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State Forestry Agency Perspectives on Carbon Management and Carbon Market Assistance to Family Forest Owners

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Family forest owners within the United States could potentially make significant contributions to sequestration efforts. However, we expect that landowners will need assistance if they are to successfully implement carbon management techniques and/or navigate through complex carbon market requirements. State forestry agencies were surveyed to gather their perspectives on carbon management and carbon market participation, assess current demand for assistance, and identify the types of state-sponsored programs available to landowners. Currently, only a few states have carbon management or carbon market assistance programs. A majority of states report that demand for carbon assistance is low, and few landowners are aware of carbon management or markets. Interestingly, and in contrast to previous estimates, demand and interest often appear unrelated to a state's physical forest sequestration capacity. Although many attributes of a carbon market present barriers, states appear to agree that certain landowner characteristics may increase participation interest.

Keywords: carbon sequestration, management assistance, family forest owners, carbon management, carbon market

Forests are considered to be one of the largest-volume and lowest-cost means of sequestering carbon (Galik et al. 2009, Gorte and Ramseur 2010). Although other sequestration options (e.g., geologic sequestration and industrial solvent CO₂ capture) require technological advancements before they can be considered economically viable, forest sequestration methods are considered to be an “immediate term” option (Pacala and Socolow 2004, US Department of Energy 2007). In the United States, forests already function as an important carbon sink (Miner et al. 2014). To pro-

vide meaningful contributions to the percentage of carbon already being sequestered, scientists caution that forestry activities need to be implemented on a large scale (Canadell and Raupach 2008, Sohngen 2009, McKinley et al. 2011).

Family forest owners¹ own 42% of the nation's forestland (Butler and Leatherberry 2004) and could be significant contributors to carbon sequestration efforts. Although a number of forest management methods can be used to increase carbon storage (e.g., afforestation, reforestation, and avoided deforestation), *improved forest management*² is

the primary method of increasing the carbon sequestration ability of currently forested land. The US Environmental Protection Agency (EPA) predicts forest management to be a leading carbon mitigation strategy at low to moderate carbon prices³ (US EPA 2005, Galik et al. 2013).

Forest landowners who would like to participate in carbon markets and sell carbon credits are typically required to (1) sign a contract for a specified time period (up to 100 years); (2) obtain an initial detailed inventory of their forestland from a professional forester; (3) obtain and follow a forest management plan; (4) certify the forestland; (5) manage the forestland in a manner that is consistent with carbon storage practices recognized by the carbon protocol; (6) keep a written record of the land management activities undertaken; and (7) allow periodic monitoring and verification of forestry practices by a third party. They must commit to practices that increase the amount of carbon stored on their land through techniques such as improved tree stocking, thinning of diseased or suppressed trees, reduced forest degradation, and delayed harvest.

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Several state/regional studies have surveyed family forest owners to determine their willingness to participate in forest carbon offset markets. The results of these studies have been mixed. Some found that a notable percentage of forest owners would be willing to participate under certain financial and contractual conditions (Simpson and Li 2010, Miller et al. 2012, 2014, Thompson and Hansen 2013), whereas others concluded that a very limited number would be willing to participate (Markowski-Lindsay et al. 2011, Dickinson et al. 2012, Thompson and Hansen 2012). Several of the studies indicated that the nonmonetary benefits of carbon market participation may have as much or more influence on a landowner's decision to participate as the monetary aspects (Markowski-Lindsay et al. 2011, Dickinson et al. 2012, Miller et al. 2012, 2014, Thompson and Hansen 2013). For example, focus group discussions with forest landowners in the Lake States region found that landowners would be willing to participate in carbon projects for little to no compensation if they received forestry assistance that allowed them to concurrently achieve other forest ownership objectives (e.g., improved aesthetics or wildlife habitat) (Miller et al. 2014).

Previous research has also found that most landowners are unfamiliar with specific carbon management techniques and the requirements to participate in carbon markets (Miller et al. 2012, Thompson and Hansen 2013). Early experimentation with carbon offset projects by forest owners in Illinois, Kentucky, Maine, Michigan, and Tennessee found that landowner assistance was essential for effective participation (Beddoe and Danks 2009, Snyder 2009a, 2009b). These early adopters received assistance in the form of free forest management plans, loans, and/or technical assistance. If landowners are to make meaningful contributions to carbon sequestration in the future, it is expected that some type of forestry assistance will be needed and/or desired. Therefore, it is important to gain an understanding of the types of assistance available and the perspectives of those likely to be called on to assist.

Given the role consulting and service foresters have in private forest management in the United States, we were interested in understanding the perspectives of professional foresters regarding the demand for carbon-related management assistance from family forest owners. We are aware of only

one study that examined the perspectives and experiences of professional foresters regarding private landowner interest in carbon sequestration projects. This 2009 pilot study asked professional foresters who were members of the Forest Guild⁴ about their perspectives on the willingness of family forest owners to participate in carbon sequestration projects and how to design projects to encourage landowner participation (Wade and Moseley 2011). Forest Guild members identified a number of barriers to family forest owner participation in forest-based carbon sequestration projects, including profitability concerns, compliance difficulties, immaturity of carbon markets, property right infringement, moral objections to carbon markets, and forester hesitation to promote carbon projects. They recommended a larger study of foresters be conducted to better understand how carbon offset projects and related incentive programs might be structured to encourage wider participation among family forest owners.

Building on this recommendation, we sought to explore the perspectives of state forestry agency personnel to gather additional insight and understanding regarding family forest owner interest in carbon management and selling carbon offsets, their need for assistance in undertaking these activities, and the ability of state forestry agencies to provide carbon-related management assistance and information. Although a relatively small portion of the total landowner population currently seek out forest management assistance from state forestry agencies (Butler 2008), state forestry agencies are a key provider of a wide range of services to

private landowners within their state including financial assistance programs, technical forestry assistance, and education (Schroeder et al. 2011). Because of their position as a primary provider of information and assistance and their likelihood of being called on to provide assistance should landowner interest in carbon management or markets increase, we suggest that state forestry agencies are uniquely situated to provide insight regarding landowner interest in forest carbon projects and their expectations of landowner needs for assistance.

