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Natural Resource Manager Perceptions of Forest Carbon Management and Carbon Market Participation in Minnesota

Robert Lane Moser [1,*], Marcella A. Windmuller-Campione [2] and Matthew B. Russell [3]

[1] Sustainable Forests Education Cooperative, University of Minnesota, 175 University Road, Cloquet, MN 55720, USA
[2] Department of Forest Resources, University of Minnesota, 1530 Cleveland Avenue N, St. Paul, MN 55108, USA
[3] Arbor Custom Analytics LLC, Bangor, ME 04401, USA
* Correspondence: moser196@umn.edu

Abstract: Forests and wood products, through the mechanisms of carbon sequestration and storage, can slow the rate of global climate change that results from greenhouse gas emissions. In recent years, both natural resource managers and the public have placed greater focus on the role of forests and wood products as a solution to help mitigate the effects of climate change. Little is known about the perceptions and viability of carbon sequestration and storage as a management goal for natural resource managers of public agencies. We explored these perceptions in Minnesota, USA. Minnesota has 7.2 million hectares of forest land managed by a diverse array of landowners, from public agencies (55% of forest land) to private (45%) owners. We sought to (1) understand natural resource managers' and forest owners' perspectives on forest carbon opportunities and (2) understand the feasibility of management strategies that could be implemented to increase forest carbon sequestration and storage at a state level. We conducted two focus groups with 15 mid- and upper-level natural resource managers and non-industrial private forest landowners, representing both rural and urban perspectives and a variety of agencies and organizations. Minnesota natural resource managers and non-industrial private forest landowners indicated that they thought managing forests for carbon was compatible with other management goals but nonetheless represented a trade-off. However, they viewed the carbon credit market as the "Wild West" and noted several barriers to entering the carbon market, such as inconsistent carbon accounting protocols and a lack of connection between the price of carbon credits and the cost of managing forest land for carbon sequestration and storage.

Keywords: forest carbon; carbon storage; carbon sequestration; carbon market

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1. Introduction

Forested ecosystems are managed for a wide range of goals and objectives and are increasingly being considered for their potential to address future effects of a changing climate [1,2]. In the United States during 2019, forest land, harvested wood products, woodlands, and urban trees offset 11% of total greenhouse gas emissions, the driver of global climate change [3,4]. The management of forests for carbon sequestration and storage is often put forth as a natural climate solution to mitigate the effects of climate change. In response, there has been an increased focus in recent years on managing forests for climate change mitigation and adaptation [5,6] and a renewed interest in reforestation and tree planting efforts across large geographic scales, e.g., [7,8]. Though a climate solutions-based management strategy for forests is not necessarily mutually exclusive of other forest management objectives (e.g., providing forest products, recreational opportunities, and wildlife habitat), selecting a specific management strategy to meet society's diverse needs typically entails trade-offs [9].

One mechanism for reconciling sometimes competing objectives is to ascribe a value to the positive attributes of forest carbon sequestration and storage through the implementation of market-based approaches in the form of forest carbon offsets [10,11]. In these markets, corporations and individuals pay for carbon dioxide emissions to offset their emissions, and forest landowners are paid for the carbon sequestration and storage that their trees provide [12], but see [13]. Improving forest management activities to increase carbon storage in the forest or associated forest products is one of the most common types of forest carbon offset projects used today [14]. Examples of other approaches are afforestation, reforestation, and protecting forests from being converted to non-forested land.

Carbon market policy, requirements, and enrollment eligibility vary widely globally and within the United States. Compliance-driven carbon markets, such as the California Air Resource Board's Cap-and-Trade Regulation and its associated Forest Offset Protocol, involve carbon offset purchases that are required by governmental bodies, yet in general only large forest landowners (e.g., those owning thousands of hectares) have participated [14,15]. Voluntary forest carbon markets, where carbon credits are sold on a voluntary basis, have expanded considerably in recent years. Voluntary carbon markets have the benefit of providing additional co-benefits [16] and can also be attractive to landowners with smaller properties. In the United States, voluntary carbon markets are currently being marketed to private forest landowners, especially non-industrial ones. More research is needed to understand the appeal of carbon markets to landowners with diverse management objectives.

