*Response to comments by the California Air Resources Board on*

# POLICY BRIEF: The California Air Resources Board's U.S. Forest offset protocol underestimates leakage

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The May 2019 policy brief, *The California Air Resources Board's U.S. Forest offset protocol underestimates leakage* (Haya, 2019), presents findings that the California's U.S. Forest offset protocol has over-credited its effect on emissions due to lenient methods for accounting for leakage. We thank the California Air Resources Board (ARB) for their recent response to this brief (ARB, 2019). Below we address the key points in ARB's response with the goal of advancing discussion about updating the protocol's leakage accounting methods to address two issues—the timing of leakage accounting, and the leakage rate applied.

## Summary of the policy brief's original criticisms

California's U.S. Forest Projects offset protocol credits forestland owners for managing their lands to hold more carbon stocks than baseline levels based on common practice for the region.[1] Credits are generated on the assumption that without the offset program, participating forestland owners would harvest timber in a way that reduces on-site carbon stocks from current levels down to baseline levels.

The policy brief's criticisms concern an issue known as leakage, which occurs when reduced timber harvesting in one location induces an increase in harvesting elsewhere to meet timber demand. The policy brief analyzes 36 projects credited under the protocol, which together generated 80% of the total forest offset credits issued to date. The study concludes that 82% of credits generated by these projects are unlikely to represent emissions reductions achieved by the protocol as a result of lenient methods for accounting for leakage effects.

The protocol underestimates emissions from leakage in two ways.

- First, there is an inconsistency in the timing of leakage accounting. In the first year of an improved forest management project, the landowner receives credits for committing not to harvest timber in a way that reduces on-site carbon stocks to baseline levels. The protocol

[1] Project baselines are based on a modeled financially feasible timber harvesting scenario that is in line with regulations and other obligations and results in average on-site carbon stocks not lower than common practice in that region.

accounts for that commitment by crediting all of the on-site carbon benefits of that commitment upfront, but deducting the associated off-site carbon deficits from inducing more harvesting elsewhere (leakage) over 100 years. This frontloads the crediting, which forestland owners effectively need to pay back over the project 100-year lifetime with increased tree growth and/or sustainable timber harvesting—a commitment that may be hard to meet as forests age and the climate changes. Instead, leakage from reduced harvesting should be deducted at the same time that increased on-site carbon from that reduced harvesting is credited.

- Second, the protocol uses a low 20% leakage rate to account for increases in harvests that occur elsewhere to meet consumer demand for wood products such as building materials, packaging, and paper that we all use on a daily basis. This leakage rate is unsupported in published literature. It is important to note that the protocol uses a single leakage rate, 20%, for all projects located in widely varying forest types.

The resulting excess offset credits have important consequences for California's global warming efforts and to other jurisdictions learning from California's experience given their large quantity. The U.S. Forest Projects offset protocol has generated 80% of California's offset credits to date, and offsets can be used to achieve over half of total reductions expected by California's cap-and-trade during 2021 to 2030 (Haya, 2018). Each offset credit replaces one ton of reduction in greenhouse gas pollution that would otherwise need to happen within California's capped sectors.

We now address responses from ARB.

**Timing: projects start in greenhouse gas debt**

*ARB (May 30, 2019): "Should carbon stored above baseline in first year be considered "greenhouse gas debt"? No, crediting is based on activities to date, not future performance"*

Projects are awarded credits in their first year for the commitment to hold and increase forest carbon over 100 years, not on the basis of project activities to date.

In its first year, each project receives credits for the carbon already held on-site, with the number of credits calculated as the difference between current carbon stocks and the 100-year average of a modeled baseline scenario, minus the estimated increase in emissions off-site due to the displacement of timber harvesting to elsewhere (i.e. minus the effects of leakage in year one). Each subsequent year, projects are rewarded for any increase in on-site carbon storage compared to the previous year, minus carbon releases from leakage in those years. Most projects generate a large sum of credits in their first year, followed by smaller amounts each subsequent year. The forest projects analyzed started with on-site carbon stocks 48% higher than their baselines on average. Forestland owners must commit to holding the credited on-site carbon for at least 100 years and to increasing carbon storage for 100 years to cover any carbon losses from leakage.