Our specific study objectives were to (1) assess state forestry agency professionals' perceptions of demand for forest carbon management assistance nationwide; (2) characterize the general interest of forest owners in managing for carbon from the perspective of state agency managers; (3) investigate opportunities for and barriers to landowner participation in carbon management and carbon markets as seen by state forestry agency professionals; (4) identify current state-level forest carbon assistance programs available to US family forest owners; and (5) characterize the outlook state forestry professionals have regarding the future of forest carbon management.

Data and Methods

To accomplish our study objectives, we surveyed state forestry agency representatives (SFARs) across the nation. The survey instrument was an electronically delivered questionnaire, designed as a writable PDF form (Adobe Acrobat 9.4 Pro Extended, 2011; Adobe Systems, Mountain View, CA). The questionnaire used a structured response format (e.g., Likert scale, multiple

Management and Policy Implications

Carbon sequestration is one means of curbing excess carbon emissions. Forestry activities are considered to be one of the largest-volume and lowest-cost means of sequestering carbon and can concurrently provide additional benefits to society. Family forest owners may make significant contributions to overall forest carbon sequestration if they are willing and able to participate. Our findings suggest there may be little relationship between a state's physical capacity to sequester carbon from family forestlands, landowner interest in managing for carbon or producing carbon offsets, and the presence of state-sponsored programs to assist landowners in developing and implementing carbon offset projects. Basing projections of carbon reduction on the number of family forest acres alone may greatly overestimate the supply of carbon offsets from family forest owners. If forest sequestration is chosen as a carbon reduction strategy, further effort is needed to clearly identify landowners who are willing to participate in carbon management and/or carbon markets. Better identifying landowners could help agencies as they consider how (or whether) to invest in programs that provide forest carbon management and market assistance and information. This nationwide analysis offers guidance to states or entities that may be interested in developing or encouraging forest sequestration efforts.

Table 1. Demand from family forest owners for carbon management and carbon market assistance during 2011.

No. of inquiries (over the past year)	Carbon management	Carbon markets
 (% of states)	
None	30	26
5 or fewer	56	54
One or more/month	6	10
Almost weekly	0	2
Not sure	8	8

choice) to elicit SFAR evaluations of (1) current demand for forest carbon-related assistance and information; (2) landowner familiarity with forest carbon activities; (3) landowner interest in managing for carbon or participating in carbon offset markets; (4) barriers and opportunities with respect to carbon management or carbon market participation; and (5) types of state-sponsored carbon-related assistance provided. SFARs were also given the opportunity to provide additional comments about forest owners and forest carbon sequestration in an open-ended response format.

Forest landowners can choose to manage their forests to increase carbon storage and/or reduce carbon loss without any desire to formerly participate in carbon offset markets. We were interested in gathering information about general carbon management and participation in forest carbon offset markets as separate activities. Therefore, each of these activities was considered independently using the following definitions

Forest Carbon Management: programs that provide information and other assistance to landowners specifically for the purpose of increasing the carbon sequestration and storage capability of their forestland (*carbon management*).

Forest Carbon Markets: programs that provide landowners with information and other assistance so that they may fulfill carbon offset requirements and access carbon markets to sell carbon credits (*carbon markets*).

The survey's target population was administrators of state forestry agencies familiar with their state's carbon-related assistance programs. Initially, the person listed on each state's federally mandated Forest Action Plan⁵ was contacted by phone, given an explanation of the purpose of our study, and asked to identify the most appropriate individual to complete the questionnaire. Administrators who could not be reached by phone were sent a personalized e-mail re-

Table 2. Family forest owner and state forestry agency staff familiarity with carbon management and carbon markets.

Forest carbon activity	Familiarity
Family forest owners:	
Carbon management	2.10
Carbon markets	1.98
State forestry agency staff:	
Land management strategies (indirectly increasing carbon)	3.71
Carbon markets	2.20

Average Likert scale ratings (1 = "no familiarity" to 4 = "extensive familiarity") of all state agency representative responses across the nation are shown.

questing this information. If the initial contact identified another individual to be better suited to complete the questionnaire, that individual was also contacted by phone or e-mail.

Following Dillman's (2007) recommendations for administering web-based surveys, a phone call (or personalized e-mail) to each SFAR served as a prenotification of the survey. When completing the questionnaire, agency representatives were encouraged to consult with other agency staff, when needed, although only one questionnaire was sent to each state. Representatives of the 50 state forestry agencies were e-mailed a cover letter and questionnaire in January 2012. Descriptive statistics were generated for the structured responses to the survey questions. Qualitative comments (i.e., responses to open-ended questions) were analyzed using inductive coding to categorize responses (Patton 2002).

Results

All 50 states responded to the survey. Survey respondents were assured that their individual comments would remain confidential. Consequently, all comments and/or suggestions given by SFARs are reported as summaries; no names or state sources are attributed to any individual quotes included in this report. Our goal was to provide an overview of the national landscape of forest carbon management and offset assistance programs and gather information regarding landowner carbon management and offset opportunities, demands, and barriers.

Current Demand for Carbon Assistance

Respondents were asked to estimate the number of inquiries their agency had received over the past year from family forest

owners interested in either managing for carbon and/or selling carbon credits. The results indicate that little demand currently exists for this type of assistance from state agencies. As shown in Table 1, approximately one-quarter of the states indicated that they had received no inquiries regarding either carbon management or carbon markets during the past 12 months (30 and 26%, respectively). Half of the respondents stated they had received five or fewer requests for information over the past year for either carbon management (56%) or carbon markets (54%). Only one state indicated that it had received inquiries from landowners on a weekly basis (for carbon markets only). When asked if they expected the number of carbon-related inquiries to change during the coming year, the majority of respondents anticipated no change in the demand for assistance for either managing for carbon (34 states) or for accessing carbon offset markets (32 states).

