GEORGIA'S FORESTRY BEST MANAGEMENT PRACTICES: STAKEHOLDER PERCEPTIONS AND THE INFLUENCE OF THE SUSTAINABLE FORESTRY INITIATIVE FIBER SOURCING STANDARD

by

CHANTAL ALIX TUMPACH

(Under the Direction of Puneet Dwivedi)

ABSTRACT

Only about 10% of the forestland in Georgia is certified by sustainable forest management programs like the Sustainable Forestry Initiative (SFI) and the Forest Stewardship Council (FSC). This creates the impression that most forests in the state are not sustainably managed. But, responsible harvesting, even from forestland that is not certified, is also important to sustainably managing forest resources. SFI certifies wood to their Fiber Souring Standard which relies heavily on forestry Best Management Practices (BMPs) to set sustainable harvesting guidelines. The success of forestry BMPs in Georgia depends on the coordination of stakeholders. However, stakeholders' perceptions and the influence of the SFI Fiber Sourcing Standard are not well measured or understood. Through SWOT-AHP analysis, we assessed the perceptions of stakeholders about forestry BMPs, and using spatial and statistical analysis, we demonstrated how the SFI Fiber Sourcing Standard is having a clear impact on the sustainable management of Georgia's forestlands.

INDEX WORDS: BMPs; forest certification; sustainable forest management; forestry policy; SWOT-AHP; forest landowners; loggers; timber harvesting; spatial modeling; Southern United States

GEORGIA'S FORESTRY BEST MANAGEMENT PRACTICES: STAKEHOLDER PERCEPTIONS AND THE INFLUENCE OF THE SUSTAINABLE FORESTRY INITIATIVE FIBER SOURCING STANDARD

by

CHANTAL ALIX TUMPACH

B.A., Agnes Scott College, 2006

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

MASTER OF SCIENCE

ATHENS, GEORGIA

2018

GEORGIA'S FORESTRY BEST MANAGEMENT PRACTICES: STAKEHOLDER PERCEPTIONS AND THE INFLUENCE OF THE SUSTAINABLE FORESTRY INITIATIVE FIBER SOURCING STANDARD

by

CHANTAL ALIX TUMPACH

Major Professor: Puneet Dwivedi

Committee: Robert Izlar
Gregory Colson

Electronic Version Approved:

Suzanne Barbour
Dean of the Graduate School
The University of Georgia
May 2018

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my advisor, Dr. Puneet Dwivedi, for his unwavering guidance and mentorship throughout my master's program. I would also like to thank Robert Izlar and Dr. Gregory Colson for their support as members of my graduate committee. I am also grateful for the support from Chase Cook as a collaborator on the research project on which I based my master's thesis.

This research would not have been possible without the support of the Sustainable Forestry Initiative through their Conservation & Community Partnerships Grant Program and the participation of the many forestry stakeholders who were involved in our study and I am very appreciative of their help. Thank you to Tommy Carroll, Scott Thackston, David Coyle, Rita Barrow, Christine McCauley, and Danielle Atkins for facilitating surveys and focus groups. In addition, I would like to acknowledge the support of Scott Thackston and Gary White of the Georgia Forestry Commission for providing access to Georgia's Silvicultural Best Management Practices Implementation and Compliance Survey database.

On a day to day basis, my lab mates have been a constant source of encouragement and feedback. Thank you to Suraj Upadhaya, Arundhati Jagadish, Karuna Paudel, and the rest of the Dwivedi Forest Sustainability Lab for creating such a positive team environment in which to learn. Finally, thank you to my friends and family for their encouragement and to Penny for bringing joy into my life every day.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION

Sustainable forestry certification programs provide frameworks for ensuring forests are managed in a manner that meets the needs of the current population while conserving resources for future generations. The emergence of today's major forest certification programs began in the early 1990s as a market-based response to a lack of transparency in the international supply chain for tropical timber (Auld, 2014). In 1992, the United Nations Conference on Environment and Development (Earth Summit) resulted in the Agenda 21 Forest Principles action plan to tackle sustainable forestry issues, but it failed to produce any binding agreements (Perera and Vlosky, 2006). During the Earth Summit, non-governmental organizations (NGOs) began developing and promoting certification and product labeling systems for retail forest products as a means of demonstrating the sustainability of the wood sources used in manufacturing (Perera and Vlosky, 2006). Soon after, international non-profit programs like the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) evolved to provide a framework these labeling systems.

Today, both FSC and PEFC are globally recognized. The FSC operates as a single organization that sets its own standards and the PEFC functions as an endorsement process by which independent national certification programs may gain international recognition (PEFC, 2011). By the late 1990s, FSC and the Sustainable Forestry Initiative (SFI), a PEFC endorsed program, became the dominant certification programs in the United States. FSC evolved through the support of environmental NGOs while the effort to develop SFI was led by forest products

companies and other industrial players (Cashore, Auld, & Newsom, 2004). The American Tree Farm System (ATFS), established in 1941 and also endorsed by the PEFC, is the third and oldest certification program in the United States and holds special significance because of is focus on private non-industrial forest (PNIF) landowners (ATFS, 2018).

The FSC, SFI, and ATFS evolved differently, but over the past two decades, they have converged to have similar structures and goals. All three programs offer forest management certification which governs environmental, social, and economic aspects of sustainable forest management. As of December 2017, SFI was the largest issuer of forest management certifications in the United States with 64.9 million acres of certified forestland compared to 33.8 million acres for FSC and 18.5 million acres for ATFS (FSC, 2017; PEFC, 2017). SFI and FSC also offer Chain-of-Custody (CoC) certification to track the progression of certified fiber along the supply chain from source to end-use (Howe et al., 2005). A third standard that is unique to SFI is the Fiber Sourcing Standard which certifies the sustainable sourcing of wood fiber from forests (SFI, 2015).

About 95 million acres of United States forestland was certified in 2017, correcting for land that was double certified by more than one program (FSC, 2017; PEFC, 2017; PEFC and FSC, 2018). Nationally, only about 12% of forestland (18% timberland) has been certified (Oswalt et al., 2014). For PNIF landowners, who own over a third of the forestland in the U.S. (Butler et al., 2015), the percentage of certified forestland is even lower because of barriers like certification costs and the lack of incentives to participate (Ma et al., 2012). This low proportion of certified forestland could lead to the impression that U.S. forestland is not sustainably managed. SFI's Fiber Sourcing Standard is designed to addresses this concern, in part, because it ensures the responsible sourcing of fiber, whether or not the forestland from where it is harvested is certified.

The SFI Fiber Sourcing Standard promotes responsible fiber procurement by forest product organizations that source roundwood or residual chips, pulp, and veneer. Through 14 principles, 12 objectives, 21 performance measures, and 55 indicators, the Fiber Sourcing Standard aims to protect biodiversity, promote regulatory compliance and the use of qualified professionals, fund research and education, and engage with communities and stakeholders (SFI, 2015). Objective 2 of SFI's Fiber Sourcing Standard is adherence to forestry Best Management Practices (BMPs) to protect water quality, and BMPs are an integral part of the standard's performance metrics involving research and education about sustainable forestry (SFI, 2015).

Forestry BMPs have been one of the biggest factors influencing sustainable wood harvesting over the years and were developed in response to the Clean Water Act of 1972 to protect water quality across many industrial activities (Phillips, 1992). It has been well established that forestry BMPs have been successful at mitigating water quality issues and improving the overall sustainability of forest resources, but stakeholder involvement is also key to continued progress and assessment (Jackson, 2014). In the state of Georgia, BMPs are considered voluntary (non-regulatory) therefore, successful implementation is dependent upon factors beyond regulatory monitoring and mandates (Cristan et al., 2016a). We address the lack of research and knowledge about stakeholder perceptions of forestry BMPs in Chapter 2 by assessing the views of Georgia forestry stakeholders to determine how various groups are different and similar in their perceptions.

In Chapter 3, we examine the relationship between BMP implementation rates as measured by the Georgia Forestry Commission (GFC) and the spread of SFI mill certification across Georgia. In Georgia, the implementation rates of forestry BMPs have increased significantly since the GFC first began to perform regular compliance surveys across the state—from around 65% in

1991, prior to the introduction of forest certification programs, and gradually increasing to and remaining above 90% since 2004 (GFC, 2015). Given that the SFI Fiber Sourcing Standard mandates following BMPs, we hypothesize that a significant relationship is observable between the location of a GFC surveyed harvest site within the sourcing radius of mill(s) certified to the Fiber Sourcing Standard and the GFC's reported implementation rate for that harvest site. Taken together, the research presented in Chapters 2 and 3 contribute to the existing body of academic literature about forestry BMPs and forest certification by providing insight about previously unexplored topics within these areas of research.

CHAPTER 2

UNDERSTANDING STAKEHOLDERS' PERCEPTIONS ABOUT FORESTRY BEST MANAGEMENT PRACTICES IN GEORGIA [1]

[1] Tumpach, C., Dwivedi, P., Izlar, R., & Cook, C. 2018. *Journal of Environmental Management*. 213: 374-381. Reprinted here with permission of the publisher.