What is the justification for awarding forestland owners offset credits for on-site carbon they already hold above baseline levels? It is important to remember that offset credits are used in lieu of reductions in California's capped sectors. California's global warming law, AB 32, specifies that offsets should not generate credits for past behavior, but must only credit *additional* reductions caused by the offset program. Credited reductions have to be "in addition to any greenhouse gas emission reduction otherwise required by law or regulation, and any other greenhouse gas emission reduction that otherwise would occur" (California Health & Safety Code § 38562(d)(2)). In other words, only truly new units of sequestration should be used to offset the emissions of the entities that will purchase the ARB offset credits. That some forestland owners across the United States historically managed their lands to hold more carbon than the average does not in itself justify increases in emissions in California's capped sectors above the cap.

The credits generated in the first year of a project must therefore be for a change in forest management practice caused by the protocol. The protocol estimates emissions reductions based on the assumption that without the offset program, forestland owners would harvest participating lands so that average on-site carbon stocks fall to baseline levels. ARB chose to credit forestland owners for refraining from this harvesting in the first year of each project even though it is unknown when and if carbon stocks would have been reduced without the offset protocol. In contrast, ARB chose to account for the carbon releases associated with the resulting leakage evenly over a project's 100-year lifetime. Ignoring whether it is justified to generate credits today for a commitment not to reduce carbon stocks over 100 years, to be consistent, the leakage associated with the reduced harvesting credited in a project's first year should also be accounted for in the first year. American Carbon Registry's voluntary market Improved Forest Management protocol already accounts for leakage in this way (American Carbon Registry, 2018).

In addition to consistency, there is a second reason to deduct leakage at the same time that the associated increases in on-site carbon stocks are credited. Practically, to maintain higher on-site carbon stocks, forestland owners will let the average tree age increase. There is considerable empirical evidence that growth rates decline as the average tree age increases in most commercial species in North America (Gray, Whittier, & Harmon, 2016; Ryan, Binkley, & Fownes, 1997; Tang, Luyssaert, Richardson, Kutsch, & Janssens, 2014). So project forest stands may experience declining rates of annual carbon sequestration. ARB's protocol, by accounting for the on-site effects of reduced harvesting in the first year of the project, while requiring landowners to pay back the leakage associated with that reduced harvesting over 100 years, creates a challenge for participating landowners. To cover the emissions impact from leakage, landowners must continue to increase on-site carbon storage for 100 years, and/or to harvest more to prevent leakage. This requirement can be difficult to meet consistently year-after-year for 100 years with older forests. This need to pay back credits (greenhouse gas debt) over the life of a project would partly be avoided if the leakage associated with increased on-site carbon stocks compared to the baseline at the start of the project was also deducted at the start of the project.

**Leakage rate: ARB uses a low leakage rate unsupported by published literature**

*ARB (May 30, 2019): "Are cited leakage studies in the policy brief applicable to the Forest Protocol? No, comparing the cited studies to the activities included in the Forest Protocol results in an apples-to-oranges comparison"*

ARB cannot point to evidence supporting its choice of a 20% leakage rate from reduced timber harvesting within the United States. Whether reduced harvesting is temporary, as it could be with managed timberlands, or long-term as in conservation forestry, reduced harvesting causes leakage as other forests will need to be harvested to meet demand for timber products. Existing published literature on leakage rates from reduced timber harvesting in the United States, though imperfect, suggests that leakage is likely to be 80% or higher. A high leakage rate is also in line with a common sense understanding of the U.S. timber market.

***Published literature on leakage rates***

Only three studies have been published that estimate leakage rates from reductions in timber harvesting in the United States: Wear & Murray (2004), Gan & McCarl (2007), and Murray, McCarl, & Lee (2004).

**Wear & Murray (2004)** use econometric modeling to trace the effects of reductions in federal timber sales in the western United States in the late 1980s through the 1990s. They estimate that 84% of the reduced timber production from federally-owned Douglas-fir and pine forests in Oregon and Washington was displaced to elsewhere within North America.

**Gan & McCarl (2007)***,* use a computable general equilibrium model, and find that if timber production were reduced in the United States 77% of that that timber harvesting would be displaced to other countries.

**Murray, McCarl, & Lee (2004)** perform a more refined analysis that not only traces leakage in terms of board feet of timber harvested, but also takes into account the carbon implications of that shift in harvesting, given that harvesting different forest types results in different amounts of carbon loss per board foot of timber produced. Focusing only on leakage within the United States, they estimate carbon-density weighted leakage rates of for old growth forest in the Pacific Northwest to be 16% and for mature forests in the South Central region to be 68%. This study also assesses leakage for avoided deforestation projects, but these lower figures are less relevant to improved forest management projects which generate leakage primarily from reduced timber harvesting rather than from reduced conversion of forests to other land uses.