Familiarity with Carbon Management and Carbon Offsets

Based on their experience with family forest landowners, SFARs believe them to be largely unfamiliar with carbon-related forest activities (Table 2). It was the opinion of the majority of respondents that landowners either had "no familiarity" (8 states) or "minimal familiarity" (35 states) with carbon markets (indicating a rating of "1" or "2" on a four-point Likert scale: 1 = "no familiarity"; 4 = "extensive familiarity"). In a few states, SFARs indicated that the landowners in their state had "some" familiarity with either forest carbon management (10 states) or carbon markets (7 states) (indicating a Likert scale rating of "3"). Although respondents stated that landowners were, on average, slightly more familiar with the concept of managing their forest for carbon than car-

bon markets, familiarity with neither activity ranked very high.

The majority of respondents indicated that their staff is familiar with the land management strategies needed to promote carbon storage (Table 2). Nationally, staff knowledge of the techniques for land management strategies averaged 3.71 (on a scale of 1 = not familiar to 4 = very familiar). Thirty-eight states (76%) gave their staffs' knowledge of such practices the highest rating possible. However, respondents considered themselves to be far less familiar with activities needed to produce carbon offsets and/or participate in forest carbon markets. When asked to rate their staffs' familiarity with opportunities to sell forest carbon credits, respondents reported that the average level of familiarity across the nation was 2.2 on the same four-point Likert scale.

Interest in Carbon Assistance

Drawing on their experiences with the family forest owners in their state, respondents were asked to indicate the level of interest they expect landowners to have in carbon management or carbon markets as a function of several landowner characteristics (Table 3). The specific landowner characteristics evaluated were as follows

- Size of parcel owned (<20 acres; 21–200 acres; >200 acres).
- Land tenure (newer owners [<10 years]; longtime owners [≥ 10 years]).
- Residential status (absentee owner; resides on or close to the property).
- Primary ownership focus (timber; recreational; amenity).
- Management plan status (has a forest management plan; does not have a forest management plan).
- Forester interaction (has worked with a forester; has not worked with a forester).

A four-point Likert scale response was used to evaluate each of these landowner characteristics for the two carbon activities we evaluated (carbon management and selling carbon credits). Response options ranged from 1 = "Not Interested" to 4 = "Very Interested." A "Not Sure" option was included for each response to avoid forcing a response from agency representatives who did not feel qualified to evaluate a particular landowner or parcel characteristic.

Respondents were also asked to identify how landowner characteristics might influence participation in forest carbon activities (Table 3). These characteristics were examined because they have been found in previ-

Table 3. State forestry agency perspectives on family forest owner participation in carbon management and carbon markets and current state programs.

State forestry agency perspectives	Carbon management	Carbon markets
Landowner characteristics expected to increase interest	Forest management plan Previous forester interaction	Forest management plan Previous forester interaction Large parcel owners
Primary barriers	Conflict with forestry objectives No interest in carbon storage Lack of tangible results	Low carbon prices Strict/costly requirements Long contract length
Most likely sequestration methods	Thinning or other stand-release techniques Reforestation Tree stocking Adjusted rotations	
Most effective outreach methods	Direct contact with foresters Training or workshops Word of mouth	

ous studies to be associated with private landowner decisions to undertake different conservation practices (e.g., parcel size: Ma et al. 2012; land tenure and residential status: Miller et al. 2012; ownership focus: Watson et al. 2013; management plan: Creamer et al. 2012; and forester interaction: Kaetzel et al. 2009). Nationally, respondents thought the landowners most likely to adopt carbon management practices are those who already have a forest management plan and have interacted with a forester. These traits, as well as large parcel ownership, were expected to increase interest in carbon markets. This finding agrees with a previous study of landowners in the Lake States area that found large parcel owners (≥ 200 acres) who had previously completed certain carbon offset requisite activities (i.e., acquired a forest management plan or certified their forestland) expressed high interest in forest carbon market participation (Miller et al. 2012).

Most and Least Likely Carbon Sequestration Methods

Survey respondents offered opinions on the likelihood landowners in their state would adopt certain carbon sequestration methods (selected from a predefined list), again based on their observations of what management activities landowners in their state typically employ (Table 3). Thinning was the forest management activity most often identified, followed by reforestation, tree stocking, and adjusted rotations. Several respondents indicated that specialized carbon storage techniques that concurrently address other (noncarbon related) specific problems or needs within their state would greatly increase the likelihood landowners would adopt them. The specialized techniques

mentioned include managing for older forests, establishing riparian buffers, restoring wildlife habitat, and planting windbreaks. Increasing tree growth through fertilization was seen as the technique least likely to be chosen by landowners as a means of increasing their forests' capacity to sequester carbon.

Effective Carbon Assistance Outreach Strategies

SFARs were asked to identify the methods thought to be potentially useful in reaching landowners regarding carbon management or carbon markets activities. Direct contact with foresters, followed by training or workshops and word of mouth, were rated as the most effective outreach methods based on previous experience with family forest owners (Table 3). SFARs indicated, on average, that webinars are the least effective means of reaching family forest owners.

Barriers to Carbon Management and Carbon Market Participation

Respondents were asked to identify the three most significant barriers landowners were likely to face when considering participation in either forest carbon management or carbon markets (Table 3). A list of potential barriers was presented for each activity along with an "other" option. With respect to carbon management, landowner attitudinal barriers were commonly cited. For instance, SFARs most often indicated that carbon management (without plans to sell on the market) may conflict with the ownership objectives of landowners or simply not be of interest to them. Skepticism regarding possible tangible outcomes associated with carbon management was also commonly cited. Importantly, whereas agency representatives

consistently indicated that landowners were unfamiliar with carbon management, lack of assistance or knowledge of where to go for assistance was not seen as being a significant barrier.

When considering barriers to carbon market participation, respondents most often cited low carbon prices, strict/costly requirements, and long-term contracts as primary barriers to greater landowner interest (Table 3). A lack of landowner awareness of carbon market opportunities was also cited frequently. Only six states (12%) mentioned “lack of assistance programs” as being a major barrier. The barriers to carbon market participation, however, were thought to be more strongly tied to market characteristics than to conflicts with a landowner’s forest ownership objectives.