Abstract

Forestry Best Management Practices (BMPs) are critical in ensuring sustainable forest management in the United States because of their effectiveness in protecting water quality, reducing soil erosion, maintaining riparian habitat, and sustaining site productivity. The success of forestry BMPs depends heavily on coordination among primary stakeholder groups. It is important to understand perceptions of such groups for successful forest policy formulation. We used the SWOT-AHP (Strengths, Weaknesses, Opportunities, and Threats analysis with the Analytical Hierarchy Process) framework to assess perceptions of three stakeholder groups (loggers, landowners, agency foresters) about forestry BMPs in Georgia, the largest roundwood producing state in the United States. The agency and logger stakeholder groups gave the highest priority to improved reputation under the strength category, whereas the landowner stakeholder group perceived sustainable forestry as the highest priority under the same category. Lack of landowner education was the highest priority under the weakness category for landowner and agency stakeholder groups, whereas the logger stakeholder group selected lack of trained personnel as the highest priority under the same category. Agency and landowner stakeholder groups gave the highest priority to training and education while loggers indicated maintenance of forest-based environmental benefits as their highest priority under the opportunity category. Finally, landowners and agency stakeholder groups perceived more regulations and restrictions as most significant in the threat category whereas the logger stakeholder group was most concerned about the insufficient accounting of cost sharing under the same category. Overall, selected stakeholder groups recognize the importance of forestry BMPs and had positive perceptions about them. A collaborative approach based on continuous feedback can streamline expectations of

stakeholder groups about forestry BMPs in Georgia and several other states that are interested in maintaining high compliance rate of forestry BMPs for ensuring sustainable forest management.

Introduction

Silvicultural activities impact 2.4% of the total length of rivers and streams in the United States (U.S. EPA, 2000). Silviculture is listed as a source of impairment to rivers and streams in 26 states, including nine in which it is considered a major source of impairment. Therefore, several states have developed and adopted forestry Best Forestry Practices (BMPs) over time to reduce the impact of silvicultural activities on water quality in response to the Federal Water Pollution Control Act of 1972 and the Clean Water Act Amendments of 1977 (Cubbage, 2004).

The effectiveness of forestry BMPs as a tool for water quality protection is well established. Aust and Blinn (2004) reviewed several studies assessing the impacts of forestry BMPs for timber harvesting and site preparation on site productivity and water quality in the 12 physiological regions of the eastern United States. They reported that the existing forestry BMPs helped improve water quality but could be refined further to reflect site-specific conditions. Grace (2005) reviewed several studies and found that BMPs can minimize the effects of non-point source pollution caused by silvicultural activities in the southern United States. Anderson and Lockaby (2011) reviewed 17 studies from different physiographic regions in the southern region of the United States (8, 6, and 3 from the Coastal Plain, Piedmont, and Mountains, respectively) and concluded that forestry BMPs improve and maintain water quality, with streamside management zones as the most effective measure. Cristan et al. (2016b) reviewed a total of 81 studies (30, 31, and 20 studies in the southern, western, and northern regions of the United States, respectively) and found that correctly implemented forestry BMPs protect water quality nationwide and help states in achieving their water quality goals. Apart from studies which focus on the effectiveness of forestry BMPs in

reducing non-point source pollution, Ice et al. (2010) reported that the compliance rate of forestry BMPs has increased significantly nationwide since 1972 and currently stands at about 89% at the national level.

The continued success of BMPs in minimizing non-point source water pollution has made them an important tool for ensuring forest stewardship. The United States Environmental Protection Agency recently reaffirmed its approval of forestry BMPs to address water quality problems related to forest roads (U.S. EPA, 2016). Similarly, forest certification programs like the Sustainable Forestry Initiative (SFI) rely on forestry BMPs to set their certification standards. For example, as a part of SFI's Fiber Sourcing Standard, certified forest product mills must include contractual obligations for loggers to follow forestry BMPs and mills must conduct periodic checks on harvest sites from where they sourced wood (SFI, 2015).

As effective as BMPs are in sustainable forest management, to answer the question of whether BMPs are working as intended, and if they are doing enough to mitigate the impacts of human activity on the environment, the social and economic perspectives should not be ignored (Jackson, 2014). While Phillips and Blinn (2007, 2004) have expressed a need to standardize the guidelines of compliance monitoring programs to make them comparable across regions, Jackson (2014) points out that the human dimensions of BMPs make regional variations unavoidable. For example, as discussed in Carter et al. (2015) forestry BMPs in the Southeastern United States developed in a non-regulatory environment with heavy input from industry and other stakeholders because of the region's market structure and general aversion to governmental rules and regulations. This contrasts with the Pacific Northwest whose forestry BMP structure has evolved into one that is regulatory with significantly more government involvement.

Stakeholders are one of the factors that drive regional BMP variation and are pivotal to the implementation, development, and assessment of BMPs. Only a handful of studies have focused on economic (Cubbage, 2004; Shaffer et al., 1998) and welfare (Sun, 2006) dimensions of forestry BMPs. Studies which focus on social dimensions of forestry BMPs (Knoot and Rickenbach, 2011; McGill et al., 2006; Munsell et al., 2006) primarily examine the attitudes of forest landowners and the impact of policy instruments on the adoption of sustainable forest management practices, including BMPs by landowners (Maker et al., 2014; Provencher et al., 2007; Vanbrakle et al., 2013). To the best of our knowledge, only Husak et al. (2004) has compared the perceptions of three stakeholder groups (family forest landowners, forestry consultants, and industry) about perceived values of benefits derived from forestry BMPs in Mississippi.

Different stakeholder groups, including forest landowners, are involved in the forestry supply chain, and each of them faces a unique set of constraints in the context of forestry BMPs. This gives us reason to believe that various stakeholder groups have different perspectives about forestry BMPs. A better understanding of perceptions of stakeholder groups about forestry BMPs may inform policymakers about possible conflicts among stakeholder groups. This information can be utilized for formulating better policies for improving the effectiveness of forestry BMPs as a tool of sustainable forest management in the United States. Coupled with the physical studies on the effectiveness of forestry BMPs, the perspective gained from our research on human dimensions of forestry BMPs will provide a complete understanding of the challenges related to forestry BMPs in the United States and hopefully, will feed into the future forest policies at regional and national levels.

SWOT-AHP Framework

SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is a planning tool used to identify internal strengths and weaknesses and external opportunities and threats related to an industry, firm, project, product, or individual (Ghazinoory et al., 2011). However, SWOT analysis does not provide a comparison of the relative priority of identified factors under different categories. The AHP (Analytic Hierarchy Process) is a multi-criteria decision-making technique that measures the relative priority of one factor over other factors through pairwise comparisons (Saaty and Vargas, 2012). The data obtained through pairwise comparisons are analyzed by following an Eigenvalue technique to determine priority values of factors as explained in Shrestha and Alavalapati (2004):

Information derived from the pair-wise comparisons can be represented as a reciprocal matrix of weights where the assigned relative weight enters into the matrix as an element a_{ij} and reciprocal of the entry ($1/a_{ij}$) goes to the opposite side of the main diagonal,

$$A = (a_{ij}) = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{pmatrix}$$

where rows indicate ratios of weights of each factor with respect to all others. In the matrix, when $i = j$, then $a_{ij} = 1$. When we multiply matrix **A** by the transpose of the vector of weights **w**, we get the resulting vector n**w**,

$$\mathbf{Aw} = n\mathbf{w}$$

where $\mathbf{w} = (w_1, w_2, \ldots, w_n)^T$ and n is the number of rows or columns. The above equation can also be written as

$$(\mathbf{A} - n\mathbf{I})\, w = 0$$

where n is also the largest eigenvalue, λ_{max}, or trace of matrix **A** and **I** is the identity matrix of size n. Saaty (1977) demonstrated that $\lambda_{max} = n$ is a necessary and sufficient condition for consistency. Inconsistency may arise when λ_{max} deviates from n due to varying responses in the pairwise comparisons. Therefore, the matrix **A** should be tested for consistency using the formula,

$$\mathbf{CI} = (\lambda_{\max} - n)/(n - 1)$$

$$\mathbf{CR} = \mathbf{CI}/\mathbf{RI}$$

where **CI** is the consistency index, **RI** is a random index generated for a random matrix of order n, and **CR** is the consistency ratio (Mawapanga and Debertin, 1996; Saaty, 1993). The general rule is that **CR** should be $\leqslant 0.1$ (10%) for the matrix to be consistent. Homogeneity of factors within each group, a smaller number of factors in each group, and a better understanding of the decision problem improves the **CI**.