Even though Murray, McCarl, & Lee use a more refined method for estimating leakage, applying these figures to ARB's protocol has two shortcomings. First, the article only analyzes leakage within the United States. The other two articles predict substantial international leakage, so the figures in Murray, McCarl, & Lee underestimate leakage. Second, since neither forest type is representative of the portfolio of forests participating in California's protocol it was unclear how to translate those two carbon density analyses into the effects of offset projects all over the United States. It is appropriate to apply a lower leakage rate to reduced harvesting in old growth forests. But the majority of forestlands participating in the protocol are not old growth forests. Without refined carbon-density data in many regions, it is more accurate to assume no difference in carbon density between the forests where logging is reduced and where leakage occurs, as is done by the two articles cited in the policy brief, rather than extrapolating carbon density analysis from only two specific forests types to reduced harvesting anywhere in the United States.

Further, the 68.3% leakage rate within the United States is more than the within-U.S. leakage rate estimated by Wear & Murray, (57.7%, see table 8). So if the rate of international leakage were the same in the South Central of the United States, as it is in the Pacific Northwest, then the carbon-density-based leakage rate for reduced harvesting in the South Central region is likely to be higher than 84%.

All three articles underrepresent total leakage from conservation on U.S. forestlands. Gan & McCarl only estimate international leakage, ignoring leakage that might occur among forestland within the United States. Wear & Murray only estimate leakage in North America, ignoring leakage that could occur elsewhere. As noted, Murray, McCarl, & Lee only estimate leakage within the United States. These three articles suggest that the leakage rate from reduced timber harvesting in the United States is greater than 80%.

As Professor Murray noted in a letter from June 3, 2019 (Murray, 2019), the two studies cited by the policy brief are not ideal predictors of leakage rates from improved forest management projects in the United States that reduce timber harvesting, and more research is needed. A more refined analysis of the carbon densities and regional timber markets that also take into account potential land conversion effects would be more accurate. However, Murray, McCarl, & Lee (2004) is the only study that we are aware of that tries to do this and as noted above, they only do the analysis for two forest types. The short-term reduction in the output of generic softwood lumber from federal lands in the Pacific Northwest is more similar to improved forest management projects on generic private timberland than modeling of changes in land use and forest utilization across other forest types. They are also more relevant than leakage estimates from reforestation and avoided deforestation projects. Given this, the best published estimates of leakage are the two studies cited by the policy brief.

Given the limited studies available and the need to choose a method for estimating leakage under ARB's offset protocol, the studies that are most relevant to improved forest management offset projects point to a leakage rate that is higher than 80%. This is supported by a common sense understanding of the timber market in the United States and in neighboring Canada.

***A high leakage rate is expected from the well-integrated U.S. timber market***

Let's take a look at what a 20% leakage rate means. On the U.S. west coast, more than 90% of the houses we all live in are built with wood (Butsic et al., 2017). If the ARB 20% leakage rate is accurate, that would mean either that four out of fives houses that would have been built from the timber produced by the offset project lands are never built, or they are built but with other materials such as cement and steel which are more greenhouse gas intensive than wood. The former option is simply not credible; the latter suggest that the protocol is perversely incentivizing an increase in emissions.

When estimating the full global change in forest carbon sequestration from a project that reduces timber harvesting in the United States, whether temporarily or long-term, it is logical to start with a leakage number close to 100% (van Kooten, Bogle, & Vries, 2014). The lumber market in the

United States is extremely well integrated across U.S. regions and with Canada. Marginal shortages in this well-traded commodity from one supplier will simply be made up from putting in a bigger order to other suppliers. For example, the reduction in large volumes of timber harvested on federal lands the Pacific Northwest in the 1990s was nearly all made up by increased sales and harvests from other producers in Canada and the U.S. Southeast (Wear & Murray, 2004).

ARB requires all offset protocols to take a conservative approach to addressing uncertainty in emissions reduction estimates. ARB defines "conservative" as choosing emission reduction methods that are more likely to under-credit than to over-credit (California Code of Regulations, title 17, § 95802). The burden of proof is on ARB to justify the use of a low leakage rate that requires the assumption that many homes in the United States will simply not be built due to lower global harvest rates of commercial softwood lumber species. There is no justification for a 20% leakage rate for U.S. forests in the published literature. Common sense understanding of the U.S. timber market and the best the literature estimating leakage rates from reduced timber harvesting in the United States point to a leakage rate that is 80% or higher.