Current Assistance Available to Family Forest Owners

SFARs were asked to provide information about programs within their state specifically designed to assist forest landowners in managing for carbon and/or selling carbon credits. A program was defined as a structured, organized effort to provide education, technical assistance, or financial incentives to landowners to help apply land management techniques specifically for the purpose of improving carbon sequestration rates and/or accessing carbon markets. Respondents were asked to disregard programs that are delivered cooperatively by state agencies on behalf of the US Department of Agriculture (e.g., Forest Stewardship or Environmental Quality Incentives programs), as it was our intention to investigate state-initiated carbon assistance that is available to family forest owners.

Carbon Management Assistance Programs

At the time of the survey (January 2012), three states indicated they had a program specifically designed to assist landowners who wish to increase carbon storage on their forestland (Table 4). These three programs are described below.

California. California’s carbon management program, *Proposition 40 Fuels Management*, was created in an effort to reduce threats to air and watershed resources caused by excess fuel loadings (CAL FIRE 2011). The program assists landowners in the implementation of vegetation management practices that increase carbon storage. The program provides financial assis-

Table 4. States with assistance programs for carbon management and carbon markets.

Current state-sponsored assistance programs	
Carbon management	Carbon markets
<p>California (<i>Proposition 40 Fuels Management</i>): Assists with forest management plan and implementation costs</p> <p>Michigan (<i>Working Forest Carbon Offset Program</i>): Assists with forest management plan and implementation costs</p> <p>Oregon (<i>Forest Resource Trust Forest Establishment Program</i>): Assists with forest management plan and implementation costs</p>	<p>California (<i>AB 32</i>): State cap-and-trade program created a carbon market platform and forestry protocol for offsets</p> <p>Georgia (<i>Carbon Sequestration Registry</i>): Created an official registry of carbon offset projects and voluntary emission reductions</p> <p>Oklahoma (<i>Oklahoma Carbon Initiative</i>): Provides fee-based certification and verification of offsets and aggregation services</p>

tance by funding 90% of the cost of acquiring a forest management plan and 75% of plan implementation practice⁶ costs (Placer County Resource Conservation District 2012). Landowners pay all costs up front but are reimbursed by the program after the practices are completed. To date, the Proposition 40 Fuels Program has granted more than \$2.5 million to landowners for projects (CAL FIRE 2011).

During 2011, California estimated that the program assisted 50 landowners and was applied to 1,600 acres of family forestland. Program staff effort in assisting landowners with sequestering additional carbon was estimated to be 3.0 full-time employees (FTEs) (1 FTE = 2,000 hours). In the survey, the SFARs gave high ratings to the program’s ability to reach its target audience and increase overall carbon sequestration, active forest management, and the acquisition of forest management plans by landowners in the state.

Michigan. Michigan’s *Working Forest Carbon Offset Program* was created to encourage landowners to enhance the carbon sequestration capacity of their forests (Michigan Department of Natural Resources and Environment 2010). Although SFARs provided information on the program for 2011, the program has been discontinued. A grant from Michigan’s Forest Stewardship Program provided the initial start-up funds (\$150,000) and staff support to initiate the program and to develop the managed forest protocol. The program provided technical and financial assistance, written materials, and assistance in preparing forest management plans. Michigan estimated that in 2011, 100 hours of staff time were devoted to program assistance and five landowners (totaling 120 acres) were enrolled.

Oregon. Oregon’s *Forest Resource Trust Forest Establishment Program* was created to increase the capacity of private forests to se-

quester carbon through treeplanting on marginal lands or improved forest management practices on existing forestland (Oregon Forestry Department 2012). Participating landowners agree to manage their forests according to an approved management plan. In turn, landowners can be reimbursed for up to 100% of the incurred costs of forestation or other approved practices (Forest Resource Trust 2009). Corporations or other entities that make financial contributions to the program can specify the type and location of forestry project(s) they would like to fund. Although participating landowners do not have restrictions on the use of their forestland, the financial donors claim the rights to carbon offsets that accrue through the life of the project (Cathcart 2000). During 2011, the program’s 0.25 full-time staff effort assisted 16 landowners and enrolled 380 acres.

Carbon Market Assistance Programs

Distinct from carbon management without market aims, California, Georgia, and Oklahoma indicated that they have a program designed to assist landowners interested in selling carbon credits (Table 4). In addition, Michigan, Illinois, Massachusetts, and Texas stated they had carbon market assistance programs that had been recently discontinued.

California. California’s carbon market program is *Assembly Bill 32: California Global Warming Solutions Act of 2006*. Referred to as AB 32, the initiative is a statewide, comprehensive, multisectorial, greenhouse gas cap-and-trade program that started on Jan. 1, 2012, with an enforceable compliance obligation beginning January 2013 (Assembly Bill 32 2006, California Air Resources Board 2011b). The program’s goal is to reduce greenhouse gas emissions to 1990 levels by the year 2020. In response to AB 32, California’s Climate Action Registry

(CCAR) created a forest protocol to account for carbon emissions and reductions through forest conservation, improved forest management practices, and reforestation (California Air Resources Board 2011a). The program provides an opportunity for landowners who are interested in sequestering carbon through forest management and selling carbon offsets.

CCAR's Forest Protocol recognizes the following projects: reforestation, improved forest management, and avoided conversion. CCAR contracts extend for a minimum of 100 years (with a penalty for early withdrawal). Projects can be located anywhere within the contiguous United States (California Air Resources Board 2011a) and California's Air Resources Board will create, monitor, and enforce greenhouse gas emissions reporting and reductions.

CAL FIRE (California Department of Forestry and Fire Protection) established a project on its La Tour Demonstration State Forest to demonstrate carbon market opportunities for small landowners, provide written materials, and connect landowners with carbon markets (e.g., aggregators). At the time of our survey, the project was just getting underway, and agency representatives were not sure how many landowners had been assisted but estimated that 500 hours of staff time had been devoted to project development in 2011.