When applied to the factors identified as a part of SWOT analysis, the AHP enhances the information through a measured comparison of the importance across factors. This provides deep insight into the potential agreements and conflicts among stakeholder groups and can be of use with policies dealing with sustainable management of natural resources. Another advantage of utilizing the SWOT-AHP framework is that a large number of participants are not needed, as inputs provided by a few experienced respondents are sufficient to reflect perceptions of a stakeholder group (Shrestha et al., 2004). The use of SWOT-AHP has become popular in the sustainable

management of natural resources because of its simplicity in identifying points of agreements and disagreements across stakeholder groups for conflict resolution (Dwivedi et al., 2016; Kukrety et al., 2013; Kurttila et al., 2000; Ramirez et al., 2012).

Methods

We used the SWOT-AHP framework to assess the perceptions of three forestry stakeholder groups—loggers, landowners, agency foresters (Georgia Forestry Commission[2], GFC)—about forestry BMPs in Georgia, the largest roundwood producing state in the United States (Oswalt et al., 2014). Forestry BMPs in Georgia were developed in 1981 and updated several times thereafter (GFC, 2009). Currently, forestry BMPs are non-regulatory in Georgia because silvicultural activities are exempt from the permitting processes provided forestry BMPs are followed. Compliance is monitored by the GFC, and regulatory agencies are only involved when improperly implemented BMPs are not sufficiently mitigated by the responsible party. Survey results of the GFC suggest that, on an average, the forestry BMP implementation rate at the state level has been between 90% and 95% since 2004 (GFC, 2015).

We conducted two focus group discussions (Washington, GA and Forsyth, GA) with loggers operating in Georgia to determine suitable factors under each SWOT category. At both focus group discussions, the participants were split into one of two groups: large (35 or more loads delivered per week) and small (less than 35 loads delivered per week). The cut-off of 35 loads delivered per week was decided by participants of focus group discussions only. The focus groups were conducted as open-ended discussions where participants were asked to share their thoughts on internal factors (strengths and weaknesses) and external factors (opportunities and threats) that

[2] The state agency responsible for the management of forest resources in Georgia.

influence their perceptions of forestry BMPs in Georgia. At the end, both groups presented their responses for further discussions. We evaluated responses from the focus group discussions and identified factors that were consistently mentioned within each SWOT category. We also consulted existing literature (Ellefson et al., 2001; Husak et al., 2004) and other field practitioners before finalizing the factors within each SWOT category. We identified a total of four strengths, four weaknesses, three opportunities, and three threats (Table 2.1).

Table 2.1: SWOT factors identified through focus group discussions.

Internal	Strengths	Weaknesses
	1 Promotes sustainable forestry	1 Lack of landowner education
	2 Maintains/increases access to markets	2 No economic incentives
	3 Promotes a culture of safety	3 Lack of trained personnel
	4 Improves the reputation of the logging community	4 Inconsistent interpretation of BMP guidelines
External	Opportunities	Threats
	1 Improved training and education opportunities	1 More regulations and restrictions
	2 Better interagency coordination	2 Insufficient accounting of cost sharing
	3 Maintenance of forest-based environmental benefits	3 Increasing urban populations

We developed a questionnaire to gauge the level of importance of each factor relative to others within the same SWOT category for each stakeholder group. This questionnaire included detailed instructions and short explanations of the identified factors to provide the same context to all respondents (Appendix A). For example, we asked participants to compare the factors of "promotes sustainable forestry" and "maintains/increases access to markets" within the strengths category (Figure 2.1). The participants marked the box that indicated the degree to which they believed one factor was more important than the other, or if they were equal. The questionnaire asked respondents to indicate their preference of one factor over the other for each pairwise comparison using the scale of Equal, Somewhat More Important, More Important, or Much More Important. We assigned weighted numerical values (Equal = 1, Somewhat More Important = 3, More Important = 5, and Much More Important = 7) to the responses for analysis (Dwivedi and Alavalapati, 2009).

Category: Strength

Factor	Much More Important	More Important	Somewhat More Important	Equal	Somewhat More Important	More Important	Much More Important	Factor
Promotes Sustainable Forestry								Maintains/Increases Access to Markets
Promotes Sustainable Forestry								Promotes a Culture of Safety
Promotes Sustainable Forestry								Improves Reputation of Logging Community
Maintains/Increases Access to Markets								Promotes a Culture of Safety
Maintains/Increases Access to Markets								Improves Reputation of Logging Community
Promotes a Culture of Safety								Improves Reputation of Logging Community

Figure 2.1: An example of pairwise comparisons of the strength category from the developed questionnaire.

For the first survey, we collected responses of 25 loggers and 10 landowners at five events throughout Georgia (Table 2.2). For the agency stakeholder group, we collected seven responses via e-mail. We aggregated individual responses from the first round of surveys by stakeholder group using the geometric mean method and then used standard AHP procedure to calculate a priority value for each factor present within each SWOT category for each stakeholder group (Saaty and Vargas, 2012). Next, we developed three more questionnaires, one for each stakeholder group, using the highest priority factor from each SWOT category. The objective of the second survey was to determine the relative priority of SWOT categories themselves with respect to each other. For the second round of surveys, we received seven valid responses from loggers and 10 from landowner stakeholder groups at two separate events and collected seven valid responses via email for the agency stakeholder group (Table 2.3). Again, we used geometric mean to aggregate individual responses followed by standard AHP procedure to calculate priority values of the top factors from each SWOT category for each stakeholder group. The priority values from the first round of surveys were multiplied by the priority values of SWOT categories from the second round of surveys to obtain an overall priority ranking of factors. This provided a perspective on the relative priorities of all SWOT factors for each stakeholder group.

Table 2.2: Survey locations and response counts for prioritizing factors under SWOT categories.
SWPA: Southeastern Wood Producers Association

Stakeholder Group	Event	Location	Date	Valid Responses
Logger	SWPA Chapter Meeting	Claxton, GA	Jan 17, 2017	11
	SWPA Chapter Meeting	Jesup, GA	Jan 31, 2017	10
	SWPA Chapter Meeting	Calhoun, GA	Feb 13, 2017	4
Landowners	Madison-Morgan Conservancy Workshop	Madison, GA	Jan 26, 2017	4
	Landowner Education Workshop	Albany, GA	Apr 11, 2017	6
Agency	Online (emails)		Mar 10-16, 2017	7

Table 2.3: Survey locations and response counts for prioritizing SWOT categories.
MTH: Georgia Master Timber Harvest Program. USDA NRCS: United States Department of Agriculture Natural Resources Conservation Service.

Stakeholder Group	Event	Location	Date	Valid Responses
Logger	MTH Workshop	Forsyth, GA	Feb 22, 2017	7
Landowners	Forest Landowner Meeting, USDA NRCS	Waverly, GA	Apr 25, 2017	10
Agency	Online (emails)		Mar 21-28, 2017	7

Results

For the logger stakeholder group, reputation explained 32% of perception within the strength category, followed by safety at 25%, access to markets at about 22%, and sustainable forestry at 21% (Figure 2.2). Historically, environmental groups have blamed the logging industry for not doing its part in ensuring the sustainability of forestry resources (Bartley, 2003). However, successful adoption of forestry BMPs has helped the logging community to demonstrate their commitment to sustainable forestry which in turn has increased the overall reputation of the industry. Shaffer and Meade (1997) mentioned that following BMPs helps in safety and increasing productivity through better planning and reducing machine downtime. This could be a reason behind the high priority given to the factor safety. While BMPs are non-regulatory in Georgia, many large mills in the state are certified to SFI's Sustainable Fiber Sourcing Standard, and thus, require BMP compliance as part of their timber purchase contracts. This could explain the high priority value given to access to markets.

