. Trugman et al. (2022), <u>Why is tree drought mortality so hard to predict?</u>, *Trends in Ecology & Evolution* 36: 520-532.

Appendix 2 — CarbonPlan comment letter to Washington Department of Ecology

- <u>CarbonPlan comment letter to Washington Department of Ecology</u> (July 15, 2022) (PDF attached)