



## FORESTS FOR CARBON: Exploring Forest Carbon Offsets in the U.S. South

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### SUMMARY

- Southern U.S. forests remove carbon dioxide from the atmosphere and store it in the form of carbon in leaves, roots, branches, trunks, soil, and woody debris and other plant litter through a process known as “carbon sequestration.” Through this process, southern forests and other woodlands play a role in regulating Earth’s climate and moderating the effects of global climate change.
- Emerging voluntary and compliance markets often have provisions for greenhouse gas emission reductions or emissions avoided by preventing forest conversion or changing forest management practices. These reductions or avoided emissions are considered “forest carbon emission reductions.”
- A “forest carbon offset” is a metric ton of carbon dioxide equivalent (CO<sub>2</sub>e), the emission of which is avoided or newly sequestered and is purchased by greenhouse gas emitters as a cost-control mechanism to compensate for emissions occurring elsewhere. Four types of forest carbon offset projects exist—reforestation, afforestation, forest conservation/avoided conversion, and improved forest management.
- Forest carbon offsets can create an incentive for southern woodland owners to engage in land management practices that retain or restore forests and bolster forest carbon sequestration capacity.
- Forest carbon offset projects must meet a number of quality criteria if they are to become credible, eligible for markets, and financially feasible for southern woodland owners. The main quality criteria include: assurance that the offset is real (including handling the issue of negative leakage), additionality/surplus, verifiability, permanence, and enforcement.
- Recently, a number of carbon offset standards have emerged that adhere to these quality criteria. These standards provide a detailed list of offset project eligibility requirements, or “protocols,” as well as methods for quantifying and verifying a project’s net emissions impact. These standards seek to provide consistency in determining offset eligibility and quantification, improve offset credibility, and lower transaction costs for offset providers.
- At present, from the financial standpoint of many southern woodland owners, income from forest carbon offsets alone is likely insufficient to outcompete real estate development. However, depending on landowner management goals and circumstances, income from forest carbon offsets might be sufficient in some instances to help pay incremental costs of sustaining forests, such as property taxes or sustainable forest management certification.
- Forest carbon offset markets, like all other markets, require robust demand, adequate supply, and good transactional infrastructure. In light of these three conditions, southern woodland owners can take several initial steps to explore and prepare for existing and upcoming markets: (1) monitor market demand for forest carbon offsets, (2) conduct a solid forest inventory to assess the potential to supply forest carbon offsets, (3) engage in project development, and (4) enroll in a credible offset registry.

### FOREST CARBON OFFSETS: AN OPPORTUNITY FOR SOUTHERN WOODLAND OWNERS?

The forests of the southern United States play a role in helping regulate Earth’s climate—its longer-term temperature, precipitation patterns, and other meteorological phenomena—by being a part of the global carbon cycle. Forests absorb or sequester carbon dioxide (CO<sub>2</sub>) during the process of

photosynthesis, storing it as carbon in leaves, roots, branches, trunks, soil, and woody debris and other plant litter. Through this process, forests help curb the buildup of atmospheric greenhouse gases that has accelerated since the Industrial Revolution (IPCC 2007).

However, as profiled in *Southern Forests for the Future* (Hanson, Yonavjak, and Clarke 2010), the forests of the southern United States face a number of threats to their extent and health, including permanent conversion of forests to suburban development. These threats, in turn, impact the ability of southern forests to sequester and store carbon. When southern forests are converted to other uses, the overall area of the nation's natural carbon sink, or repository, shrinks.<sup>1</sup>

One much-talked-about approach for addressing these threats is for woodland owners to receive payments for generating forest carbon offsets. A “forest carbon offset” is a metric ton of carbon dioxide equivalent (CO<sub>2</sub>e), the emission of which is avoided or newly sequestered and is purchased by greenhouse gas emitters as a cost-control mechanism to compensate for emissions occurring elsewhere. By providing an additional revenue stream, the argument goes, forest carbon offsets might help reduce the economic pressure on woodland owners to convert their forests to other uses or manage them in a manner that lowers forest carbon stocks. Such payments could occur in emerging voluntary carbon markets, where demand is not the result of a regulatory requirement, or compliance carbon markets, where demand is a result of a regulatory requirement.

As part of WRI's *Southern Forests for the Future Incentives Series* (Box 1), this issue brief explores forest carbon offsets in the context of the southern United States. Much has been written, discussed, and anticipated about forest carbon offsets over recent years, and this brief seeks to summarize some of the essentials by addressing the following questions:

- What role do southern U.S. forests play in sequestering and storing carbon?
- What forest carbon offset markets exist or are emerging that are potentially relevant for southern woodland owners?
- What challenges do forest carbon offset projects still face in the marketplace?
- What are solutions to overcoming these challenges?
- How can southern woodland owners prepare for and engage in emerging carbon markets?

This brief is intended as an introductory resource for southern woodland owners, nongovernmental organizations active in the region, offset project developers, and other forest carbon offset market stakeholders.

Examples in the issue brief utilize the Climate Action Reserve (CAR) program for several reasons. First, the voluntary CAR

## Box 1

## About the Southern Forests for the Future Incentives Series

Over the coming decades, several direct drivers of change are expected to affect the forests of the southern United States and their ability to provide ecosystem services. These direct drivers include suburban encroachment, unsustainable forest management practices, climate change, surface mining, pest and pathogen outbreaks, invasive species, and wildfire. In light of these drivers of change, what types of incentives, markets, and practices--collectively called “measures”--could help ensure that southern U.S. forests continue to supply needed ecosystem services and the native biodiversity that underpins these services? The *Southern Forests for the Future Incentives Series*, available at [www.SeeSouthernForests.org/issue-brief](http://www.SeeSouthernForests.org/issue-brief), explores several such measures.

The series follows the U.S. Forest Service convention of defining “the South” as the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. Furthermore, the series is premised on the fact that southern U.S. forests provide a wide variety of benefits, or “ecosystem services,” to people, communities, and businesses. For example, these forests filter water, control soil erosion, help regulate climate by sequestering carbon, and offer outdoor recreation opportunities.

This series follows and builds upon *Southern Forests for the Future*, a publication that profiles the forests of the southern United States, providing data, maps, and other information about their distribution and makeup, condition, and trends. It explores questions such as: Why are southern forests important? What is their history? What factors are likely to impact the quantity and quality of these forests going forward? The publication also outlines a wide variety of measures for conserving and sustainably managing these forests. The *Southern Forests for the Future Incentives Series* delves deeper into some of these measures.

For additional information about southern U.S. forests, visit [www.SeeSouthernForests.org](http://www.SeeSouthernForests.org). Developed by WRI, this interactive site provides a wide range of information about southern forests, including current and historic satellite images that allow users to zoom in on areas of interest, overlay maps showing selected forest features and drivers of change, historic forest photos, and case studies of innovative approaches for sustaining forests in the region.

forest carbon offset protocol is applicable in the one compliance market in which offsets from southern U.S. forests are eligible, California's emerging Greenhouse Gas Emissions Trading program. In addition, at the time of publication, there are more CAR-certified forest carbon offset projects listed and registered in the southern United States than in any other region of the country, and more CAR-certified forest carbon offset projects listed and registered than the other two voluntary programs in which southern landowners are eligible, the American Carbon Registry (ACS) and the Verified Carbon Standard (VCS).