Georgia. Georgia's *Carbon Sequestration Registry* program was established as a means of linking carbon emitters with forest carbon sequestration projects (Georgia Carbon 2007). The program provides technical assistance and written materials to landowners and connects them to others who can assist them in accessing carbon markets. An online database tracks and records carbon sequestration realized from a variety of allowable forest practices within Georgia (e.g., treeplanting, forest conservation, and forest management activities). Companies that want to purchase carbon offsets use the Registry's database to find and evaluate carbon offset projects (Georgia Carbon 2007). The program also officially records offset projects. During 2011, an estimated 100 forest landowners were assisted through the program and approximately 25,000 acres were enrolled.

Oklahoma. Oklahoma's carbon market program, the *Oklahoma Carbon Initiative*, provides fee-based certification and verification of emission offsets through the Oklahoma Conservation Commission (OCC) (OCC 2008). Although the OCC provides quality

Table 5. States experiencing increased demand for carbon management assistance (using three criteria to determine demand).

State	Carbon management criteria		
	Current demand	Expected demand	Current or planned program
California			X
Florida	X		
Hawaii		X	X
Michigan			X
Mississippi	X	X	
Oregon	X		X

assurance for carbon sequestration projects, it does not buy or sell carbon credits. The Oklahoma Carbon Initiative (OCI) also operates as an aggregator arm of the OCC in which it bundles carbon offsets into quantities that can be subsequently sold through compliance or voluntary markets. Landowners participating in the program also receive technical training and written materials. Forestry agency representatives indicated that the program did not assist any landowners in 2011 and 0.5 FTE of staff effort was devoted to the program. The program has since transitioned to Oklahoma's new ECOpass program (OCC 2013).

Overall Interest

Whereas SFARs across the nation generally report that interest in forest carbon projects has been minimal, pockets of activity and interest exist. We contrasted those states where increased demand for assistance and activity occurs with areas of very low demand and activity.

Areas of Elevated Interest across the Nation. States projected to have increased demand for forest carbon assistance and information were determined by assessing the following criteria: the number of inquiries to state forest agencies made within the last year ($\geq 1/\text{month}$), an expectation of increased demand in the future (if an increase would raise demand to $\geq 1/\text{month}$), and the presence of carbon programs or programs planned for the future. Based on these criteria, six states were found to be experiencing or expecting increased demand for *carbon management* assistance. These states are located in the Pacific (3), Southern (2), and Lake States (1) regions (Table 5). Assessing demand for *carbon market* assistance by the same criteria, eight states are experiencing increased current or expected demand from family forest landowners. These states are lo-

Table 6. States experiencing increased demand for carbon market assistance (using three criteria to determine demand).

State	Carbon market criteria		
	Current demand	Expected demand	Current or planned program
California			X
Florida	X		
Georgia	X		X
Hawaii		X	
Illinois	X		
Mississippi	X	X	
Oklahoma	X		X
Texas	X		

cated in the Southern (5), Pacific (2), and Lake States (1) regions (Table 6).

Areas of Low Demand across the Nation. Across much of the county, family forest owner interest in carbon-related activity appears to be very low, as shown by the lack of inquiries to state forestry agencies. The identification of states considered to have very low demand for carbon-related assistance was based on current and expected demand for state agency carbon assistance and/or information. States that indicated they had received "no inquiries" for either carbon management or carbon markets or had received "no inquiries" for one activity and ≤ 5 for the other and expected this level of demand to continue, were considered to have a very low level of demand for carbon related assistance. With use of these criteria, 15 states are currently experiencing no demand for carbon management assistance and 13 states are experiencing no demand for carbon market assistance. These states are scattered across the nation with the highest concentration occurring in the New England and Mid-Atlantic regions.

Evaluation of Demand Patterns. A variety of analyses were conducted to evaluate the various demand levels across the nation to identify spatial patterns or other possible explanatory factors. For instance, forest ownership patterns within the United States (Butler 2008) were juxtaposed with low and elevated demand for carbon market assistance. No clear patterns that could help explain increased activity and demand for forest carbon offset programs (or lack of demand) emerged. Although some states with a high percentage of privately owned forestland show increased activity and demand, other states with a very high percentage of family owned forestland are showing little or no activity or demand. Yet certain states

with a modest amount of their land area in private forests (as measured by total area and percentage of forests that are privately owned) are experiencing (or expect to experience) elevated interest in forest carbon sequestration and carbon market participation. In a few states that might be expected to have little demand for forest carbon offsetting (based on the amount of private forestland), programs have been established to assist landowners in accessing carbon markets.

Additional analyses were conducted including regional greenhouse initiatives, other climate and vehicle emission standard initiatives, active wood production areas, and active carbon offset areas. For example, states that have initiated carbon reduction measures were plotted and compared with those states experiencing both low and increased demand for forest carbon activities. Again, no clear patterns were detected.

Providing Context to Survey Results: Additional SFAR Comments

Several respondents provided additional comments to describe the general landscape of forest carbon-related activity within their state. The SFARs from seven states reported that an overall lack of interest in carbon management and markets within their state has been observed. Examples of statements to this effect include “There is little to no interest, and even less activity. Carbon sequestration is just not on very many people’s minds here.” Other states experiencing a low level of interest in forest carbon activities by landowners cited certain carbon market attributes, namely low carbon prices, complex requirements, and long-term commitments, as contributors to the lack of interest. Other states commented that they do not have adequate funding to provide many types of carbon management or carbon market assistance.

Five states commented that carbon market conditions are too weak, inadequate, or uncertain to interest landowners. Statements illustrative of this perspective include “Carbon credits will most likely not build momentum unless strong, clearly defined carbon markets develop.” However, others cited reasons that were unrelated to market characteristics or conditions (e.g., conflicting landowner management objectives, negative attitudes toward climate change issues, and parcelization), as represented by the following comments: “I believe management for carbon sequestration could be desirable

among forest landowners as long as it doesn’t conflict with other ownership objectives (especially forest health, protection from fire, and wildlife habitat improvement); that is, as a secondary objective”; and “Those that do have acreage have doubts about climate change in general.”