The adoption of forest carbon management strategies and enrollment of forests in carbon markets depend largely on forest ownership patterns and objectives [17]. Landowner willingness to enroll forests in carbon markets varies by region, e.g., [18–20]. One region where ownership factors can be further explored to elucidate forest carbon management decisions is the US Lake States (defined as Michigan, Minnesota, and Wisconsin), which have vast areas of public and private ownerships in forests that support a variety of species and productivity levels [21]. If we better understand the perspectives of diverse stakeholders on the opportunities and limitations of forest carbon management, we will be better informed about next steps in discussing, developing, and implementing approaches to forest carbon sequestration and storage for mitigation of climate change.

The objective of this work was to gain stakeholder perspectives on the opportunities, advantages, and obstacles to adopting a framework that places a monetary value on forest carbon management and establishes carbon markets across Minnesota, USA. Specific objectives were to (1) conduct a series of focus groups with mid- to upper-level natural resource managers and non-industrial private forest landowners across the state to understand their perspectives on forest carbon opportunities and (2) understand the feasibility of management strategies that could be implemented to increase forest carbon sequestration and storage at a state level.

2. Materials and Methods

2.1. Study Area

Minnesota is a heavily forested state and its forests have been managed since time immemorial [22]. In the early 1800's, Euro-American settlers estimated 12.7 million hectares of forest land in area that would become the state of Minnesota [23]. However, an influx of settlers and subsequent destructive logging practices (1880–1910) greatly reduced forest cover (<8 million hectares in the 1930's). Concerted efforts during the 20th and 21st centuries have increased forest land cover (7.2 million hectares of forest land documented in 2019 [24]) through sustainable forest management, to which the many natural resource organizations within Minnesota have contributed [21].

Minnesota forest land spans four ecoregions—Tallgrass Aspen Parklands, Laurentian Mixed Forest, Eastern Broadleaf Forest, and Prairie Parkland—manifested in a diverse mixture of forest communities. Many forest communities reach their range limits in Minnesota. For example, jack pine (*Pinus banksiana* Lamb) resides at the western edge of its range, and the lowland conifer ecosystems (dominated by black spruce (*Picea mariana* (Mill)). and eastern larch (*Larix laricina* (Du Roi) K. Koch), are at the southern edge of their range.

Minnesota forests are in the hands of a diverse set of governmental organizations and private entities [21]. There is a relatively even split between public (55%) and private (45%) forest lands within the state; private forest lands include private industrial and non-industrial (i.e., family forest) ownership. Across all ownerships forests are actively managed for multiple goals and objectives; in 2019, just under 70,000 hectares of land were actively managed through silvicultural treatments (e.g., regeneration harvest or intermediate treatments). Conventional forest products produced in Minnesota include short-lived paper products and longer-lived dimensional lumber and telephone poles [25].

2.2. Focus Groups

We chose to use focus groups as our data collection method for this study to fully elicit the range of perspectives of participants from a variety of professional backgrounds and experience. Focus groups can be effective in the early stages of understanding phenomena to guide future research efforts, including surveys [26,27]. We wanted to reach natural resource administrators in Minnesota, a narrow slice of the natural resource manager community, so a survey would not have been appropriate. For validity of the research effort, smaller populations necessitate higher response rates [28,29], which can be difficult to achieve using surveys [30]. Another key benefit of focus groups is that they may give rise to discussions between or among participants which can generate high quality data and address themes not considered by the moderator [31]. Participants' engagement in these discussions and their responses to the moderator's line of questioning are thus shaped by fellow participants; impromptu discussions can even help participants call up ideas they would not otherwise have remembered [27,31].