### SOUTHERN FORESTS SEQUESTER AND STORE VAST AMOUNTS OF CARBON

When managed well or left in their natural state,<sup>2</sup> southern forests sequester and store large amounts of carbon and therefore can play a role in regulating Earth's climate and moderating the effects of global climate change (IPCC 2007). Forests act as major repositories of carbon because live trees and other plants absorb atmospheric CO<sub>2</sub> during the process of photosynthesis. Through this process, some of the CO<sub>2</sub> becomes stored as carbon in leaves, branches, trunks, and roots, while some is stored in soils when leaves and other litter decay. Carbon is also delivered directly to soils through a tree's root systems. Some of this carbon gets released through microbial decomposition and some stays in the organic layer and becomes part of the long-term soil carbon pool.

In 2009, U.S. forests absorbed an estimated 863 million metric tons of CO<sub>2</sub>e, or 235 million metric tons of carbon, an amount equal to approximately 13 percent of the country's gross greenhouse gas emissions from electricity generation, transportation, industry, and other sector sources (EPA 2011).<sup>3</sup> For the South, it is estimated that the carbon sequestered by managed forests accounts for one third of the carbon storage capacity of continental U.S. forests (Jose 2007). Furthermore, according to some studies, the southeastern United States—comprised of Virginia, North Carolina, South Carolina, Georgia, and Florida (as defined by Stoy 2008)—represents the U.S. region with the highest potential to serve as an increased carbon sink because of its favorable climate and growing conditions relative to other regions (Pacala et al. 2001 and Potter et al. 2006 from Stoy 2008).

It is important to note that southern forests vary widely in the amount of carbon they can sequester and store on an annual and long-term basis. Influential factors include the forest type, stand age, type and frequency of management practices, and

initial conditions of the land—whether it is forest or nonforest. Forest carbon offset project standards, discussed below, can help woodland owners understand the carbon implications of various forest types and management practices.

### OFFSET MARKETS COULD CREATE INCENTIVES FOR FOREST CONSERVATION AND SUSTAINABLE MANAGEMENT

Existing and emerging markets for carbon offsets could help create incentives for woodland owners to engage in land management practices that increase forest carbon sequestration and storage capacity.<sup>4</sup> In a carbon market, an individual, business, university, or other entity purchases a carbon offset from another entity, thereby compensating the latter to reduce greenhouse gas emissions or increase greenhouse gas sequestration in lieu of the former reducing its own emissions.

The incentive takes the form of a carbon offset, which is a unit of CO<sub>2</sub> that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere. These offsets, or “credits,” measured in metric tons of CO<sub>2</sub>e,<sup>5</sup> are an alternative to direct reductions by a company or other entity to meet its greenhouse gas reduction targets (Goodward and Kelly 2010; WRI and WBCSD 2004). This brief concentrates on offsets generated by forest carbon offset projects.

#### Types of forest carbon offset projects

There are four types of forest carbon offset projects that can generate forest carbon offset credits (project size can fluctuate greatly depending on the project type).

- *Reforestation*, which refers to projects that restore tree cover on land that was once forested but has been without forest cover for a period of time (e.g., 10 years).
- *Afforestation*, which refers to projects that establish tree cover on land that was either never previously forested or cleared of forest cover for more than a specified period of time (e.g., more than 30 or 40 years). Reforestation and afforestation projects are sometimes grouped or categorized together, as both refer to projects in which trees are grown.
- *Forest conservation/avoided conversion*, which refers to avoiding the conversion of forested land to nonforest uses (e.g., agriculture, residential).
- *Improved forest management*, which refers to forest management activities that enhance or maintain carbon stocks on currently forested land. Examples include reduced impact logging and longer rotation management.

## Types of offset markets

There are two general types of markets for forest carbon offsets: voluntary and compliance.

### *Voluntary markets*

In a voluntary market, individuals, businesses, universities, cities, or other entities purchase offsets to reduce the “carbon footprint” associated with their activities or operations for reasons other than complying with a law or regulation. “Business cases” for voluntary purchases include the following:

- *Meet voluntary targets.* Some entities purchase offsets to meet voluntary greenhouse gas emission reduction targets that may be triggered by corporate social responsibility initiatives. For example, in 2009, at least 475 Fortune 500 companies with combined U.S. assets of \$55 trillion had voluntary CO<sub>2</sub> emission programs.<sup>6</sup> Forest carbon offsets can contribute and are contributing to some of these goals.
- *Enhance brand image.* Some entities purchase forest carbon offsets in order to enhance their brand image by demonstrating leadership on two high-profile environmental issues, climate change and forest conservation. Some of these entities communicate their offset purchases to environmentally conscious customer segments in order to build customer loyalty.
- *Secure low-cost, precompliance offsets.* Hedge funds, traders, commodity funds, banks, aggregators, carbon project developers, or potentially regulated companies sometimes purchase offsets in order to access inexpensive carbon reductions with the expectation that offset demand—and therefore prices—will increase in the future as a result of potential regulations at the state, regional, or national level. These entities are hedging that they may be able to use these low-cost offsets for future compliance or be able to sell them at a higher price to other entities facing compliance targets. These offsets are often known as “precompliance” purchases. One survey found that in 2009, precompliance purchasers constituted the majority of voluntary market offset buyers in the United States for all offset types.<sup>7</sup>
- *Learn by doing.* Other firms purchase offsets to gain a better understanding of an emerging market in which they might participate more actively in the future.

Offsets on the voluntary market are purchased through a formal exchange<sup>8</sup> or on the decentralized “over-the-counter” market, where buyers and sellers engage directly, through a broker, or via an offset retailer storefront (Peters-Stanley et al. 2011).<sup>9</sup> The United States continues to remain the epicenter of the

global voluntary carbon market, accounting for more than one third of voluntary carbon offsets generated and nearly half of those purchased—although not all of these are forest carbon offsets (Peters-Stanley et al. 2011).

### *Compliance markets*

In a compliance market, entities such as electric utilities and manufacturers purchase offsets in order to comply with a law requiring them to reduce their greenhouse gas emissions.<sup>10</sup> In some greenhouse gas compliance markets, regulated entities, such as power plants, are allowed to purchase offsets from nonregulated entities, such as woodland owners, to help the former meet their emission reduction targets.<sup>11</sup> Since nonregulated entities are not required to reduce their greenhouse gas emissions, any emission reductions they make through qualified offset projects are considered equivalent to reductions made by regulated entities, if the reductions by nonregulated entities would not have occurred in the absence of the offset project.<sup>12</sup> If allowed by the market’s design, the purchase of offsets serves as a cost-compliance mechanism.

Offsets are eligible in some states and regions with mandated greenhouse gas emissions reduction targets or “cap-and-trade” programs.<sup>13</sup> Launched in 2008, the Regional Greenhouse Gas Initiative (RGGI), with participating states in the northeast and Mid-Atlantic, was the first U.S. compliance market in which forest carbon offsets were eligible. At the time of publication, however, no forest carbon offsets had been sold under RGGI.<sup>14</sup> Forest carbon offsets are also allowed in California’s greenhouse gas cap-and-trade program, which is slated to begin in January 2012.<sup>15,16</sup> The Western Climate Initiative includes forest carbon offset provisions in its program design document, but the only other entities poised to join California in the WCI by 2013 are British Columbia and Quebec. At the time of publication, forest carbon offsets from southern U.S. forests are technically eligible, presuming they meet program requirements, in California’s Greenhouse Gas Emissions Trading program and RGGI.

Voluntary and compliance markets can coexist, and in some instances offsets generated for the voluntary market might be eligible for the compliance market (i.e., CAR and California’s Greenhouse Gas Emissions Trading program slated to begin in 2012).