Several states cited lack of awareness of carbon management and market opportunities by both landowners and agency foresters. Some respondents indicated that their foresters expressed apprehension about talking to landowners about carbon-related activities when they were not very familiar with these opportunities themselves: “Although our agency foresters have attended a seminar about carbon credits, it is still very new and [we are] not comfortable talking to landowners about it”; and “This survey is way, way too early for landowners in [state].”

Comments such as these are supported by our survey results, which show a low level of familiarity with carbon markets by SFARs in several states. On average, respondents indicate they are unfamiliar with carbon credits and do not feel knowledgeable about the workings of the market. In addition, many SFARs commented verbally, during the initial phone contact, that unless foresters feel comfortable with the concept of carbon management and carbon markets, it is unlikely that they will encourage landowners to undertake such activities.

Discussion

Previous research found that certain landowners value prospective forest management assistance, advice from a professional forester, and/or potential carbon co-benefits far more than a monetary return for carbon credit sales (Miller et al. 2014). This finding highlights the value some landowners place on forestry information and assistance programs and their willingness to overcome other carbon market barriers if assistance is provided and emphasizes the need to consider the perspectives of those who may be called on to provide carbon project assistance. Our study provides new information regarding the expectations for family forest owner interest and carbon management/market assistance by the agencies likely to be the major providers of such assistance—state forestry agencies.

Across the nation, it appears that forest landowners have a low level of familiarity with the concept of carbon management and selling carbon credits. Many landowners are

simply unaware that their forest can be managed in a way that sequesters additional carbon. Currently, only a few states have developed programs designed to assist landowners in managing for carbon or accessing carbon markets. The small number of states that have developed state-sponsored carbon assistance programs is most likely indicative of the fact that few landowners are requesting such assistance, and this may be due to the overall lack of familiarity with forest sequestration consistent across the nation.

Based on the comments made by a number of SFARs, other factors also affect the availability of carbon management assistance. These include budget and staffing limitations, a lack of established forest carbon management practices, the political environment of individual states, uncertain federal climate policy, and limited biophysical capabilities in some states. Although a few states have indicated that they plan to increase carbon management assistance, most forestry agencies across the nation expect to make no changes in landowner carbon assistance.

So, what advice can be provided to those entities interested in encouraging carbon sequestration on family forests through improved forest management? Forest carbon management and carbon markets are still emerging enterprises. Early pilot initiatives have run their course; however, it appears that few landowners were aware of them. Furthermore, similar to early research findings conducted with members of the Forest Guild (Wade and Moseley 2011), many forestry professionals acknowledge that they also are unfamiliar with carbon management and carbon market requirements. In addition, until forest carbon market opportunities and guidelines become more established, many SFARs have indicated that their agencies are not likely to invest staff time to learn the details of such markets nor to pass on information regarding carbon markets to landowners and/or encourage participation. Therefore, if forest sequestration is a desired mitigation strategy and/or voluntary forest carbon market opportunities expand, formal training and information should be directed toward foresters as well as landowners. Direct interaction with professional foresters, through workshops and other training, may be the most effective means of then transferring this information to family forest owners.

In the immediate term, efforts to increase forest carbon management or market participation may wish to focus attention on those landowners SFARs consider to be the most likely to participate under current carbon program requirements. Previously obtaining a forest management plan and interacting with foresters were the overall qualities estimated to lead to increased participation of landowners. In addition, when considering carbon market participation alone, landowners with larger parcels (>200 acres) are expected to have an increased interest in participating. Targeting large parcel owners and those who have already fulfilled some carbon market requirements may be an effective approach for increasing the supply of carbon sequestration from family forest landowners.

It must be acknowledged that our study gathered the perspectives of SFARs who may primarily interact with landowners considered more engaged than the typical forest landowner (e.g., involved in forest management, education workshops, and technical assistance). This subset of owners may not be representative of the average landowner, which may lead to overestimation of interest levels when the total landowner population is considered. Our study underscores the importance of understanding what factors motivate a landowner to participate in carbon management and carbon markets. Landowner behavior and the corresponding impacts to overall carbon sequestration are driven by many factors besides markets (Miner et al. 2014). Previous research with landowners who would not be considered engaged owners (i.e., a very low percentage of owners with a previous forest management plan or a certified forest) displayed interest in carbon management and markets (Miller et al. 2014). We suggest that there may be a new segment of landowners who are interested in forest benefits that can be achieved through carbon management and/or carbon market participation.

Rather than developing new carbon programs, it may be most effective and efficient to incorporate forest sequestration into existing forest management programs as an additional management objective (Cook and Ma 2014). Several state and federal programs already in place incorporate techniques that are consistent with carbon se-

questration strategies (e.g., Forest Legacy, Forest Stewardship, and Environmental Quality Incentives). The challenge is to redesign the current programs so that they meaningfully address multiple purposes and appeal to a large landowner population.

Conclusions

Our research was motivated, in part, by the belief that landowners will need assistance to manage for carbon or sell carbon offsets. However, our study found that SFARs report little demand for carbon-related assistance, and many believe the lack of assistance may not be a major impediment for many landowners. What is not known, however, is whether this low demand is a function of lack of awareness, lack of interest, lack of understanding, or lack of knowing who to go to for information. These are all different issues, which have different solutions. States should not assume that a lack of demand for information and assistance with carbon management is an indication of a lack of interest on the part of forest landowners. Further research with forest landowners in different regions of the nation is needed to explore these topics.