Two focus group discussions were conducted in winter 2021, comprising 15 total mid- to upper-level natural resource managers and non-industrial private forest landowners in Minnesota. We screened the professional participants to choose those with a more administrative rather than field background in their daily work; the goal of this screening process was to involve individuals with a greater understanding of policy implementation and broad-scale management considerations. Focus group discussions lasted two hours each and were held over the video communication software Zoom Meetings (Zoom Video Communications). Previous research in the region has used Zoom efficiently to gather data from focus groups [32]. Table 1 summarizes the nature of the organizations represented in the focus groups.

Table 1. Participants' organizations represented in the focus groups, including resource managers from both rural and urban forestry settings throughout Minnesota. Federal organizations represented included the Natural Resources Conservation Service, the Northern Institute of Applied Climate Science, and the USDA Forest Service. Multiple state representatives participated in the focus groups, including those from the Minnesota Department of Natural Resources.

Organization Type	Participants
Federal	3
State	4
County	1
Industry	2
Tribal	1
Non-industrial Private Forest	1
Non-governmental Organization	3

Qualitative data collection efforts can be guided in real time by saturation, which refers to the richness and overall quality of qualitative data [33]. Though it is impossible to predict how many focus groups will be necessary to reach saturation before data collection has begun, studies attempting to quantify saturation suggest roughly 80% of themes can be discovered in two focus groups, with diminishing returns in subsequent focus groups [34,35]. Saturation must also be considered in the context of the logistics of populating focus groups. In our study, further focus groups were not feasible because of the limited pool of potential participants, and by extension, confounding intra-group dynamics such as ensuring a diversity of perspectives and organizations.

Questions posed to the focus groups pertained to carbon sequestration and storage in the context of current and future management, quantifying Minnesota's forest carbon, and carbon markets (Table 2). We also used an activity to explore the feasibility of four different management strategies to increase forest carbon storage and sequestration see [36], in [37] via the online audience engagement platform Menti (Mentimeter AB). After participants individually ranked the viability of these strategies for their respective land bases, they were able to view the aggregated rankings on Menti and discuss the reasoning behind their choices.

Table 2. The questioning route for both focus groups. During the focus group we asked participants to rank four management strategies and then discussed the results and reasoning behind these rankings.

Question
How have the broader management goals for you or your organization changed over the last 20 years?
To what extent is carbon management currently incorporated into your forest management plans?
In what ways is carbon sequestration and storage compatible with your management plans in the future?
Activity: Rate these four broad actions on how viable they are for your landbase.
Avoid emissions by reducing forest conversion
Increase forest area
Prevent emissions by reducing risk of fire, disease, and mortality
Increase carbon in existing forests and products through silviculture
Is there a capacity to assist landowners and managers with inventory efforts to determine carbon storage?
What resources already exist in Minnesota to better inform forest carbon management and carbon markets?
What economic markets would need to exist for carbon management to be viable?

Due to the depth and complexity associated with forest carbon as a topic, we used a constructivist grounded theory approach to this study see [38], in [39]. Verbatim, de-identified transcripts of the focus group audio recordings were analyzed using the qualitative analysis software NVivo version 13 (QSR International). Coding was conducted inductively over multiple rounds of analysis to form themes.

3. Results

3.1. Potential for Value-Added Opportunities for Forest Carbon and Carbon Markets

All participants noted an increased emphasis on managing forests for climate change adaptation and mitigation over the last 20 to 30 years. However, they said that the most progress has been made in recent years. For example, one participant observed that there had been "more focus on climate change in terms of growing forests that aren't adversely impacted by climate change or finding a way to keep certain culturally important species on the landscape that aren't forecasted to do well". Another participant explained that "for a while it was our safe space just to talk about climate change adaptation" before there was broader support to answer such questions as "How can forests store more carbon, sequester carbon, lock carbon away on long-lived wood products, [and] displace other fossil-fuel-intensive forms of energy?" Multiple participants also observed increased public interest in forest carbon and planting and preserving trees.