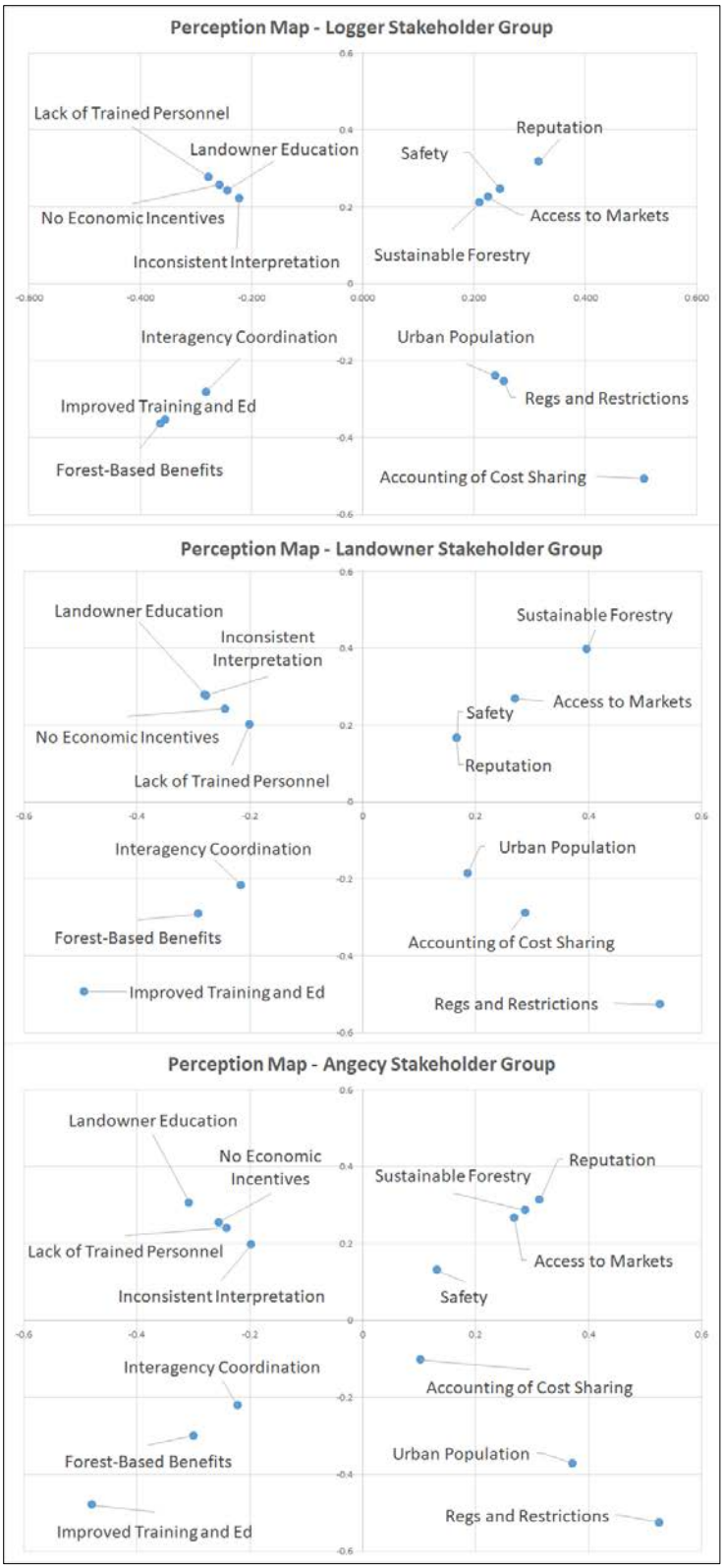

Figure 2.2: Perception maps of SWOT factors for each stakeholder group.
The further away a factor is from the origin, the more that factor explains the perception of the stakeholder group for a SWOT category. The value of Confidence Ratios are less than 10% for all the pairwise comparisons showing consistency in responses.

Lack of trained personnel explained about 28% of loggers' perception in the weakness category with no economic incentives, landowner education, and inconsistent interpretation explaining 26%, 24%, and 22%, respectively. The factors of forest-based benefits and improved training and education both explained about 36% of the perception of the logger stakeholder group about opportunities followed by interagency coordination explaining the remaining 22%. The factor accounting of cost sharing explained 51% of loggers' perception of threats, with 25% explained by regulations and restrictions and 24% by urban population. Costs related to forestry BMPs have gone up in recent years (Cubbage, 2004). Loggers have to absorb the majority of this cost as landowners are typically paid based on market prices of roundwood products, and there is no direct support from the industry or government towards cost sharing.

For the overall perception of the landowner stakeholder group in the strength category, the factors of sustainable forestry, access to markets, safety, and reputation explained 40%, 27%, 17%, and 17%, respectively. A high priority value of sustainable forestry is understandable, as forest landowners typically have multiple objectives for forestland management (Butler and Leatherberry, 2004). Inconsistent interpretation and landowner education both explained 28% of perception in the weaknesses category, followed by 24% for no economic incentives and 20% for lack of trained personnel. Perceptions about opportunities were explained by improved training and education (49%), forest-based benefits (29%), and interagency coordination (22%). A high priority value of improved training and education under the opportunity category and landowner education under the weakness category reflects on a common understanding that a large percentage of family forest landowners are unaware of or have limited knowledge of forestry BMPs in Georgia. Regulations and restrictions explained the largest proportion of the threat category at

53%, followed by an accounting of cost sharing and the urban population at 28% and 19%, respectively.

Within the agency stakeholder group, reputation explained 31% of perception for the strength category followed by 29% for sustainable forestry, 27% for access to markets, and 13% for safety. Under the weakness category, 31% of perception was explained by landowner education, 26% by no economic incentive, 24% by lack of trained personnel, and 20% by inconsistent interpretation. The agency group's perception regarding opportunities was explained by improved training and education at 48%, forest-based benefits at 30%, and interagency coordination at 22%. Finally, regulations and restrictions explained 53% of the perception for the threats category, followed by 37% for the urban population, and 10% for an accounting of cost sharing. A high priority value of 53% for regulations and restrictions under the threat category could be attributed to the general observation that an increase in regulations and restrictions could lead to more interagency coordination issues and increased chances of inconsistent interpretations. In some cases, existing forestry BMPs provide general guidelines and are subject to different interpretations by different stakeholder groups depending upon local context.

The perceptions of the highest priority factors from each SWOT category for each stakeholder group (Figure 2.3) shows they are mostly positive for the landowner and agency stakeholder groups (62% and 64% positive, respectively) and almost equally positive and negative for the logger group (48% positive versus 52% negative). Our results support the findings of Husak et al. (Husak et al., 2004) that forestry stakeholder recognize and appreciate the positive benefits of BMPs. The strength category (sustainable forestry) and opportunity category (improved training and education) drove the positive perception of the landowner stakeholder group. Similarly, the positive perception of the agency stakeholder group was dominated by the strength category

(reputation) and opportunity category (improved training and education). The weakness category (lack of trained personnel) followed by the threat category (accounting of cost sharing) contributed to the overall negative perception of the logger stakeholder group.

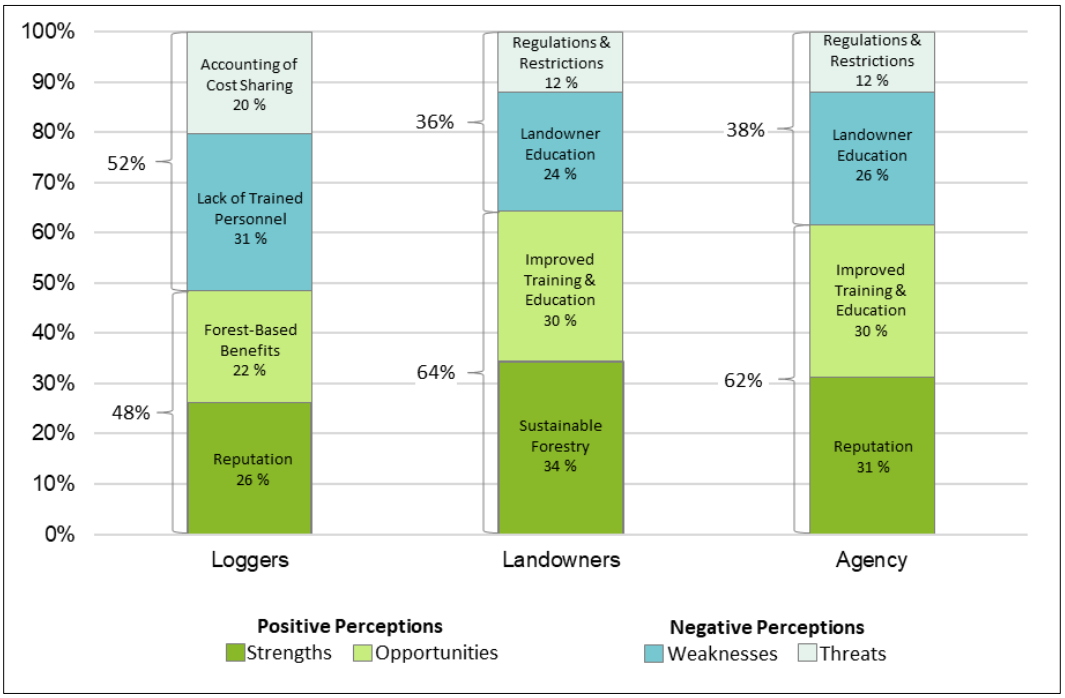

Figure 2.3: Highest priority factors under each SWOT category for each stakeholder group.
The values of Confidence Ratios are less than 10% for all the pairwise comparisons showing consistency in responses.

Discussions

Sustainable forestry, improved training and education, and accounting of cost sharing showed significant differences across stakeholder groups in terms of overall priorities given to these factors (Figure 2.4). Overall, landowners perceived sustainable forestry as having greater importance than the agency and logger stakeholder groups. Conversely, the logger stakeholder group perceived accounting of cost sharing as having greater importance than the landowner and agency stakeholder groups. The logger stakeholder group cited cost sharing as the highest priority factor while it was the lowest and second lowest for agency and landowners, respectively. Landowners and agency perceived improved training and education as their highest priority factor while it held only moderate importance for loggers. Presumably, the landowner stakeholder group

is aware of their need for more information on forestry BMPs and the agency stakeholder group is willing to supply the information on forestry BMPs as a part of their organizational mandate.