Our findings suggest there may be little relationship between a state's physical capacity to sequester carbon from family forestlands, landowner interest in managing for carbon or producing carbon offsets, and the presence of state-sponsored programs to assist landowners in developing and implementing carbon offset projects. Basing projections of the carbon reduction potential or future domestic carbon offset supply on the number of family forest acres alone, as has been done in previous studies (US EPA 2005), may greatly overestimate the supply of carbon projects from family forest owners. This conclusion is consistent with that of the Butler et al. (2010) study of the biophysical versus social availability of wood for harvest: the physical capacity to produce timber is not a reliable indicator of landowner willingness to undertake such forest management practices. Identifying landowners willing to manage for carbon is more complex than identifying those who may have the greatest biological potential to sequester carbon.

Additional information is needed to more clearly identify landowners who are willing to participate in carbon management

and/or carbon markets. Such understanding is necessary to accurately estimate the supply of carbon management projects originating from the nation's family forests. Better identifying these landowners could help agencies as they consider how (or whether) to invest in programs that provide forest carbon management and market assistance and information.

Endnotes

1. Family forest owners are defined as individuals, married couples, family estates and trusts, or other groups of unincorporated individuals who own forested land in the United States.
2. Improved forest management methods include extending harvest/rotations, minimizing disturbances to the forest floor, stocking of long-lived/climate-adaptive tree species, and natural disturbance risk management.
3. At a price of \$5/MT, the EPA predicts a combination of forest management and agricultural soil sequestration to be a leading carbon mitigation strategy. At \$15/MT, Forest Management is predicted to be the leading strategy. See Table 4-5 of EPA Report 430-R-05-006 in the Supplemental Material.⁵
4. The Forest Guild is a United States and Canada-based association of professional foresters who promote sound forestry practices.
5. For more information, see www.forestation-plans.org.
6. Practices may include site preparation, tree-planting, tree shelters, canopy cover, thinning, pruning, stand release, brush control, invasive weeds, land conservation, wildlife/riparian. (Placer County Resource Conservation District 2012).

Literature Cited

- ASSEMBLY BILL 32. 2006. *The Global Warming Solutions Act of 2006*, Chapter 488. Available online at www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf; last accessed May 1, 2014.
- BEDDOE, R., AND C. DANKS. 2009. *Carbon trading: A joint effort between the Delta Institute, Illinois and Michigan*. Available online at www.uvm.edu/%7Ecfc/casestudies/Delta_website_final_051613.pdf; last accessed May 1, 2014.
- BUTLER, B.J. 2008. *Family forest owners of the United States, 2006*. USDA For. Serv., Gen. Tech. Rep. NRS-27, Northern Research Station, Newtown Square, PA. 72 p.
- BUTLER, B.J., AND E. LEATHERBERRY. 2004. America's family forest owners. *J. For.* 102(7):4-9.
- BUTLER, B.J., Z. MA, D.B. KITTREDGE, AND P. CATANZARO. 2010. Social versus biophysical availability of wood in the northern United States. *North. J. Appl. For.* 27(4):151-159.
- CALIFORNIA AIR RESOURCES BOARD. 2011a. *Compliance offset protocol US forest projects*. Avail-

⁵ Supplementary data are available with this article at <http://dx.doi.org/10.5849/jof.14-063>.