Prices and trading volumes of forest carbon (and other) offsets for both voluntary and compliance markets are provided by the Ecosystem Marketplace<sup>17</sup> and the World Bank’s State and Trends of the Carbon Market 2011.<sup>18</sup>

## CRITERIA NEED TO BE MET TO ENSURE HIGH-QUALITY OFFSETS

The demand for and value of forest carbon offsets will depend in part on their credibility or integrity, which is based on how they are defined, measured, represented, and guaranteed (Broekhoff 2007). Offset integrity is important because many offset programs—even voluntary ones—are designed with an eye toward meeting compliance market standards for eligibility. These standards are stringent because carbon offsets enable an emissions reduction target to be met while allowing offset purchasers to continue emitting greenhouse gases. Offsets lacking in integrity could result in an emissions reduction target not being met and buyers paying for something that they are not receiving.

As such, forest carbon offsets must satisfy a number of quality criteria if they are to be credible and market eligible. Some of the key quality criteria include the following:

- **Real.** Forest carbon offset project owners must demonstrate that the project has reduced emissions according to predefined rules and procedures designed to ensure that an offset represents a real reduction in greenhouse gases. This criterion preserves the integrity of the “cap” on emissions or the emissions reduction target. One challenge in ensuring that a forest carbon offset is real is known as **negative leakage**. Leakage refers to the unanticipated changes in greenhouse gas emissions that occur outside the project’s accounting boundary as a result of the project’s activities (Schwarze, Niles, and Olander 2002). With negative leakage, a project causes forest clearing or other CO<sub>2</sub>-emitting activities to shift to other locations and therefore the total net real emission reductions are lower than the gross reductions within the project boundary.<sup>19</sup> Negative leakage can occur in two ways (Fenderson et al. 2009).<sup>20</sup> “Internal leakage” occurs when activities on the forest carbon offset project portion of an owner’s woodland result in changes in CO<sub>2</sub> emissions on a different portion of the same owner’s woodland that is outside the project boundary. An example of internal leakage is when reduced harvests in one part of someone’s forest result in increased harvest in another area of the same person’s forest. “External leakage” occurs when one forest owner’s carbon sequestration activities result in changes in another forest owner’s behavior in a manner that increases the latter’s CO<sub>2</sub> emissions.
- **Additional/surplus.** Additionality refers to the need to demonstrate that every ton of CO<sub>2</sub> sequestered or ton of emissions avoided by the offset project would not have happened in the absence of that project. Emissions or emission reductions that would have happened without the project are considered “business-as-usual” and do not represent new emission reductions.<sup>21</sup> A simple way to think about the additionality of a forest carbon offset is to ask, would the carbon sequestration have happened in the absence of the project? If the answer is no, then the project is generating offsets that are additional. If the answer is yes, then the project is not generating offsets that are additional. Since offsets are used to compensate for continued or increased emissions elsewhere, if the offsets are not additional then their use allows a net increase in total emissions. Hence buyers and other stakeholders take additionality seriously. It should be noted that calculating the net amount of carbon that would be captured in the absence of the project, the “baseline” against which project-derived offsets are calculated, is not easy in the forest sector or in other sectors such as agriculture.
- **Verifiable.** To be credible to buyers, the offset project needs to be monitored and regularly verified by an independent, qualified third party. Monitoring requires quantifiability, which refers to the ability to accurately and precisely quantify with a sufficient degree of confidence the amount of carbon sequestered and stored annually by a forest carbon offset project. Good quantification involves creating a full account or inventory of all forest carbon stocks and flows over time—including carbon accumulation in dead woody biomass and soils—and the flows associated with harvesting.<sup>22,23</sup>
- **Permanent.** Permanence refers to emission reductions or removals that are not reversible—the CO<sub>2</sub> cannot be rereleased into the atmosphere. If the CO<sub>2</sub> were released back into the atmosphere after even a few decades, it would not help mitigate the effects of global climate change over the long-term (Archer et al. 2009). Permanence is an issue for forest carbon offsets because carbon sequestration and storage in forests is a biological process that can be reversed by unintentional natural events, such as fires and pests, or by intentional human action. For instance, if the owner of a woodland that is part of a forest carbon offset project were to convert the woodland into a housing development, a large portion of the carbon stored by that woodland would be released back into the atmosphere.<sup>24</sup>

- **Enforceable.** One credit can only credibly offset one metric ton of CO<sub>2</sub>e emissions. As a result, ownership of each credit should be clearly established and its use tracked to avoid double counting. A fluid and robust carbon market requires that any trades, including future markets, are enforceable so that both buyers and sellers of credits can be certain that each individual credit is valid for use, whether in the voluntary or compliance market.

### STANDARDS HAVE EMERGED THAT APPLY THESE QUALITY CRITERIA

A number of carbon offset standards, each with its own set of protocols, have emerged<sup>25</sup> which apply these quality criteria. A carbon offset standard provides a detailed list of offset project eligibility requirements and methods for quantifying and verifying a project’s emission impact (Goodward and Kelly 2010). These standards seek to provide quality benchmarks and consistency in determining offset eligibility and quantification, improve offset credibility, and lower transaction costs for offset providers. Four of these standards are currently applicable (based on marketplace criteria as determined by legal program requirements) in the U.S. South, which means southern landowners can sell credits in the marketplace (Box 2).

Box 2	Forest Carbon Offset Standards Applicable to the U.S. South
<p>Programs with forest carbon offset standards that are legally applicable to projects in the southern United States include the following:</p> <ul style="list-style-type: none"> <li>• Climate Action Reserve (CAR), <a href="http://www.climateactionreserve.org">www.climateactionreserve.org</a></li> <li>• Verified Carbon Standard (VCS), <a href="http://www.v-c-s.org">www.v-c-s.org</a></li> <li>• American Carbon Registry (ACR), <a href="http://www.americancarbonregistry.org">www.americancarbonregistry.org</a></li> <li>• The Gold Standard (GS), <a href="http://www.cdmgoldstandard.org">www.cdmgoldstandard.org</a></li> </ul> <p>At the time of publication, only CAR has a forest carbon offset protocol that is eligible in a compliance market---California’s Greenhouse Gas Emissions Trading Program established by the cap-and-trade rules under AB32.</p> <p>For more information, visit <a href="http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm">http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm</a>.</p>	

### Applying quality criteria

Although the details of each standard vary, many seek to satisfy the quality criteria, namely by addressing the following:

- **Real.** Standards vary in their approach to the issue of whether the offset is considered real, including assessing the issue of negative leakage. CAR, for instance, has a standard discounting formula to capture external leakage, but it does not take into account case-by-case or regional variation with regard to greenhouse gas emissions (which is very difficult to do). No explicit mechanism is required to quantify internal leakage because it is assumed that other eligibility requirements address that issue (i.e., by requiring that landowners demonstrate that their full holdings are managed in accordance with a sustainable harvest plan and that this plan is approved through a third-party forest certification program or a state entity). To prevent people from taking advantage of the market, there are restrictions on how project boundaries may be defined. Projects must be managed in a similar way or have similar carbon stocking to the rest of an entity’s ownership within an assessment area. If there is a large difference in stocking, discounts are applied to prevent crediting of nonadditional tons. VCS and ACR also have similar approaches to the negative leakage issue. With regard to avoided conversion projects, the negative leakage issue is one of the most difficult for standards to address.
- **Additional/surplus.** Standards typically use one of two approaches for demonstrating the net additionality of a forest carbon offset. One method is “project-specific additionality,” wherein one evaluates the emissions from a proposed project against the emissions from a “business-as-usual” scenario, the alternative scenario deemed the most financially likely in the absence of the offset payment. The other method is “standardized additionality criteria,” wherein one evaluates a project against a set of consistent criteria for a particular project type. Criteria could include that the project is not mandated by law and not common practice in the region and/or has emissions rates lower than most others in its class of activity. These criteria exclude projects that are considered nonadditional and prevent the need for developing a “business-as-usual” scenario for each individual project (Goodward and Kelly 2010; WRI and WBCSD 2004). Each of these methods must ensure that the net additional carbon removed from the atmosphere is higher than the net amount of carbon that would have been captured in the absence of the carbon offset project.