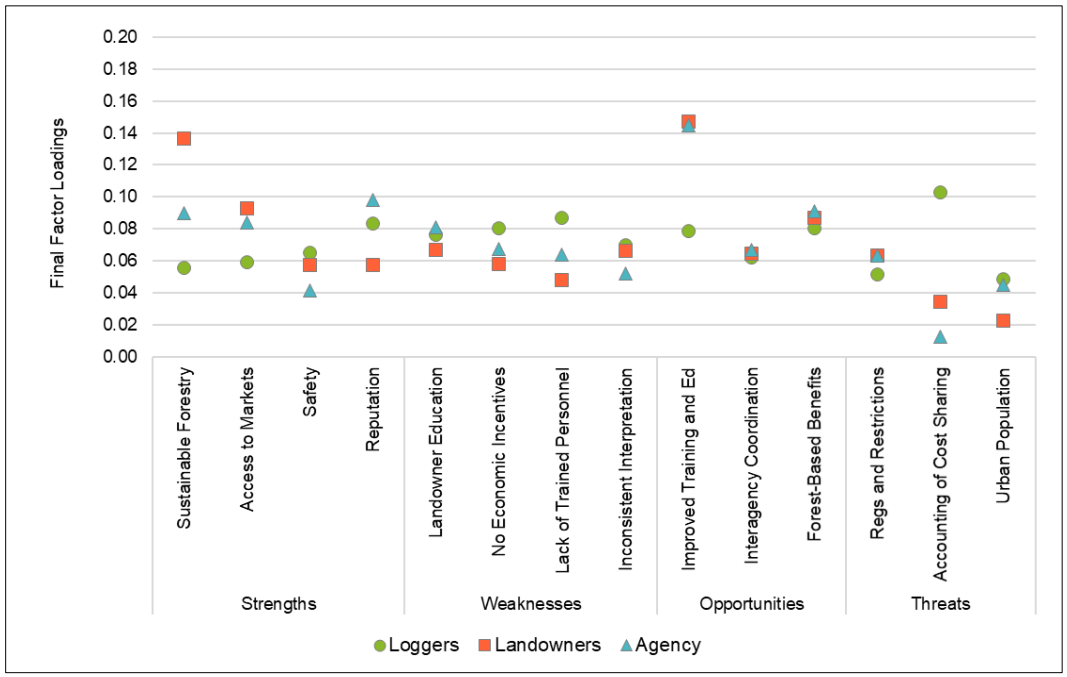

Figure 2.4: Final priority of factors for each stakeholder group.

Under the opportunity category, only the factor forest-based benefits was consistent across all groups among the top five priority factors from each of the stakeholder groups (Figure 2.5). This indicates a common understanding exists among selected forestry stakeholder groups about the effects of forestry BMPs on the overall well-being of people and the environment. Agency and landowner stakeholder groups also perceived sustainable forestry and access to markets under the strength category to be one of their top five factors. All stakeholder groups perceived training to be important to BMP implementation, but they differed in their perceptions of whether it should be externally or internally focused. Landowners and agency ranked the external factor of improved training and education under the opportunity category as their top priority, whereas the logger stakeholder group indicated the internal factor of lack of trained personnel under the weakness category as their second top priority. Loggers are responsible for making many BMP decisions

and must have the technical knowledge necessary for the execution of BMPs during the harvesting process. An aging workforce coupled with the difficulty of providing hands-on field training to younger loggers towards forestry BMPs were concerns raised by the logger stakeholder group. Other than forest-based benefits, the only other top five factor that the logger stakeholder group shared with another stakeholder group was reputation under the strength category with the agency stakeholder group. Following forestry BMPs is a tangible way to demonstrate a commitment to responsible and sustainable forestry, and therefore, improve the public reputation of the logging as a profession.

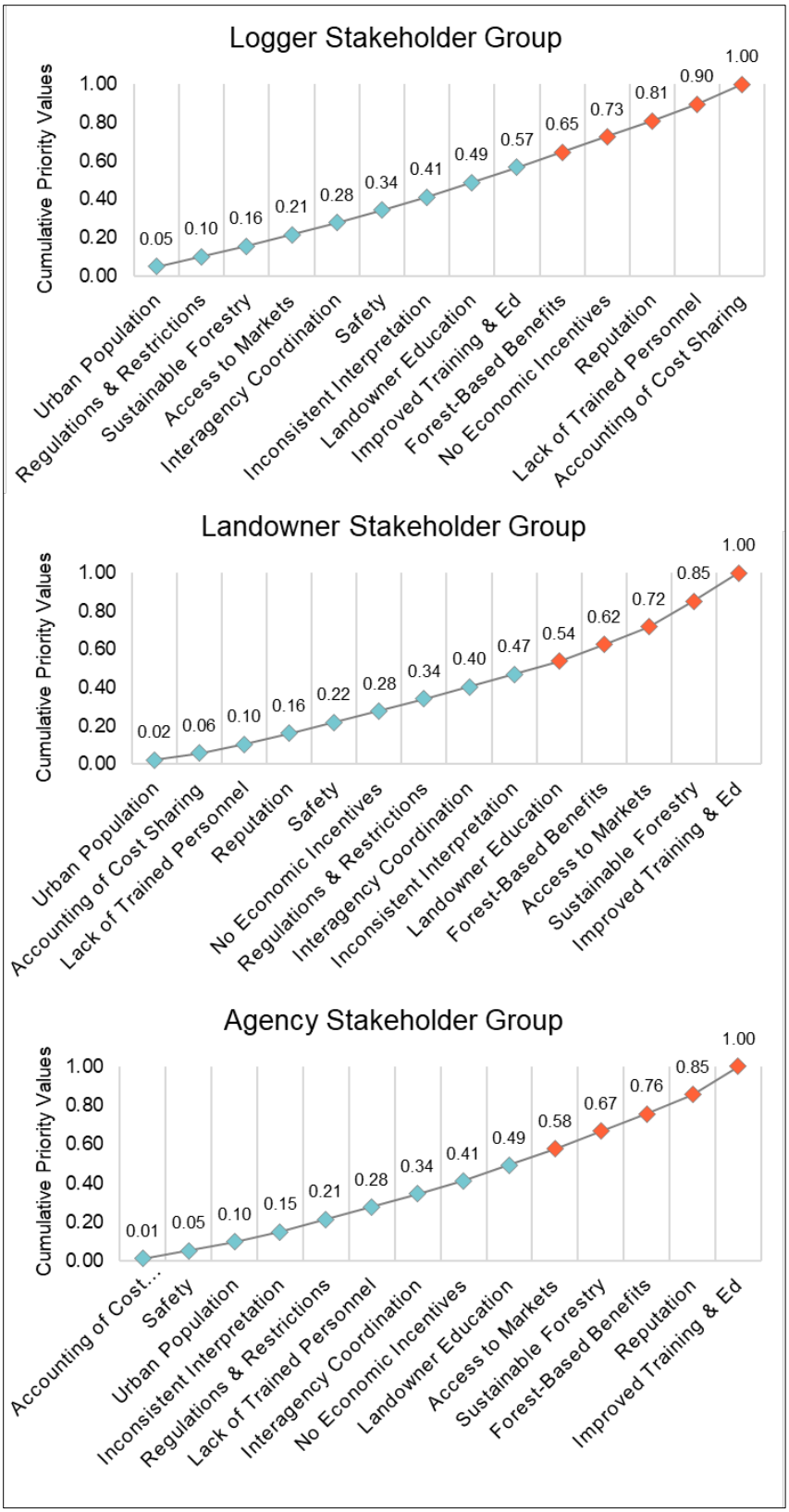

Figure 2.5: Final order of factors for each stakeholder group.
Top five factors are highlighted.

Overall, our results suggest that the perspectives of the logger stakeholder group about forestry BMPs in Georgia vary noticeably from the landowner and agency stakeholder groups. The cost of BMP implementation was one of the biggest concerns of loggers with an accounting of cost sharing (threat) and no economic incentives (weakness) comprising over 18% of the overall perception of forestry BMPs. A survey conducted by Blinn et al. (2001) suggested that loggers are concerned about paying much of the costs of implementing forestry BMPs without adequate compensation. This is especially true in light of the fact that forestry BMP implementation costs are increasing (Cubbage, 2004). Sun (2006) explored welfare effects of forestry BMPs and reported that while consumers of forest products had the largest absolute welfare loss from costs related to the implementation of forestry BMPs, loggers experienced the greatest relative welfare losses with landowners sharing the burden, while mills experienced little change to their welfare. A study found that the tight profit margin of timber harvesting makes a realistic accounting of the costs of forestry BMPs in bidding processes an important determinant for profitability, but not all loggers are doing this well (Germain et al., 2016). Considering this, it is not surprising that financial burdens overshadow most other factors for loggers coupled with a shortage of qualified employees. We also found the perceptions of landowner and agency stakeholder groups were very similar and focused mostly on educational needs. This reflects that fact that the majority of forest landowners are not well aware of forest-related issues and agency and extension professionals are continuously trying to encourage their broader participation in forestry-related educational programs (Measells et al., 2006).