Among natural resource managers, participants found that forest carbon "was part of the discussion when [we] describe, 'These are the effects of our land management actions on the forest,' but [forest carbon] is not the driving force behind decisions". For most participants, but particularly federal and state natural resource managers, forest carbon represented a trade-off—an additional consideration that needs to be considered as an additional value alongside other forest values such as wildlife, water quality, or timber production. For example, one participant observed that "on public lands we need to consider all these different values and since we are in the beginning stages of trying to find ways to sequester and store more carbon on public lands, we're looking for those opportunities that aren't incompatible with other uses".

All participants felt that forest carbon was compatible with most existing management practices. One public land manager observed:

"[Forest carbon] has always been there. It just may not have been as direct; so if you think about carbon sequestration, it is very similar to managing for forest growth. [Carbon] storage is very similar to managing for older forests and forest products . . . Those things have always been in our forest management plans from the beginning of my career, so we've always been cognizant of managing for fast growing forests, productive healthy forests, managing the age classes, holding onto some older forests, managing to supply timber industry to keep forest products management healthy in this state—those concepts have always been there".

Where participants noticed recent changes in the context of compatibility was that forest carbon was explicitly defined rather than intrinsically part of their organizations' typical forest management. Despite close alignment of forest carbon with multiple management goals, participants noted specific instances where managing for carbon sequestration and storage was a distinct trade-off.

3.2. Concerns and Considerations

One area where participants felt forest carbon might decrease as a result of management was in the context of landscape restoration to the structure, composition, and function of the pre-Euro-American settlement era. The historical stocking of forest types such as oak savannas or other fire-dependent systems where fire is currently excluded may have been lower than current levels. Furthermore, reincorporating fire into the management of fire-dependent systems was perceived as an area of incompatibility with carbon sequestration and storage goals. Participants also noted that forests managed for resilience to climate change might carry lower stocking than is typically prescribed to mitigate drought, pest, or disease pressure, representing a decrease in carbon sequestration compared to a fully stocked stand. While participants felt that managing for carbon was incompatible with these other management goals, they were uncertain about the extent of the trade-off, in part because of variability in carbon accounting protocols.

Participants who managed public lands reported improvements in the quality and applicability of carbon estimates in the last 20 years but saw opportunities for further refinement. For example, advanced software can now better model trade-offs between forest carbon and other values, thereby more directly informing forest management planning. Statewide LiDAR (light detection and ranging) flown at a sufficient density to accurately estimate carbon was viewed as a promising option, particularly to quantify non-industrial private forest land owner parcels that lack the inventory data of agency and Tribal lands. However, while LiDAR technology exists to quantify carbon at finer scales, the inability to consistently do so was a stated shortcoming. Cost was a barrier, both for an initial flight and for securing subsequent flights to continue to track growth; one participant mentioned that "if the LiDAR is collected once, [the legislature (which sets the state budget, one of the primary funding sources for applied research in Minnesota)] think(s) it's done". Many participants felt that collaboration across several stakeholders would be necessary as land management agencies alone would not be able to fund LiDAR data collection to a scale that would be effective for estimating carbon.

Beyond data collection methods, participants noted that inconsistent carbon metrics were an obstacle to managing forests for carbon sequestration and storage. One individual said that "there's multiple carbon pools and for some audiences you count different pools over different time frames. So there are real reasons for differences, but it creates confusion and conflict and incompatibility between results and so it hinders all kinds of progress". Other participants felt that carbon accounting methods would need to be standardized, at the state level or otherwise, to allow for consistent carbon assessments from one landowner to the next. The carbon equation was viewed as having many complex variables such as land conversion considerations, wildfire risk, soil carbon, and trade-offs between storing carbon in live trees (e.g., delaying harvest in favor of "storing carbon on the stump" according to one participant) and storing it in wood products (harvesting stands at their respective biological rotation ages). Both the current inconsistency and the variety of confounding variables in carbon calculations led to significant uncertainty and skepticism toward entering forested properties into carbon markets.