- **Verifiable.** Over the past decade, technical methods for quantifying the emissions impact of a forest carbon offset project have emerged. For instance, in 2005 WRI and the World Business Council for Sustainable Development (WBCSD) published the *Greenhouse Gas Protocol for Project Accounting*, which provides a general framework for quantifying emissions reductions from offset projects. Since then, entities in Box 2, such as CAR, have adopted more detailed methods that are based on the WRI/WBCSD project protocol. VCS and ACR also have detailed quantification approaches in their protocols.

Most standards rely on third-party auditors or “verifiers” to perform due diligence and assure the veracity of the information about the project. Verification requires that the project as a whole meets the chosen standard and that each offset generated and credit issued for sale is based on data that meet the requirements of the standard. Eligible, independent third-party verifiers may differ between offset standards. To find a list of accredited verifiers, visit the Web site of each standard listed in Box 2.

- **Permanent.** Several mechanisms exist to increase the likelihood that a forest carbon offset is permanent or to compensate for the risk of impermanence from reversals, including: (a) establishment of a “buffer” pool or set-aside offset credits that can be tapped if reversals occur, (b) insurance, (c) use of temporary credits that are valid for a period of time but recertified or replaced at some predetermined future date, and (d) buyer or seller liability where the buyer or seller is responsible for providing offsets to replace any that are undone by reversal. In each of these mechanisms, tons of offset emissions that are reversed get replaced, thereby ensuring the integrity of the market.
- **Enforceable.** Most standards rely on registries to facilitate enforceability.<sup>26</sup> These standards may differ depending on whether the offset is listed in a voluntary or compliance market. Forms or other contracts associated with registry application serve as important references for enforcement. Registries can also have their own protocols (i.e., CAR has its own offset protocols) that require the use of contracts to allow enforcement of the agreement to maintain the carbon storage and sequestration on which offsets are based.

## Protocols and southern forests

Forest carbon offset protocols have just begun to apply to southern forests. At the time of publication, there are 36 CAR forest carbon offset projects formally listed, and only one has progressed all the way through registration in the South.<sup>27</sup> Seventeen of these CAR projects are improved forest management projects, 14 are avoided conversion projects, and five are reforestation projects. South Carolina has the most projects, followed by North Carolina, Virginia, Alabama, Arkansas, Tennessee, and Georgia. Because CAR version 3.2 standards have been available for only about a year, only two CAR forestry projects nationwide (one in the South and one in California) have progressed all the way through to verification and registration of credits, at the time of publication.

At the time of publication, there are no VCS projects and only one ACR project listed in the South. The Gold Standard (GS) has no projects in the South. Pilot initiatives, like the Carbon Canopy project, are currently working to increase the number of private woodland owners enrolled in forest carbon offset markets (Box 3).

### Box 3

#### Carbon Canopy

Carbon Canopy is an innovative initiative that seeks to leverage markets for ecosystem services to increase the amount of southern U.S. forests certified by the Forest Stewardship Council (FSC). The initiative is piloting forest carbon projects in which woodland owners improve their forest management practices to generate carbon offsets that meet Climate Action Reserve (CAR) standards and, at the same time, to yield forest products that meet FSC-certification criteria. The carbon offset revenue is designed to help compensate woodland owners for the cost of certification, and can provide a substantial new revenue stream.

Carbon Canopy brings together companies, private woodland owners, and nongovernmental organizations to achieve this vision. Participants include Staples, The Coca-Cola Company, Columbia Forest Products, Conservation Forestry LLC, Domtar Corporation, The Forestland Group, The Home Depot, Interface Inc., Dogwood Alliance, Pacific Forest Trust, Environmental Defense Fund, Green Press Initiative, Keystone Center, Rainforest Alliance, and the World Resources Institute. Pilots are underway in the Appalachian region of North Carolina, Tennessee, and Virginia and are scheduled for completion by early 2012.

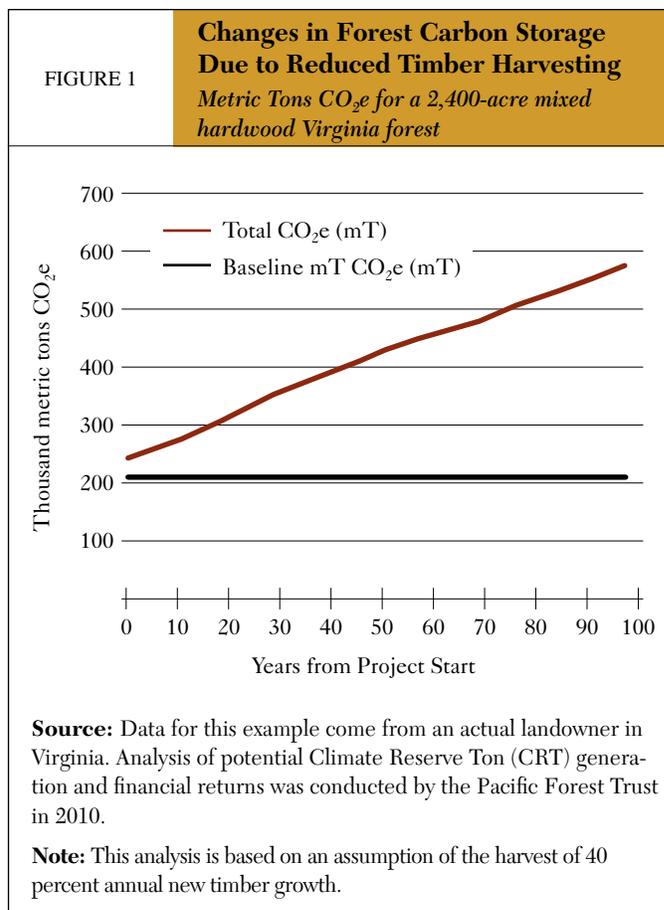
For more information about Carbon Canopy and how to become involved, visit: [www.carboncanopy.com](http://www.carboncanopy.com).

## FOREST CARBON OFFSET PROJECTS NEED TO BE ECONOMICALLY VIABLE, TOO

It is not enough for a forest carbon offset to be credible and market eligible; it also needs to be economically viable. Forest carbon offset projects incur a number of costs. For instance, project development expenses are associated with creating forest management plans and implementing the necessary land management practices. Transaction costs, which can be relatively high given the novelty of the market, include the time and expenses incurred researching opportunities for selling offsets, verifying the project, marketing the offsets, and ensuring offset integrity over time.<sup>28</sup> Landowners face opportunity costs, too, in the form of forgone woodland revenue the owner would have earned in the absence of the project. The revenue side of the equation is a function of the market price for offsets and the expected amount of offsets the project will likely yield. The latter can differ depending on forest type, accounting methodology, project size, and—in the case of improved forest management practices—length of rotation extension.

Forest carbon offset projects can be economically viable depending on a variety of factors. To illustrate, consider a 2,400-acre forest in Virginia that seeks to become an offset project adhering to the CAR protocol. The owner aspires to generate carbon offset credits by harvesting less timber per year than growth from the forest. This forest starts with above average carbon stocking as indicated by a standardized additionality criterion of the mean stocking on private lands for the forest types found in the project area (according to the U.S. Forest Service Forest Inventory and Analysis). By harvesting less forest products than the amount of wood grown on the parcel, the project would continue to accrue carbon for many years and be awarded credit for not depleting carbon that legally and financially is available for harvest. Thus, the project is a form of “improved forest management.”