Conclusion

We used the SWOT-AHP (Strengths, Weaknesses, Opportunities, and Threats analysis with the Analytical Hierarchy Process) framework to assess perceptions of three stakeholder groups

(loggers, landowners, agency foresters) about forestry BMPs in Georgia to identify potential conflicts among identified stakeholder groups and use the same information for effective policymaking. Based on our findings, we suggest the following for ensuring greater coordination among selected stakeholder groups:

- A state-wide education program should be developed for forest landowners to inform and educate them about the importance of sustainable forestry management in general, and forestry BMPs, in particular.
- An in-the-field training program should be developed to provide young loggers with hands-on, practical education about implementing forestry BMPs. This is critical as lack of trained manpower could adversely affect BMP implementation rates in coming years.
- A platform should be developed where members of logger, landowner, and agency stakeholder groups can discuss issues related to forestry BMPs at regular intervals. This will create better coordination and bring clarity to the interpretation of forestry BMPs. This will also build trust among identified stakeholder groups leading to synergetic solutions to points of conflict.

We hope that future research will incorporate perceptions of industry stakeholder group. Additionally, the potential solutions that we have proposed are based on inputs received from stakeholders. It would be nice to prioritize suggested solutions using a similar approach in future research. We hope that our study fills a critical gap that exists in our understanding about perceptions of stakeholder groups about forestry BMPs in Georgia and leads to better policy formulation for sustaining higher BMP implementation rates. We are also hopeful that our study will help other states in engaging local stakeholder groups in a constructive manner for ensuring sustainable management forest resources alike.

CHAPTER 3

EFFECTS OF THE SUSTAINABLE FORESTRY INITIATIVE FIBER SOURCING STANDARD ON THE AVERAGE IMPLEMENTATION RATE OF FORESTRY BEST MANAGEMENT PRACTICES IN GEORGIA, UNITED STATES

Abstract

Much of the discourse on the sustainability of forestlands revolves around the total acreage under certified forestland. It is typically assumed that certified forestland is the hallmark of sustainable forestry. Though we do not necessarily disagree with this argument, we do believe that this line of reasoning has led to a general perception that non-certified forests are not sustainably managed. In this regard, the role of the Sustainable Forestry Initiative's (SFI) Fiber Sourcing Standard becomes critical in promoting sustainable forestland management on non-certified forestlands. We used an innovative spatial approach to determine the influence of the SFI Fiber Sourcing Standard on Georgia's forestlands over space and time. We also determined the role of the SFI Fiber Sourcing Standard in increasing the implementation rate of forestry Best Management Practices (BMPs) in Georgia. Our results suggest that at least 80% of total forestland in Georgia is affected by the SFI Fiber Sourcing Standard. We also found that the average forestry BMP implementation rate on harvested sites which are within the sourcing radius of mills certified to the SFI Fiber Sourcing Standard is about 2% higher relative to harvested sites which are located outside the sourcing radius of any such mill. Our results clearly indicate that the majority of forestlands, including non-certified forestlands, are sustainability managed in Georgia, as forestry BMPs are a strong indicator of forestland sustainability.

Additionally, the SFI Fiber Sourcing Standard is helpful in increasing BMP implementation rates across Georgia. We hope that our results will bring much-needed clarity to the sustainability of non-certified forestlands in Georgia and other forested regions in North America.

Introduction

Sustainable forest certification programs like the Programme for the Endorsement of Forest Certification (PEFC) and the Forest Stewardship Council (FSC) are promoting sustainable forestry practices worldwide. Most existing certification schemes focus on certification of forest management (this includes forestland certification) and chain of custody (CoC). The PEFC certifies over 750 million acres and 11,000 CoCs worldwide, with over 116 million acres and 200 CoCs in the United States alone, by endorsing over 30 national certification systems (PEFC, 2016).

The Sustainable Forestry Initiative (SFI) is a PEFC endorsed system operating in the United States and Canada which, in addition to forest management and CoC standards, offers a unique Fiber Sourcing Standard for those wood consuming mills that procure wood directly from certified and uncertified forestlands (SFI, 2015). The SFI 2015-2019 Fiber Sourcing Standard promotes responsible forestry practices through 14 principles, 13 objectives, 21 performance measures, and 55 indicators. These fiber sourcing requirements include measures to broaden the practice of biodiversity, use forestry Best Management Practices (BMPs) to protect water quality, provide outreach to landowners, and use the services of harvesting professionals trained through the Master Timber Harvester Program (SFI, 2015). Other popular forest certification schemes in the United States like the FSC and the American Tree Farm System (ATFS) do not have an equivalent standard. Additionally, the participating wood consuming mills under SFI's Fiber Sourcing Standard must be third party audited to ensure compliance with the requirements of the standard.

Sustainable wood procurement from non-certified lands is especially important in the southeastern United States which is dominated by family forest landowners for whom forest management certification can often be impractical or out of reach due to cost considerations. This is especially true in Georgia, the largest roundwood producing state in the United States (Oswalt et al., 2014), where about half a million family forest landowners own about 14 million acres of forestlands, i.e., 58.3% of total forestlands in the state. Therefore, it is not a surprise that only about 10% of forestland in Georgia is certified to various forest management certification schemes including the SFI Forest Management Standard. However, there are nearly 200 primary wood-consuming mills in Georgia out of which 41 consume more than 350,000 tons of roundwood per year (GFC, 2017). Of the 41 large, wood-consuming mills, 28 were certified to the SFI Fiber Sourcing Standard prior to 2015. As a result, it is generally believed that the SFI Fiber Sourcing Standard is instrumental in ensuring the sustainability of forestry resources in Georgia. In turn, the SFI Fiber Sourcing Standard helps wood consuming mills in Georgia to access national and international markets where buyers are continuously seeking finished wood products made out of wood sourced from a sustainably managed forestland.

A prominent feature of the SFI Fiber Sourcing Standard is adherence to forestry BMPs for maintaining water quality. Wood consuming mills must include a contractual obligation to follow forestry BMPs in their procurement agreements with trained loggers and must perform periodic random checks on harvested sites located on non-certified forestlands that are subject to their own procurement activities. In addition to the BMP audits performed by wood consuming mills certified to the SFI Fiber Sourcing Standard, the Georgia Forestry Commission (GFC) performs a biennial survey throughout the state to track BMP implementation rates on recently (typically less than two years) harvested sites (GFC, 2015). The GFC uses the results of these surveys to comply

with the Federal Clean Water Act of 1972. All surveys typically follow guidelines set forth in Georgia's Best Management Practices for Forestry manual for estimating the average BMP implementation rate. Concurrence can be easily observed between increasing BMP implementation rates with the introduction and expansion of the SFI Fiber Sourcing Standard beginning the mid-1990s (Figure 3.1). The overall mean implementation rate of forestry BMPs for the first Georgia survey performed in 1991 was only 65%, but the rate steadily increased and has remained above 90% since 2004 (Georgia Forestry Commission, 2015). Many forestry experts believe a relationship exists between the increased implementation rate of forestry BMPs and the adoption of the SFI Fiber Sourcing Standard by wood-consuming mills in Georgia. However, no proof exists to establish a direct relationship between the SFI Fiber Sourcing Standard and implementation rates of forestry BMPs in Georgia.

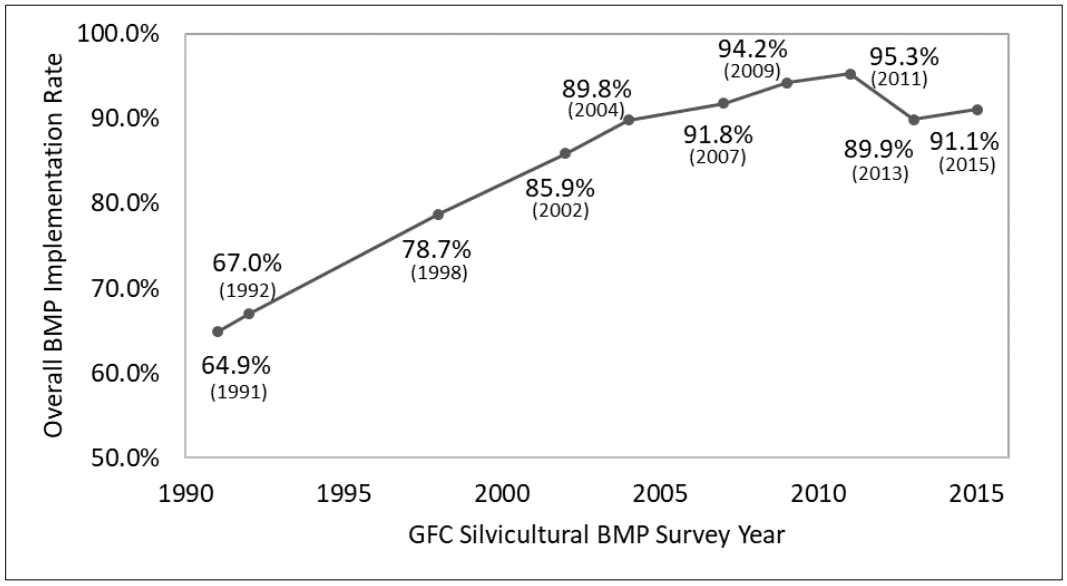

Figure 3.1: Overall implementation rates from the Georgia Forestry Commission's Silvicultural Best Management Practices Implementation and Compliance Survey.