Multiple participants compared the carbon market to the "Wild West", in reference to several new companies and organizations that were created in recent years. They cited a range of companies—some since dissolved—that offered carbon offset agreements from one year up to 20, 40, or even 100 years. One participant observed that "if we're going to have carbon markets that incentivize active working forests for multiple benefits, then the valuation of carbon has to relate to the costs of producing that carbon". Many individuals mentioned this lack of connection between the price of carbon credits and the cost of carbon storage and sequestration. One person questioned the methodology for carbon valuation, in which carbon is valued based on an alternative scenario. This participant asked, "Do water markets or biodiversity markets depend on what would have happened otherwise? No, they probably just pay for the outcome".

Both state and federal public land managers stated they were reluctant to enter the carbon market as doing so could be viewed as endorsing a certain protocol or methodology. A federal land manager suspected that "we would probably need some kind of national legislation or national market set up.... I don't even know if we'd be able to participate in the state [market] if it existed". State land managers were also unsure about whether participation in the market aligned with legislative clean energy mandates related to forests, and whether the credits generated on state lands were sold outside of the state. Multiple participants were concerned about public perception toward entering the carbon market. One person stated that participation in the market was viewed as "taking blood money from large companies to allow them to pollute more". Another participant felt that entry to the carbon markets for non-industrial private forest landowners hinged on "both the marketing education as well as the economic elements to help people take action".

3.3. Forest Management Strategies for Carbon

Participants were asked to rank the viability of four forest carbon management strategies for their respective land bases (Table 3). The strategy of increasing carbon in existing forests and products through silviculture was viewed as the most viable in the two focus groups, closely followed by preventing emissions by reducing risk of fire, disease, and mortality.

Table 3. Four management strategies that could be used to increase carbon sequestration and storage and the number of times participants ranked each strategy first (most viable for their land base), second, third, or fourth. Responses were weighted by assigning a value of four to first place, three to second place, two to third place, and one to fourth place. Data was collected by using Menti (Mentimeter AB). One participant was unable to submit their rankings through Menti and was thus not directly counted. Management strategies were drawn from the 2019 Intergovernmental Panel on Climate Change special report [36].

Management Strategy	First Place	Second Place	Third Place	Fourth Place	Weighted Average
Avoid emissions by reducing forest conversion	3	0	3	8	6.5
Increase forest area	2	3	4	5	7.5
Prevent emissions by reducing risk of fire, disease, and mortality	5	4	4	1	10.25
Increase carbon in existing forests and products through silviculture	4	7	3	0	10.75

The strategy of avoiding emissions by reducing conversion of forest land to other uses was rated either high or low by public land managers based on their interpretation. For some, legislative mandates that required the land to remain forested made this an easy choice to rate highly. Other participants viewed it as one of the least viable options because forest conversion in their land base was not viewed as a possibility to begin with. In either case, public land management agencies saw this option as a default and explained that land was not being lost to conversion on a significant scale in Minnesota.

Participants were undecided on the viability of a strategy of increasing forest area. One participant felt that it would be most viable to work with private landowners to plant trees in areas where stocking could be increased or on suitable sites that are currently not forested. Another participant felt that increasing forest area among private landowners would be viable if the incentives to plant and maintain forest area outweighed incentives to convert forest land in favor of other land uses such as subsidized agricultural practices. One person reported working "with private landowners to plant abandoned hay land or abandoned grazing land to trees and vice versa, if taxes are better". Increasing forest area was viewed as the path of least resistance, a management approach that would be comparatively easy to implement and have the most pronounced positive impact on carbon storage. However, one participant mentioned that a logistical obstacle to planting efforts could be current tree nursery capacity and the ability to obtain enough trees. Conversely, some participants did not have the capacity to increase tree planting efforts on their forested land base. Others were concerned about competing with row crop agricultural lands.