Suppose the owner harvests 40 percent of annual new timber growth. In this scenario, the trajectory of carbon stored in the forest over a 100-year time horizon would increase considerably above the baseline (Figure 1). The incremental carbon storage plus initial storage above the baseline is the amount eligible for forest carbon offsets. With costs of inventory, verification, and transaction fees included and a modest pricing assumption of \$8.50 per metric ton of CO<sub>2</sub>e rising to \$12 per metric ton of CO<sub>2</sub>e after 12 years, the “40 percent harvest” scenario would earn an undiscounted net profit from carbon offsets alone of \$1.29 million over a 100-year period. The net present value at a 5 percent discount rate would be \$373,000,



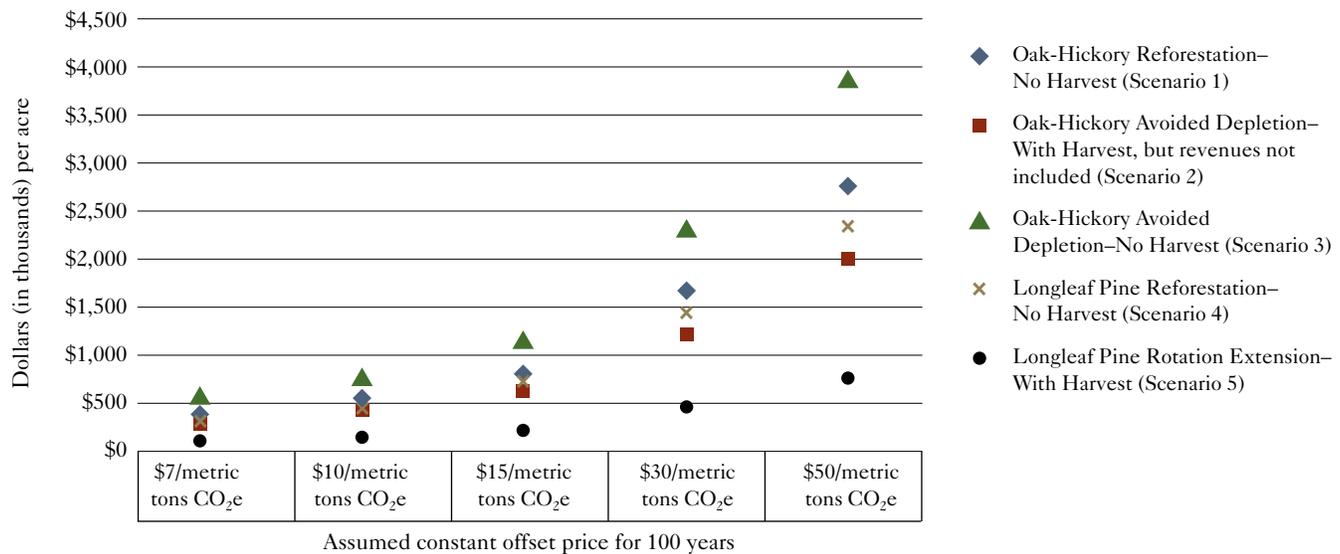
or about \$155/acre. See Appendix 1 for an explanation of the calculations and assumptions.

How significant is this amount? The undiscounted cash flows spread out evenly over the course of the 100-year time period would average \$5.38 per acre per year, *not counting revenue from timber harvesting*. In some counties in the South, this amount could approximate the annual property tax levels for woodlands. The amount also approaches the annual revenue (not profit) per acre for hunting fees earned by some large corporate timberland owners.<sup>29</sup>

It is important to note that some types of carbon offset projects do not generate an even cash flow over time, but rather are “front-loaded”—most of the credits are generated in the first few years for either avoided depletion of carbon stocks (from overharvesting or other unsustainable management practices) compared to allowable timber harvest or avoided conversion compared to loss of forest to real estate development. In these front-loaded scenarios, investing the proceeds from the first few years of credit sales in low-risk instruments, such as a certificate of deposit or a savings bond, can yield significant

FIGURE 2

### 100-Year Total Discounted Gross Income Per Acre Under Five Scenarios Using the CAR Forest Carbon Offsets Protocol



**Source:** Underlying data on forest carbon growth curves is from Smith et al. 2006. The scenario construction and analysis are original work conducted by the Pacific Forest Trust in 2010.

income over many years. For example, a project that generates \$400,000 from credits over its first 5 years but no more credits after that would yield \$1.95 million over 100 years, in addition to, or net of project management costs, if that initial income earned just 2 percent annual interest.

Figure 2 summarizes an illustration of potential total gross earnings per acre for a range of offset credit prices for five scenarios relevant to the South. The scenarios differ in terms of the type of forest and offset project but all use a 5 percent discount rate and a 100-year project commitment period as set forth by the CAR protocol.<sup>30</sup> The payments within each scenario are a total gross discounted revenue or income over the 100-year period for constant prices per metric ton of CO<sub>2</sub>e of \$7, \$10, \$15, \$30, and \$50. Key aspects of Figure 2 include the following:

- Scenario 1 is an oak-hickory reforestation project on land that has been idle pasture for 10 years with no timber harvest. Landowner payments per acre slowly increase over the 100-year project life as carbon storage increases. Total discounted income over the 100-year period ranges from \$399 per acre at an average offset credit price of \$7/metric ton of CO<sub>2</sub>e to \$2,822 per acre with a credit price of \$50/metric ton of CO<sub>2</sub>e.
- Scenario 2 involves a landowner with an oak-hickory forest facing imminent development threat and receiving an up-front carbon payment for not converting the forest to development and maintaining carbon stocks above the average for this forest type. The total discounted gross payments range from \$288 to \$2,058 per acre depending on the offset price. In this scenario, the woodland owner would also receive income from periodic sustainable timber harvests (this revenue does not appear in the figure).
- Scenario 3 is identical to Scenario 2, except that the woodland owner decides to sell biomass accumulation in the stand as a carbon offset rather than engaging in timber harvests. Total discounted gross payments range from \$545 to \$3,891 per acre, depending on the offset price.
- Scenario 4 involves reforestation of a longleaf pine stand with no timber harvest. Annual payments for storage slowly increase over time. Total discounted gross payments range from \$335 to \$2,395 per acre, depending on the offset price.
- Scenario 5 is based on extending the rotation age for harvest of a longleaf pine stand from 20 to 40 years. Longer rotations store more carbon in the forest relative to stands that are harvested more frequently (Smith et al. 2009). Extending rotations generates total discounted gross payments of \$109 to \$781 per acre, depending on the offset price.

The cost of generating the offset and the transaction costs would need to be included to arrive at net income for the woodland owner. Discounted costs over the same 100-year time period for CAR projects are estimated to be between \$100 and \$185/acre over the life of the project, depending on the number of years during which credits are generated and sold. (More years of credit generation means more verification and sales costs.)

These scenarios suggest that, from the financial perspective of woodland owners, income from carbon offsets alone is not sufficient to outcompete real estate development. Particularly given the lower near-term price projections for offsets (in the \$8–\$12/metric ton of CO<sub>2</sub>e range), the opportunity costs of selling woodlands to development is currently higher per acre than the revenue to be earned by generating carbon offsets. Even at higher carbon prices, gross revenues of nearly \$4,000 per acre (Scenario 3) cannot compete with land prices of \$10,000+ per acre in many areas.