The majority of studies focusing on forestry BMPs in the United States analyze the impact of forestry BMPs on water quality (Aust and Blinn, 2004; Cristan et al., 2016b; Grace, 2005). Only a handful of studies have analyzed the economic and welfare impacts of forestry BMPs (Cubbage,

2004; Shaffer et al., 1998; Sun, 2006). Studies which focus on the social dimensions of forestry BMPs primarily examine the attitudes of forest landowners and the impact of policy instruments on adoption of sustainable forest management practices, including BMPs by landowners (Knoot and Rickenbach, 2011; Maker et al., 2014; McGill et al., 2006; Munsell et al., 2006; Provencher et al., 2007; Vanbrakle et al., 2013). Most studies focus on political (Cashore et al., 2004), institutional (Rametsteiner, 2002), governance (Ebeling and Yasué, 2009; Gulbrandsen, 2004), and marketing (Owari et al., 2006) impacts of forest certification. Only Newsom et al. (2005) have looked at the relationship between forest certification and BMPs in the United States suggesting that in the process of becoming certified, forest landowners are often required to make important changes to their BMP-related practices, especially in those states where forestry BMPs are non-regulatory in nature (e.g., Georgia).

No study, to the best of our understanding, has yet analyzed the relationship between the implementation rate of forestry BMPs and the SFI Fiber Sourcing Standard in the United States. This gap in our knowledge becomes even more critical as anecdotal evidence about the direct connection between BMP implementation and the SFI Fiber Sourcing Standard is a part of parlance within forestry stakeholder groups. Therefore, we developed an innovative spatial approach to a) analyze the percentage of total land and forestland influenced by the SFI Fiber Sourcing Standard, b) examine differences in BMP implementation rates across survey sites located inside and outside of the sourcing radius of wood-consuming mills certified to the SFI Fiber Sourcing Standard, and c) define the role of the SFI Fiber Sourcing Standard in increasing the BMP implementation rates within Georgia over time. We hope that our research will bring much-needed clarity about the efficacy of the SFI Fiber Sourcing Standard in ensuring an integrated landscape-based sustainable forest management approach.

Methods

We compiled a directory of roundwood consuming mills in Georgia using the 2015 Georgia Wood-Using Industries Directory published by the Georgia Forestry Commission (GFC, 2017) and the Primary Forest Products Locator database maintained by the Southern Group of State Foresters (Southern Group of State Foresters, 2017). Locations from these two sources were cross-referenced, and geographical coordinates and roundwood consumption were confirmed. A survey was sent to current mills certified to the SFI Fiber Sourcing Standard (as of 2017) to obtain an initial year of certification with a 59% response rate (n = 32). For the mills that did not respond, we obtained the certification year from SFI's records and third-party audit reports.

We used the data from Georgia's Silvicultural Best Management Practices Implementation and Compliance Surveys conducted by the GFC for the years 1998, 2002, 2004, 2007, 2009, 2011, 2013, and 2015. Site-level results were not available for the survey years 1991 and 1992. The number of harvest sites sampled for the GFC's BMP Implementation and Compliance Survey has decreased over time, but sample sizes remained large enough to achieve at least a 5% margin of error (GFC, 2015). To obtain a consistent and comparable measurements from year to year, we cross-referenced the questions from each survey year resulting in 103 BMP implementation questions that had been assessed on each survey site for every survey year. The 1998 survey questions were significantly different from 2002 through 2015, so we did not include the 1998 survey in our analysis. To obtain an overall BMP implementation rate for each survey site, we calculated the proportion of compliant answers out of the total number of factors assessed. Questions marked as "Not Applicable" to a survey site were not included in the implementation rate calculation.

We imported the locations of every wood consuming mill certified to the SFI Fiber Sourcing Standard into ArcGIS version 10.4. For each survey year, mills that received their certification prior to the year of the survey were counted as certified. Mills that received their certification in the year of the survey were not counted until the next survey year. Forty and 50-mile buffers were created around each mill to reflect the fiber sourcing radius and therefore, demarcate the size of the mill's wood basket. We selected a 40-mile sourcing radius as this is the minimum contractual sourcing radius across southern states (TimberMart-South, 2017). We selected a conservative 50-mile sourcing radius as 54 miles is the historical average sourcing radius (2006-2017) across wood consuming mills in the US South (TimberMart-South, 2017). Additionally, we imported the location of survey sites present in the GFC's database for all of the survey years (2002-2015) along with relevant attributes (land ownership, physiographic region, terrain, and slope) into ArcGIS. Using the Spatial Analysis Toolbox in ArcGIS, we calculated the number of overlapping wood baskets at a survey site for a given survey year for the sourcing radii of 40-miles first and then for 50-miles.

We developed a Tobit regression model (Tobin, 1958) to determine the influence of the total number of overlapping wood baskets on the mean BMP implementation rate at survey sites across years for a sourcing radius of 40-miles. We developed a suitable Tobit regression model for a sourcing radius of 50-miles as well. The use of a Tobit regression model is appropriate when a latent dependent variable is censored with many observations occurring at the limiting value. Without these censored limits on the dependent variable, the Tobit regression model is the same as to ordinary least squares (OLS) model. In our study, the use of the Tobit regression model was necessary because the BMP implementation rate on a surveyed harvest site is censored from both

sides as the range of the variable is from 0% (lower limit) to 100% (upper limit) with a clustering of observations at the upper limit constraint.

Results

For the 40-mile sourcing radius, the total land base in Georgia that fell within the sourcing radius of mills certified to the SFI Fiber Sourcing Standard nearly doubled from 15.5 million acres (41% of total land) in 2002 to 30.9 million acres (81% of total land) in 2015 (Table 3.1). For a sourcing radius of 50-mile, this increase was from 21.2 million acres (56% of total land) to 35.3 million acres (93% of total land) over the same period (Figure 3.2).

Table 3.1: Total land base in Georgia (million acres) influenced by the SFI Fiber Sourcing Standard.

Survey Year	Mills certified to the SFI Fiber Sourcing Standard prior to survey years (#)	40-mile Sourcing Radius Buffer	50-mile Sourcing Radius Buffer
2002	7	15.5 (41%)	21.2 (56%)
2004	8	18.7 (49%)	25.8 (68%)
2007	11	22.7 (60%)	29.3 (77%)
2009	19	27.0 (71%)	33.8 (89%)
2011	22	28.4 (75%)	34.4 (90%)
2013	24	30.0 (79%)	35.1 (92%)
2015	28	30.9 (81%)	35.3 (93%)