Multiple participants viewed the strategies of increasing carbon in existing forests and products through silviculture, and preventing emissions by reducing risk of fire, disease, and mortality as interchangeable with regard to their ranking. One participant explained, "You're really doing both in terms of forest management, you're always looking at the entire system—both silviculture as well as fire risk and disease and mortality". Another participant noted that a healthy forest allowed better management of insects and disease. In the context of urban forests, these two strategies were similarly top-ranked as participants emphasized actively managing disease and maintaining large, healthy, mature trees. However, markets were a limitation where management of some forest types was concerned. The loss of a paper mill and a lack of biomass markets in particular hindered their ability to remove dead woody material or ladder fuels from the landscape and convert them to products rather than leave them to decompose. In one area where there are chip mills, supply is markedly higher than their chipping capacity.

While public land managers generally felt both of these strategies were the most viable, there was concern that neither was as viable for private landowners. One participant observed that "[the strategy of reducing risk of fire, disease, and mortality] seems hard if you're trying to connect with all of those private landowners out there—it's a lot of touches, it's a lot of convincing, it's a lot of nuance". Multiple participants pointed to the limited capacity to reach the large and diverse number of private landowners through existing programs such as the Minnesota Department of Natural Resources' Cooperative Forest Management or using consultants.

4. Discussion

We found that participants felt natural resource management organizations were already indirectly managing Minnesota forests for carbon sequestration and storage for at least the last 20 years through current sustainable forestry practices. Managing for forest carbon was thus viewed as theoretically compatible with existing management objectives on most forest types across Minnesota's diverse forest landscape, and participants noted that only recently has carbon-oriented management been explicitly considered in prescriptions and broader forest plans. Consequently, for most natural resource organizations, carbon sequestration and storage has become another value for which forests are managed and represented a trade-off for managers who are required by law to manage for multiple uses and values [40]. However, natural resource managers noted that policies and procedures related to navigating complex and dynamic carbon markets, highly variable carbon accounting protocols, and the implications of state and federal policy decisions raise many questions and concerns about entering carbon markets for both public and private land managers [41,42], but see [6].

The carbon market provides an opportunity for an increase in the value of small diameter or lower value trees [43]. This was noted by our participants who expressed challenges with recent mill closures in Minnesota that previously utilized low-valued wood in traditional forest products uses. It should be noted that maximizing carbon storage may represent a significant trade-off in terms of ecosystem services and overarching goals for the forest ecosystem; Visseren-Hamaker and colleagues [44] using the United Nations (UN) Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+) note current trade-offs and discussions surrounding land use for multiple ecosystems services including carbon storage, biodiversity, and economic livelihood and opportunities. Some argue that carbon markets, especially those that fall under the Improved Forest Management (IFM) protocol, are not necessarily improving forest conditions for the long term [17]. The relative density of US forests has increased in the last 20 years [45]. Consequently, there is a greater need to consider forest management and silvicultural opportunities for dense stands.

"Appropriate" forest density has emerged as an important trade-off for natural resource managers to consider (e.g., [46]). A variety of resources—such as stand density index (SDI; [47]), Gingrich stocking charts [48], and leaf area index (LAI; [49])—are used in the development of silvicultural prescriptions; while each of these tools is unique, they are all essentially trying to quantify and allocate available growing space within a stand [50]. However, many of these tools were developed decades ago, and some of the sample data are about 80 to 100 years old [51,52]. There is concern that the current tools being utilized to inform density management are representative of past conditions and may not apply to current and future projected climatic conditions [53,54]. Additionally, many results in climate adaptation research support decisions to reduce stand density in an effort to reduce impacts from drought and increase individual tree resources for defenses against insects and diseases [55]. Our results indicate that in Minnesota, and perhaps in other regions where density management of forests is accomplished in efforts to maintain forest health, stocking guidelines should consider carbon storage and sequestration patterns as they are integrated into silvicultural prescriptions. Our focus group participants emphasized lower stocking as a strategy to create more resiliency to climate change, a perspective that should be considered with carbon programs that attempt to increase carbon stocks across the landscape.