Income from forest carbon offsets, however, might be sufficient in some instances to pay property taxes or the “incremental” costs of sustainably managing forests, such as the cost of sustainable forest management certification. But as carbon prices exceed \$20–\$25/metric ton of CO<sub>2</sub>e, the value starts to look like an attractive part of an investment portfolio that could include timber harvesting in addition to carbon sequestration. For nonindustrial landowners that do not need or desire to maximize timber revenue, even \$10/metric ton can provide income that would otherwise go uncaptured and could help pay for the costs of retaining the land and conducting sustainable forestry. Prices exceeding \$30/metric ton of CO<sub>2</sub>e start to compete with current timber values for mixed hardwood in some locales in the South. Two harvests at 40-year intervals would yield a discounted gross revenue of \$2,488 per acre at a price of \$23/short ton of hardwood timber compared to \$2,335 per acre at \$30/metric ton CO<sub>2</sub>e and no timber harvest over a 100-year period.

It is important to understand that opportunity costs differ depending on the financial and other objectives of the woodland owner. Woodland owners considering projects should conduct careful analyses of potential returns from sales of carbon credits and have a clear sense of their own long-term goals and objectives, both financial and otherwise.

## THINKING OF PARTICIPATING IN A FOREST CARBON OFFSET MARKET?

Like all other markets, forest carbon offset markets require robust demand, adequate supply, and good transactional infrastructure. In light of these three conditions, southern woodland owners can take several initial steps if they decide to explore and prepare for these evolving markets: (1) monitor market demand for forest carbon offsets, (2) assess their own potential to supply forest carbon offsets, (3) engage in project development, and (4) enroll in a credible offset registry.<sup>31</sup>

### Monitor market demand

Southern woodland owners interested in forest carbon offset markets should stay abreast of the state of offset demand since this factor will have the biggest impact on forest carbon offset pricing and market growth. Developments that would indicate a growing appetite for forest carbon offsets include:

- prices for forest carbon offsets in either the voluntary or compliance markets (i.e., California’s Greenhouse Gas Emissions Trading Program) begin to increase;
- more companies, universities, government agencies, and other large institutions publicly establish aggressive greenhouse gas emission reduction targets and allow forest carbon offsets to meet at least a portion of their commitments to reduce their carbon footprints;
- existing U.S. regional greenhouse gas cap-and-trade programs, such as the RGGI, adjust their designs to achieve deeper emissions reductions, leading to higher allowance prices and potentially increased demand for offsets;
- other states or regions implement greenhouse gas cap-and-trade programs, such as the Midwestern Greenhouse Gas Reduction Accord or the Western Climate Initiative, and allow forest carbon offsets from the South (and other regions) to be eligible; and
- a federal U.S. greenhouse gas cap-and-trade program emerges for which domestic forest carbon offsets are eligible.

Woodland owners can access information about forest carbon offset prices, trading volumes, and other developments in both voluntary and regulatory carbon markets from online and published resources provided by the Ecosystem Marketplace and the World Bank.<sup>32</sup>

## Assess own potential to supply

If interested in participating in forest carbon markets, southern woodland owners should determine the additional carbon sequestration and storage potential of their land and whether this amount is sufficient for economically viable forest carbon offset generation. Important considerations include the following:

- The type of forest carbon offset project that is most appropriate: afforestation, reforestation, forest conservation/avoided conversion, and/or improved forest management. Factors to consider include the project type(s) eligible for the intended market, the landowner's forest management aspirations and capabilities, and the current condition of the land—it is not possible, for instance, to do an afforestation project on existing woodland.
- The offset standard to use, which may affect the volume and cost of offsets generated from a given project. Be sure to assess how well the standard addresses the technical issues of negative leakage to determine whether the offset is real, additionality/surplus, verifiability, permanence, and enforceability. The better the standard addresses these issues, the more credible and market eligible a forest carbon offset will likely be. Furthermore, be sure to assess other features of standards, such as the following:
  - *Forest carbon offset project types*—The project types that are eligible.
  - *Length of commitment*—The amount of time for which the forest carbon offset project is committed. Commitment periods vary in that the VCS requires 20 years, the ACR requires 40 years, and CAR requires 100 years. Woodland owners should be aware that the commitment periods can be attached to the land covenant, are legally binding for the period, and can trigger penalties if broken. Thus, woodland owners should consider this feature in the context of long-term plans for their land.
  - *Aggregation eligibility and criteria*—Provisions allowing landowners to collaborate or aggregate their land when generating forest carbon offsets. Aggregation occurs when several landowners pool their projects together for the purposes of inventory data accuracy and verification.
  - *Verification and monitoring*—What type of verification and monitoring is required, how frequently these activities are required, who conducts them, and how these activities change as a result of landowner aggregation (if aggregation is allowed).
- *Approach to forest management*—What the program requires in terms of certification of sustainable forest management, whether working forests are eligible, and related requirements.
- *Approach to risk*—Whether a risk buffer pool is required to handle unintended reversals and whether the standard offers a “buyout with penalty” if a landowner decides to get out of the agreement or sell their land.
- *Cobenefits*—Whether the additional benefits generated by forest carbon offset projects, such as watershed protection and provision of wildlife habitat, are recognized. Note that each of these considerations will have an effect on the forest carbon offset project's economics. Very early on in the process, woodland owners should discuss these impacts with a certified project developer.
- The potential economics of a forest carbon offset project, including all costs, potential revenue, and the owner's hurdle rate or acceptable financial return.
- Which third-party specialist(s) to engage to help design the offset project, quantify changes in carbon stocks and flows, conduct verification and other technical activities, and help access the market.
- Whether to conduct the forest carbon offset project alone or to collaborate with other nearby landowners. For instance, woodland owners can voluntarily aggregate themselves into a woodland owner association, coordinating forest management approaches, sharing best practices, and enabling buyers to interact with just one point of contact. Aggregation can help individual landowners reduce costs by enabling economies of scale and diversifying risk. Alternatively, landowners can contract with an aggregator—a business that brokers and takes care of enrolling woodlands in forest carbon offset programs.

## Engage in project development

After assessing the potential for forest carbon offset supply, woodland owners need to decide whether to initiate a project. As with timber management plans, forest carbon offset projects require up-front investment to develop, and project development can take 18–24 months before offsets are generated. Development requires either up-front investment or engagement with a project developer who provides services in exchange for a portion of revenues from offset sales.

Major project development steps to keep in mind include the following:

- Develop an accurate carbon inventory.
- Conduct modeling and analyses of baseline and project scenarios.
- Conduct an internal financial feasibility analysis to increase confidence in potential returns.
- Write up all project documentation according to the requirements of the chosen standard.
- Submit project paperwork for review by the registry.
- Retain a third-party verifier to conduct the verification process.
- Finalize credit registration with the chosen registry.

Carbon offset markets are typically “pay-for-performance,” meaning that carbon offset revenue will only flow after carbon sequestration has occurred and been verified. Any carbon offset that will be of value either in the voluntary or regulatory market requires third-party verification. In addition, each standard usually has requirements for: (1) the accuracy of forest inventory data upon which carbon calculations are made and (2) the use of forest growth and yield models, plus the application of biomass equations, in order to establish the baseline and project scenarios.<sup>33,34</sup>

In addition to these costs, registries themselves usually require fees for a project to be officially registered. These fees pay for staff to assess the eligibility of projects, answer questions about protocol implementation, keep project paperwork in order, and oversee the verification process. Taken together, these requirements lead to the need to spend money prior to being able to gain income from the sale of carbon offset credits.

Expenses for high-quality inventory data collection, expertise in forest modeling and statistics, project documentation development, and hiring a third-part verifier to get a project registered could run approximately \$35,300 for a 2,470-acre

project (Galik, Baker and Grinnell 2009). Some expenses, such as timber inventory, increase with the size of the project area. Verification, technical support, and registry fees, however, do not generally increase proportionally with the size of the project, so larger projects tend to be less expensive per acre.