**The policy brief accurately interprets the protocol**

*ARB (May 30, 2019): "Does UC Berkeley policy brief accurately portray Forest Protocol leakage considerations? No, the policy brief misrepresents how leakage is accounted for in the Protocol. Policy brief only identifies the 20% activity-shifting leakage in the Protocol, and asserts it should be 80% based on inapplicable studies. Policy brief neglects to mention the 80% market-shifting leakage included in the Protocol."*

The protocol only applies a single 20% rate to estimate the carbon impacts of leakage. The 80% figure mentioned by ARB is mathematically derived from the 20% leakage rate and is used to calculate the effects of the protocol on carbon held long-term in harvested wood products, rather than the application of a second separate market-shifting leakage rate.

To ensure that the policy brief is based on an accurate understanding of the protocol, the analysis starts by recalculating the number of credits generated, and does so very accurately for all 36 projects analyzed.

***The analysis accurately reproduces ARB's calculations***

The analysis presented in the policy brief accurately reproduced the calculations for the credits issued for all 36 projects analyzed before evaluating the impact of ARB's problematic treatment of leakage, as discussed above. Across the 36 projects, the policy brief's replicated calculation of the total number of credits issued for those projects differed from the actual number reported in project documents by only 0.1%. This indicates that the analysis is consistent with ARB's own calculations.

The analysis spreadsheet, along with a table comparing the number of credits calculated by this spreadsheet and reported in the project documents for all 36 projects, are available on the Berkeley Carbon Trading Project website. An earlier version of this spreadsheet was shared with ARB for their comment on April 9, 2018 without a response.

***The 80% factor in Equation 5.1 is mathematically derived from the choice of a 20% leakage rate, and is not the application of a separate 80% leakage rate***

The calculation in the analysis spreadsheet is based on Equation 5.1, which is used to calculate the emissions reduced by each improved forest management offset project. ARB notes in their response that they use two leakage rates in that equation—20% and 80%. This is not the case. The 80% factor in Equation 5.1 is mathematically derived from the use of a 20% leakage rate. Here is a brief explanation of why this is. For the first year of each project, Equation 5.1 is used to calculate the emissions reduced by the project as the difference in actual on-site carbon compared to the baseline scenario, minus two factors:

Factor 1: Carbon held long-term in harvested wood products. When timber is harvested, not all of the carbon taken from the site enters the atmosphere in the near term; some remains long-term in wood products like houses and furniture. The number of credits awarded to projects is lessened by the reduction in carbon held long-term in wood products.

Factor 2: Leakage. The protocol takes into account the loss of carbon due to the leakage induced by the project—the displacement of timber harvested to other forestlands.

These two factors interact. When timber harvesting is displaced to somewhere else, some of that harvested forest carbon induced by the project ends up being held long-term in timber products. If 20% of the reduction in timber harvesting on project lands is displaced to somewhere else, 20% of the reduction in carbon held long-term in harvested wood product is made up for by that increase in harvesting on those other lands. So for Factor 1, instead of deducting 100% of the reduction in carbon held long-term in harvest wood products, only 80% is deducted. The 80% leakage factor in Equation 5.1 is thus mathematically derived from the use of a 20% leakage rate.[2] If the 20% leakage rate were increased, the 80% leakage factor would decrease by the same amount.

**Recommended changes to the protocol**

The policy brief lays out how the protocol can be amended to more accurately account for leakage from improved forest management projects:

(1) In the first year of each project, leakage should be deducted equal to the product of the leakage rate and the difference in on-site carbon stocks between the project and the baseline. This difference is the loss that would occur if the forestland owner chooses to manage their

[2] Here is a specific example using figures from the sample project described by ARB (2019, p12). According to ARB's example, each year in the baseline, 20,000 tons of carbon in trees would have been harvested, and that harvesting would have resulted in 4,500 tons of carbon held long-term in wood products. (I include here the longer descriptions of these values as per Equation 5.1 in the protocol itself.) In the example project, 10,000 tons of carbon in trees was actually harvested, resulting in 2,000 tons of carbon being held long-term in harvested wood products. Using the protocol's 20% leakage rate, we can calculate the effect of the protocol on carbon held long-term in harvested wood products as: 80% of (4,500 minus 2,000) (the second term in the equation). The 80% factor takes into account that 20% of harvesting is leaked to elsewhere, so 20% of the reduction in harvested wood products produced by the project is compensated for by increased harvesting elsewhere due to leakage.

land as per the baseline scenario, which the protocol assumes would happen without the offset project. In all subsequent years, the average carbon in harvested trees in the baseline scenario can be recalculated so that the average harvest rate over 100 years remains the same;

(2) The protocol should apply a leakage rate that is at least 80%.

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