Within North America, forest area has increased slightly between 1990 and 2015 [56]. In some North American ecosystems, the reforestation of agricultural lands can represent an opportunity for additional carbon storage, thus meeting the goal of additional trees as a natural climate solution [2]. Participants in our study noted that incentives for private landowners to plant trees would provide potentially huge carbon gains; however, they noted the logistical challenge related to nursery capacity.

Additionally, participants noted the need to consider the silvics and the ecological community when considering carbon management, especially increased tree density and/or cover. In fire-dependent ecosystems across the US, the increase in tree cover is the result of fire suppression policies; with greater tree density comes an increase in aboveground carbon, but also greater fire risk [57]. Additionally, fire risk and susceptibility are predicted to increase across large areas within the United States [58–60]. Natural resource managers will need to consider these trade-offs when developing management activities. Lastly, carbon markets may need to account for low severity, frequent fires as part of the management strategies within frequent fire systems, such as those being implemented in savanna ecosystems in Australia [61].

Carbon markets may also need to be more flexible in terms of length and permissible activities in response to ownership type [62,63]. Non-industrial or family forest land owners accounted for 39% of forest land owners in the US in 2018 [64]. Family forest landowners own forests for a wide variety of reasons, own various sized parcels, and own for various lengths of time [64]. There have been many barriers noted for family forest landowners entering the carbon market including small parcel size, forest inventory requirements, and length of contracts [65–67]. However, for those landowners who are more interested in passive forest management, entering the forest carbon market may provide a new source of income [68]. However, enrollment begs the questions: Would the landowners have managed their land any differently absent the carbon credits? If not, does the carbon stored on their forests represent "new" or "additional" carbon [69,70]? Our focus group participants stressed the need for outreach programs to private landowners to better inform them of forest carbon opportunities as a source of revenue and a way to steward their lands. Finally, given the sheer number and range of potential values and reasons for owning within family forest landowners, further research will be needed to understand why a family forest landowner chooses or declines to enter the carbon market, and how best to encourage participation [71].

The logistics of entering a carbon market will be different for an individual family forest landowner compared to a natural resource management organization which manages public forest lands. This consideration was brought up by numerous participants who work for public land management agencies. Previous policies are already in place on some lands such as trust lands (e.g., school trust lands; [72]). The individual policies regarding school trust lands vary by state; in Minnesota the state Department of Natural Resources is required to return the highest potential value back to the state; proceeds are then invested in the school system [73]. Similarly, the USDA Forest Service has the obligation to provide for a sustained yield of ecosystem goods and services on the national forests [74]. The additional requirement of entering the carbon market could result in additional policy and subsequently increased complexity in developing and implementing silvicultural prescriptions and forest management practices [75]. Land management planning could become especially complicated for large management organizations whose lands include multiple forest ecosystems and forest disturbance dynamics; on some of these lands carbon management may not be feasible for ecological, economic, or social reasons. To inform planning decisions, it will be critical for natural resource management organizations to consult with individuals at the local level, both within the community, including Tribal nations, and with the people implementing forest management practices (foresters, silviculturists, ecological specialists, and logging professionals) [76,77].

5. Conclusions

We found that mitigating the effects of climate change through forest carbon management was perceived to be a viable management goal across land ownerships represented in the focus groups from Minnesota. Forest carbon management aligns with multiple sustainable forest management practices. It nonetheless represents a trade-off to landowners, particularly public land management agencies for whom forest carbon simply represents another value that needs to be accounted for in landscape management plans. In addition, fire-dependent systems and climate change adaptation strategies promoting decreased density [55,57] were two key areas that participants identified as directly incompatible with carbon sequestration and storage. A standard carbon accounting methodology would reduce uncertainty and confusion toward entering the carbon market, particularly for non-industrial private forest landowners on smaller parcels, as would connecting the price of carbon to the cost of managing forest land for carbon. Regardless of the accounting methodology, forest carbon is a relatively new value to be balanced with the existing suite of needs and values that forests provide.

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