These upfront costs can result in a financing gap that includes costs associated with project design and start-up, such as establishing a nursery for seedlings, as well as transaction costs, such as legal costs and other costs associated with closing the deal. Start-up funding is currently a barrier to growth in the number of carbon offset projects. Philanthropic sources often help bridge this financing gap by channeling funds through nongovernmental organizations or investors who are willing to undertake risk (Waage and Hamilton 2011). Some private entities are also developing contractual models whereby the company bears some (or all) of the upfront costs in exchange for a claim on future revenue.

Aggregation can be another way to make it easier and less expensive for small landowners to enter the carbon market. The more acres in the aggregate, the less expensive it is for individual landowners to collect data and the less frequently each landowner has to undergo field verification. For example, under CAR’s aggregation guidelines, an individual landowner undergoes field verification every 6 years, but any one landowner within an aggregate undergoes field verification only every 12 years.<sup>35</sup>

### **Enroll in a credible offset registry**

If a woodland owner decides to implement a forest carbon offset project, the owner should enroll the project and the offsets it generates in an offset registry to ensure credibility. CAR, VCS, and ACR, for instance, have their own registry for projects that follow their respective protocols. Recording offsets in a registry is required for participation in compliance markets and is recommended for participation in voluntary markets since the transparency afforded by registries can bolster buyer confidence in offset quality and integrity.

## TAKING STOCK

The steps outlined above can help southern woodland owners pursue existing forest carbon offset opportunities and prepare for future ones. Owners, however, should enter this market with realistic expectations. Despite much discussion over the past few years regarding forests and climate change, forest carbon offsets—and the voluntary and compliance markets for them—are still relatively new and offset prices, for the most part, remain low. Thus, economic returns to woodland owners will be modest per acre at least in the near term. As a result, profits from forest carbon offsets are unlikely to counter the per acre opportunity cost of selling off forests for residential or commercial development.

But this conclusion should not dampen interest. For example, returns would improve if forest carbon offset demand in either voluntary or compliance markets were to increase. Likewise, for some woodland owners, even a small new revenue stream is sufficient to cover property taxes, sustainable forest certification costs, or other incremental expenses associated with forest ownership. Furthermore, other types of incentives are available to southern woodland owners that could help them maintain their forests (Yonavjak et al. 2011).

Although forest carbon offsets may not to be a panacea for southern forest conservation, they are yet another option in the portfolio of approaches for sustaining southern forests for the future.

## APPENDIX 1. ASSUMPTIONS USED IN ECONOMIC ANALYSIS OF A HYPOTHETICAL 2,400-ACRE FOREST CARBON OFFSET PROJECT IN VIRGINIA

The project is located in the Allegheny North Cumberland Mountains Super Section in Virginia and is comprised mostly of mixed hardwood and oak-hickory stands, with a small component of white pine. Starting stocks and input for growth and harvest modeling were derived from current inventory data on the property.

This forest starts with above average carbon stocking as indicated by a standardized additionality criterion of the mean stocking on private lands for the forest types found in the project area (data from the U.S. Forest Service Forest Inventory and Analysis). Harvest was modeled as 40 percent of annual growth over a 100-year period. This harvest assumption results in a steady increase of carbon stocks during the assessment period.

Growth rates are based on observed data from the property and on growth and yield tables for the region. These were estimated to decrease as the stands reached culmination of mean annual increment in later years. Stands were modeled to grow at 2.25 percent per year during the first 25 years, 1.5 percent during years 26--50, and 1 percent per year during years 51--100.

Prices for a Climate Action Reserve (CAR)-verified metric ton of carbon dioxide equivalent (CO<sub>2</sub>e)—known as a Climate Reserve Ton (CRT)—were assumed as follows:

- 2009–2014: \$8.50/CRT
- 2015–2020: \$10.00/CRT
- 2021–2050: \$12.00/CRT

These price assumptions are likely conservative in that prices for CRTs in the California market are projected to be as high as \$30 or more by 2020 (Point Carbon 2011). However, given the uncertainties associated with predicting price trends, the authors felt it was prudent to assume a small increase in price over time.

The project generates 368,000 total CRTs over the 100-year period. After buffer contributions (see next paragraph), 294,431 CRTs remain for sale. Because the project starts above the Common Practice Indicator for the baseline, the greatest number of credits generated on an annual basis occurs in the first year (33,000). The baseline is the Forest Inventory and Analysis (FIA) mean for the forest types on private lands in the assessment areas contained in the project. Every year after the first, the project generates between 2,600 and 4,500 CRTs per year based on annual growth that is not harvested.

A yearly buffer contribution of CRTs as required by CAR Version 3.2 was assumed to be 20 percent. The buffer pool is used to pay into an insurance pool that all projects verified through CAR can access in the case of unintentional reversals. This is a conservative buffer contribution assumption because the contribution may be lower—possibly as low as 12 percent—if careful management and conservation easements are used.

The costs of developing and maintaining the forest carbon offset project are assumed as follows:

- Initial project development: \$25,000
- Technical support during verification: \$2,500
- Initial field inventory: \$24,000 (\$10/acre)
- Verification: \$17,500 first year and then again every sixth year for field verification, \$7,500 for desk verifications in intervening years
- On-going project management: \$5,000/year (inventory management, reporting to CAR)
- Periodic field inventory updates: \$25,000 every 10 years
- CAR project fees: \$500 onetime account setup fee, \$500 onetime project submittal fee, \$500 annual account maintenance fee, \$0.20/CRT registration fee, \$0.03/CRT transfer fee (when credits are sold)

Gross proceeds from sales of CRTs total \$3.36 million. Total costs are \$2.07 million for a net profit of \$1.29 million over the 100-year project life. This figure is not discounted. Applying a discount rate of 5 percent to take into account the assumption that most people prefer income sooner rather than later, the net present value of the project (revenue minus costs over 100 years, discounted at 5 percent per year) is \$372,000, or about \$155 per acre.

Note: The 2,400-acre case study was done as a preliminary analysis using carbon from living trees as a surrogate for the entire project. Full project development under CAR v. 3.1 and 3.2 require the incorporation of wood products, but this was not incorporated into the analysis.