- able online at www.arb.ca.gov/cc/capandtrade/protocols/usforestprojects.htm; last accessed May 1, 2014.
- CALIFORNIA AIR RESOURCES BOARD. 2011b. *Assembly bill 32: Global Warming Solutions Act*. California Environmental Protection Agency, Air Resources Board. Available online at www.arb.ca.gov/cc/capandtrade/capandtrade.htm; last accessed Oct. 1, 2013.
- CAL FIRE. 2011. *Proposition 40 fuels management program*. California Department of Forestry and Fire Protection. Available online at www.fire.ca.gov/resource_mgt/resource_mgt_forestry_assistance_prop40.php; last accessed May 1, 2012.
- CANADELL, J.G., AND M.R. RAUPACH. 2008. Managing forests for climate change mitigation. *Science* 320(5882):1456–1457.
- CATHCART, J. 2000. Carbon sequestration—A working example in Oregon. *J. For.* 98(9):32–37.
- COOK, S., AND Z. MA. 2014. Carbon sequestration and private rangelands: Insights from Utah landowners and implications for policy development. *Land Use Policy* 36:522–532.
- CREAMER, S.F., K.A. BLATNER, AND B.J. BUTLER. 2012. Certification of family forests: What influences owners' awareness and participation? *J. For. Econ.* 18(2):131–144.
- DICKINSON, B.J., T.H. STEVENS, M. MARKOWSKI-LINDSAY, AND D.B. KITTREDGE. 2012. Estimated participation in US carbon sequestration programs: A study of NIPF landowners in Massachusetts. *J. For. Econ.* 18(1):36–46.
- DILLMAN, D.A. 2007. *Mail and internet surveys: The tailored design method 2007 update with new internet, visual, and mixed-mode guide*. John Wiley & Sons, Inc., Hoboken, NJ. 565 p.
- FOREST RESOURCE TRUST. 2009. *Forest Resource Trust 2009 Oregon administrative rule (OAR) changes*. Available online at www.forestresource.trust.oregon.gov/ODF/privateforests/docs/FRT_2009_OAR_Changes.pdf; last accessed Oct. 1, 2013.
- GALIK, C., M. MOBLEY, AND D. RICHTER. 2009. A virtual “field test” of forest management carbon offset protocols: The influence of accounting. *Mitig. Adapt.* 14:677–690.
- GALIK, C.S., B.C. MURRAY, AND D.E. MERCER. 2013. Where Is the carbon? Carbon sequestration potential from private forestland in the Southern United States. *J. For.* 111(1):17–25.
- GEORGIA CARBON. 2007. *The Georgia Carbon Sequestration Registry project protocol, version 1.0 July 2007*. Available online at www.gacarbon.org; last accessed Oct. 1, 2013.
- GORTE, R., AND J. RAMSEUR. 2010. *Forest carbon markets: Potential and drawbacks*. CRS report for Congress. Congressional Res. Serv. Rep. 7-5700:1–17. Available online at <http://new.nationalaglawcenter.org/wp-content/uploads/assets/crs/RL34560.pdf>; last accessed Oct. 1, 2013.
- KAETZEL, B.R., D.G. HODGES, D. HOUSTON, AND J.M. FLY. 2009. Predicting the probability of landowner participation in conservation assistance programs: A case study of Northern Cumberland Plateau of Tennessee. *South. J. Appl. For.* 33(1):5–8.
- MA, Z., B.J. BUTLER, D.B. KITTREDGE, AND P. CATANZARO. 2012. Factors associated with landowner involvement in forest conservation programs in the US: Implications for policy design and outreach. *Land Use Policy* 29(1):53–61.
- MARKOWSKI-LINDSAY, M., T. STEVENS, D.B. KITTREDGE, B.J. BUTLER, AND P. CATANZARO. 2011. Barriers to Massachusetts forest landowner participation in carbon markets. *Ecol. Econ.* 71:180–190.
- MCKINLEY, D., M. RYAN, R. BIRDSEY, C. GIARDINA, M. HARMON, L. HEATH, R. HOUGHTON, ET AL. 2011. A synthesis of current knowledge on forests and carbon storage in the United States. *Ecol. Applic.* 21(6):1902–1924.
- MICHIGAN DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENT. 2010. *Michigan forest resource assessment and strategy*. Available online at www.michigan.gov/documents/dnr/Strategic_457570_7.pdf; last accessed Oct. 1, 2013.
- MILLER, K.A., S.A. SNYDER, AND M.A. KILGORE. 2012. An assessment of forest landowner interest in selling forest carbon credits in the Lake States, USA. *For. Policy Econ.* 25:114–122.
- MILLER, K.A., S.A. SNYDER, M.A. KILGORE, AND M.A. DAVENPORT. 2014. Family forest landowners' interest in forest carbon offset programs: Focus group findings from the Lake States, USA. *Environ. Manage.* 54:1399–1411.
- MINER, R.A., R.C. ABT, J.L. BOWYER, M. BUFORD, R.W. MALMSHEIMER, J. O'LAUGHLIN, E.E. O'NEIL, R.A. SEDJO, AND K.E. SKOG. 2014. Forest carbon accounting considerations in US bioenergy policy. *J. For.* 112(6):591–606.
- OKLAHOMA CONSERVATION COMMISSION. 2008. *Central North Canadian River Conservation District hosts “groundbreaking” carbon event*. Available online at www.ok.gov/conservation/News/Carbon_Media_Event_CNCRCD_8-28-08.html; last accessed Oct. 1, 2013.
- OKLAHOMA CONSERVATION COMMISSION. 2013. *Carbon sequestration certification program project. ECOpass*. Available online at www.ok.gov/conservation/Agency_Divisions/Water_Quality_Division/WQ_Carbon/Projects/; last accessed Oct. 1, 2013.
- OREGON FORESTRY DEPARTMENT. 2012. *Forest Resource Trust—Forest establishment program*. Available online at www.forestresource.trust.oregon.gov/; last accessed Oct. 1, 2013.
- PACALA, S., AND R. SOCOLOW. 2004. Stabilization wedges: Solving the climate problem for the next 50 years with current technologies. *Science* 305(5686):968–972.
- PLACER COUNTY RESOURCE CONSERVATION DISTRICT. 2012. *Proposition 40 Fuels Management Program*. Available online at www.placercountyrctd.org/forest/FuelsMgtPgm.php; last accessed Oct. 1, 2013.
- PATTON, M.Q. 2002. *Qualitative evaluation and research methods*. Sage Publications, Inc., Thousand Oaks, CA. 536 p.
- SIMPSON, H., AND Y. LI. 2010. *Environmental credit marketing survey report*. Texas Forest Service Sustainable Forestry Department, College Station, TX. 23 p.
- SCHROEDER, J., D. BECKER, AND M. KILGORE. 2011. *State forestry programs, budget strategies, and the recession*. Staff Pap. Ser. No. 213, University of Minnesota, Department of Forest Resources, St. Paul, MN. 16 p.
- SNYDER, S.A. 2009a. *Appalachian family forest landowner pool: Opportunities for rural landowners*. Unpublished white paper, USDA For. Serv., Northern Research Station. Available from the author on request.
- SNYDER, S.A. 2009b. *Michigan family forest landowner pool: A pilot demonstration project*. Unpublished white paper, USDA For. Serv., Northern Research Station. Available from the author on request.
- SOHNEN, B. 2009. *An analysis of forestry carbon sequestration as a response to climate change*. Copenhagen Consensus on Climate. Available online at http://aede.osu.edu/sites/drupal-aede.web/files/AP_Forestry_Sohnen_v_2_0.pdf; last accessed Oct. 1, 2013.
- THOMPSON, D.W., AND E.N. HANSEN. 2012. Factors affecting the attitudes of nonindustrial private forest landowners regarding carbon sequestration and trading. *J. For.* 110(3):129–137.
- THOMPSON, D.W., AND E.N. HANSEN. 2013. Carbon storage on non-industrial private forestland: An application of the theory of planned behavior. *Small-Scale For.* 12:631–657.
- US DEPARTMENT OF ENERGY. 2007. *Carbon sequestration technology and program plan 2007*. Office of Fossil Energy, National Energy Technology Laboratory. Available online at www.eurekaert.org/features/doe/2007-05/detl-dr2051107.php; last accessed May 1, 2014.
- US ENVIRONMENTAL PROTECTION AGENCY. 2005. *Greenhouse gas mitigation potential in US forestry and agriculture*. EPA 430-R-05-006. Available online at http://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryID=85583; last accessed Dec. 3, 2014.
- WADE, D., AND C. MOSELEY. 2011. Foresters' perceptions of family forest owner willingness to participate in forest carbon markets. *North. J. Appl. For.* 28(4):199–203.
- WATSON, A.C., J. SULLIVAN, G.S. AMACHER, AND C. ASARO. 2013. Cost sharing for pre-commercial thinning in southern pine plantations: Willingness to participate in Virginia's pine bark beetle prevention program. *For. Policy Econ.* 34:65–72.