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## ENDNOTES

1. Permanent loss of forest to development results in a loss of carbon sequestration and storage benefits. Yet improved forest management practices can help increase the size of the nation's carbon sink in working forests.
2. Note that forests can be sources of greenhouse gas emissions, as well, if management practices decrease forest carbon stocks over time.
3. This figure includes the net million metric tons carbon dioxide equivalent (CO<sub>2</sub>e) absorbed by forests (EPA 2011).
4. More tools are needed for landowners to be able to assess their eligibility for various ecosystem service markets. Some tools are beginning to emerge, such as LandServer ([www.landserver.org](http://www.landserver.org)), a Web-based tool that provides farmers and woodland owners with a quick and easy natural resource assessment, an evaluation of the property's potential to receive payments for implementing conservation actions, and information for how to get started.
5. Carbon dioxide equivalency is a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO<sub>2</sub> that would have the same global warming potential, when measured over a specific timescale (generally 100 years).
6. For more information, visit <http://www.pwc.com/gx/en/carbon-disclosure-project/index.jhtml>.
7. Point Carbon surveyed a "small but influential group of players" with a good view of both demand and supply of voluntary carbon credits (including forest carbon offsets). Based on the cohort's responses, Point Carbon found that "precompliance" purchases made up 65 percent of the total primary market in 2009, and the remaining 35 percent of purchases were "voluntary," where the buyers wanted to simply reduce their carbon footprint (Point Carbon 2010).
8. In previous years, large volumes of voluntary credits were transacted on through the Chicago Climate Exchange (CCX), a formal exchange and a membership-based cap-and-trade program that expired in December 2010.
9. Currently, the majority of voluntary offset transactions still do not occur on a formal exchange.
10. Some states, like Oregon, do not have a cap-and-trade program, although they have legislation that requires entities like power plants to reduce their greenhouse gas emissions; these entities are allowed to purchase offsets to reach their carbon emission reduction targets. Washington State also has similar legislation, though it has not yet been used because new facilities have chosen not to use offsets to meet their obligations. Massachusetts also has a mandatory GHG emissions reduction legislation.
11. Regulated entities may also purchase emission allowances from other regulated entities.
12. The critical factor for purchasing offsets is whether these commodities are equivalent to allowances, or if the use of forest offsets imposes additional obligations (personal communication with Nicholas Bianco at WRI).
13. Cap-and-trade is an environmental policy tool that delivers results within a mandatory cap on emissions while providing sources of the emissions flexibility on how they comply. For more information, visit <http://www.epa.gov/capandtrade/>.
14. The reason for the lack of transactions in this regional market is that the RGGI allowance price is currently too low to drive significant investment in offsets (for instance, RGGI auction clearing prices of CO<sub>2</sub> allowances fell from \$2.07 in March 2010 to \$1.86 in December 2010. For more information about RGGI allowance prices, see RGGI's annual report on the market for CO<sub>2</sub> allowances (2010): [http://www.rggi.org/docs/MM\\_2010\\_Annual\\_Report.pdf](http://www.rggi.org/docs/MM_2010_Annual_Report.pdf). For more information on each participating state's annual CO<sub>2</sub> emissions budget through 2015, see: [http://www.rggi.org/docs/mou\\_final\\_12\\_20\\_05.pdf](http://www.rggi.org/docs/mou_final_12_20_05.pdf)). In addition, all offset projects for RGGI must be located within one of the participating states or any other state or U.S. jurisdiction where a cooperating regulatory agency has entered into a memorandum of understanding (MOU) with the appropriate regulatory agency in all 10 RGGI states to provide oversight support for the project. No southern states have currently signed an MOU. In addition, if the "stage-two trigger price" (\$10 per metric ton CO<sub>2</sub>e) comes into effect, the eligible project location is expanded to include offsets from any governmental mandatory program outside the United States with a tonnage limit on greenhouse gas emissions. See <http://www.co2offsetresearch.org/policy/ComparisonTableEligibility.html> for more information.
15. In December 2010, the California Air Resources Board (CARB) adopted regulations allowing four different offset types, including forest carbon offsets. These regulations will allow credits generated from projects already developed under the Climate Action Reserve (CAR) to be eligible until 2014. By that date, all projects will need to be developed under regulatory protocols adopted by CARB. The forest protocols adopted by CARB are similar to the one used by CAR. In September 2009, CAR adopted standards that allow projects anywhere in the United States to qualify.
16. AB32 (The Global Warming Solutions Act of 2006) sets the goal for greenhouse gas reductions and calls for the market-based program. The actual cap-and-trade design was set forth by the cap-and-trade rules passed December 16, 2010, which can be viewed at <http://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm>.
17. Visit: <http://www.ecosystemmarketplace.com>.
18. This publication can be found at [http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/StateAndTrend\\_LowRes.pdf](http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/StateAndTrend_LowRes.pdf)
19. Positive leakage occurs when a project yields increased carbon dioxide (CO<sub>2</sub>) sequestration or avoided emissions outside the project's boundary. For example, a protected forest may help adjacent forests stay healthy (also known as ecological leakage), or an industry may reformulate production methods to be less carbon intensive as a result of a forest project, which is known as life-cycle leakage (Schwarze, Niles, and Olander 2002).

20. Emissions leakage and product leakage are other terms that are often used. Emissions leakage refers to a scenario where wood processors may shift operations to neighboring landowners or even another country if large landowners or certain countries agree to preserve their forests. Ultimately, this shift in operations would not actually result in a decline in overall deforestation. With product leakage, avoided deforestation may lead builders to replace wood products, such as lumber and plywood, with other, more energy-intensive greenhouse gas-emitting products, such as concrete and masonry walls and steel and aluminum framing. For more information, visit <http://ncseonline.org/NLE/CRSreports/10Jun/RL34560.pdf>.
21. See Woodward and Kelly 2010.
22. When creating a carbon inventory, some changes in carbon flux are either highly variable or otherwise difficult to cost-effectively measure (i.e., some aspects of soil carbon sequestration) with sufficient accuracy to determine whether a change in carbon flux has in fact occurred. Thus, these activities cannot be considered verifiable until improved and cost-effective methods for measuring their effect have been developed and incorporated into forest carbon offset protocols. At the time of publication, ACR and VCS forest protocols for the U.S. do not include soil, litter, or shrub pools. CAR is in the process of developing soil measurement models for its forest carbon offset protocol, but they have not yet been released.
23. Based on research compiled by Wayburn et al. (2007), standing live trees account for 64 percent of forest labile carbon (carbon that is easily released into the atmosphere, and includes trees, but not soil in time frames of 100 years or less). Between 20-33 percent of labile forest carbon ends up in forest products. Up to 40 percent of this carbon is stored over the long term in products such as saw timber and furniture, lasting 20 to more than 100 years. The remainder is stored for the short term in products such as paper, lasting five years or less. Decay rates for these products vary, however, and paper products, for instance may be land-filled or burned. Therefore, when taken as a whole, the average estimate for the decay rate for all forest products combined is 2 percent/year.
24. For more information about reversal risks, see Galik and Jackson 2009.
25. Standards are developed by programs such as CAR, which is a national offsets program that establishes regulatory-quality standards for the development, quantification and verification of greenhouse gas emissions reduction projects in North America. CAR also issues carbon offset credits known specifically to the CAR program as Climate Reserve Tonnes (CRT) generated from such projects and tracks the transaction of credits over time in a transparent, publicly-accessible system. The CAR specifically operates alongside its sister program the California Climate Action Registry, which was created by the State of California in 2001 to address climate change through voluntary calculation and public reporting of emissions.
26. Projects are often assured through enforceable contracts, such as an easement attached to the forested property that requires continued forest cover or third-party verification. For some markets and practices, assurance of sustainable forest management can be obtained through forest certification, such as the Forest Stewardship Council or the Sustainable Forestry Initiative, which have set standards and rely on independent third parties for certification of sustainable management practices. For more information, visit <http://ncseonline.org/NLE/CRSreports/10Jun/RL34560.pdf>
27. These data are from the CAR Web site, <http://www.climateactionreserve.org>.
28. However, transaction costs will likely continue to decrease as the market matures.
29. Personal communication with Paula Swedeen, anonymous, November 17, 2010.
30. The CAR forest carbon offsets protocol requires that the project owner maintain the carbon stock, representing credits that are registered, for 100 years from the year of registration. This requirement addresses the need for biological offsets to be permanent and is the most accepted regulatory standard for permanence.
31. For a good overview of what it takes for woodland owners to participate in forest carbon markets, visit the Woodland Carbon Web site at <http://www.woodlandcarbon.com/forest-owner-resources>.
32. These reports can be found at [http://www.forest-trends.org/~forestr/publication\\_details.php?publicationID=2828](http://www.forest-trends.org/~forestr/publication_details.php?publicationID=2828) and [http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/StateAndTrend\\_LowRes.pdf](http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/StateAndTrend_LowRes.pdf)
33. The baseline refers to a description and quantification of how much carbon a forest would store under existing management in the absence of a carbon offset project. Baseline will differ by forest type, management regime, and a host of other conditions.
34. The project scenario is a projection of how much additional carbon a forest would store under intentional actions to either increase overall storage or decrease emissions from harvest or conversion.
35. Visit <http://www.climateactionreserve.org/how/protocols/adopted/forest/current/> and click on "Guidelines for Aggregating Forest Projects."

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