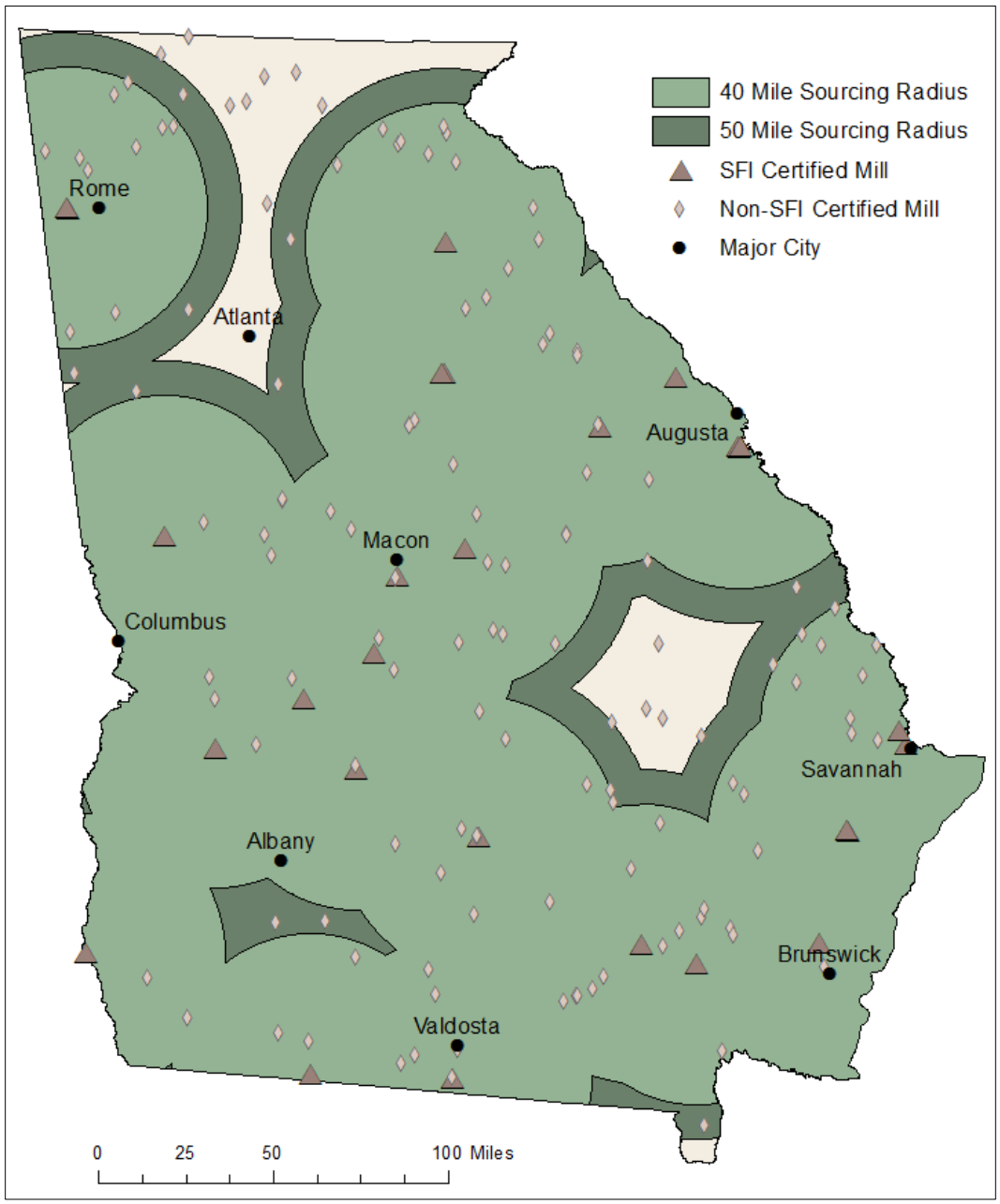

Figure 3.2: Wood baskets of mills certified to the SFI Fiber Sourcing Standard prior to 2015.

We used National Land Cover Data for 2001, 2005, and 2011 for Georgia to estimate the influence of the SFI Fiber Sourcing Standard on the landscape. We found that the total forestland influenced by the SFI Fiber Sourcing standard has gone up over time due to an increase in certified wood consuming mills (Figure 3.3). In the year 2002, only about 10 million acres of forestland (40.0% of total forestland) in Georgia were influenced by the SFI Fiber Sourcing Standard for a

sourcing radius of 40-miles, but in 2015 this went up to about 19 million acres of forestland (80.6% of forestland). The percentage of Georgia's forestland affected by the SFI Fiber Sourcing Standard for a sourcing radius of 50-miles has gone up from 55.4% in 2000 to 92.0% in 2015.

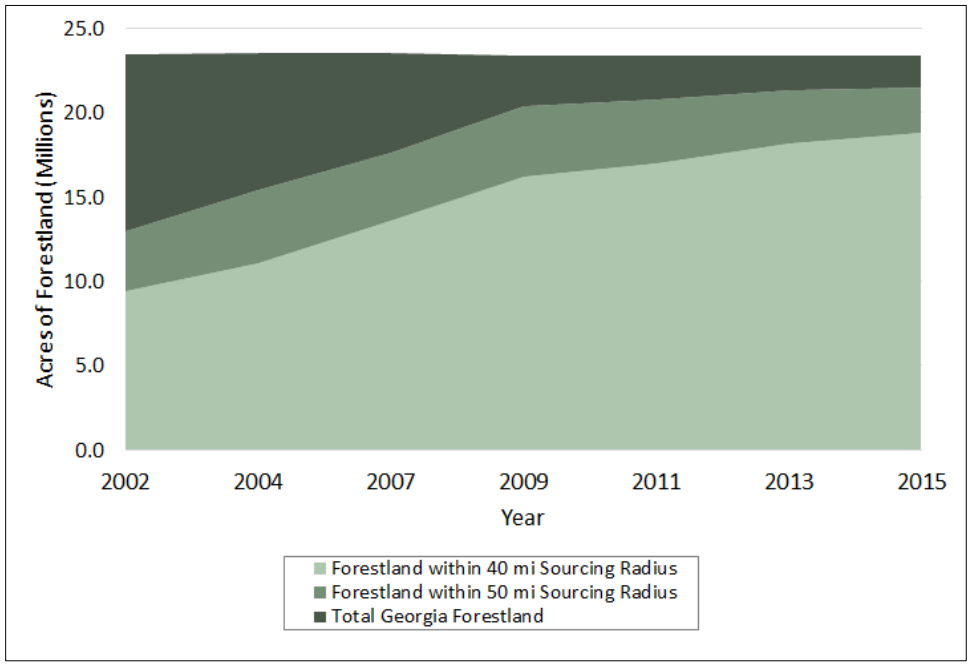

Figure 3.3: Total forestland in Georgia affected by the SFI Fiber Sourcing Standard prior to 2015.

The percent of survey sites that fell within the 40-mile sourcing radius of an SFI certified mill rose from 45% in 2002 to 87% in 2015 (Table 3.2). Similarly, the percent of survey sites that fell within the 50-mile sourcing radius of an SFI certified mill rose from 62% in 2002 to 95% in 2015. This is attributable to the increasing number of wood mills (7 prior to 2002 to 28 prior to 2015) certified to the SFI Fiber Sourcing Standard in Georgia.

Table 3.2: Survey site count by year for 40- and 50-mile sourcing radii.
Yes: Within the fiber sourcing radius of at least one wood consuming mill certified to SFI Fiber Sourcing Standard.
No: Outside of the sourcing radius.
Percentage of total mills in each category for each year in parentheses.

Survey Year	# Survey Sites	Within 40-mile Sourcing Radius Buffer		Within 50-mile Sourcing Radius Buffer	
		Yes	No	Yes	No
2002	314	142 (45%)	172 (55%)	195 (62%)	119 (38%)
2004	312	184 (59%)	128 (41%)	245 (79%)	67 (21%)
2007	334	211 (63%)	123 (37%)	269 (81%)	64 (19%)
2009	211	155 (73%)	56 (27%)	191 (91%)	20 (9%)
2011	182	136 (75%)	46 (25%)	172 (95%)	10 (5%)
2013	184	146 (79%)	38 (21%)	170 (92%)	14 (8%)
2015	187	162 (87%)	25 (13%)	178 (95%)	9 (5%)

The distribution of BMP implementation rates was not normal, so we used the non-parametric Wilcoxon signed-rank test to compare the mean implementation rates of survey sites within the sourcing radius of at least one certified mill versus outside of the sourcing radius of any certified mills. For a 40-mile sourcing radius, the mean implementation rate (92.3%) for survey sites located within the sourcing radius was statistically significantly different from the mean implementation rate (90.9%) for those survey sites located outside the sourcing radius [Z = -2.54, p-value = 0.012] at a 95% confidence level (Figure 3.4). For a 50-mile sourcing radius, we found a similar result where the mean implementation rate (92.1%) for survey sites located within the sourcing radius was statistically significantly different from the mean implementation rate (90.5%) for those survey sites located outside the sourcing radius [Z = -2.62, p-value = 0.009] at the 95% confidence level (Figure 3.5). For a sourcing radius of 40-miles, the total number of overlapping wood baskets on survey sites increased from 45.2% to 86.6% over the period of 2002 to 2015 (Table 3.2). The same case was observed with the 50-mile sourcing radius (Appendix B). Again, this could be attributed to the growing number of mills certified to the SFI Fiber Sourcing Standard in Georgia.

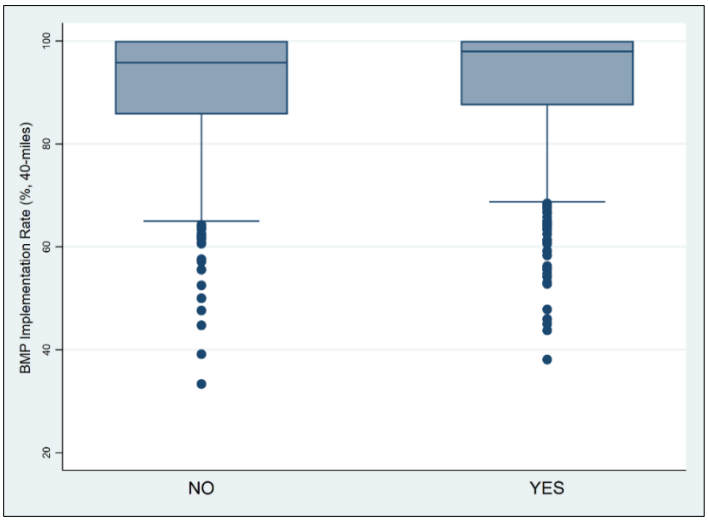

Figure 3.4: BMP implementation rates on survey sites located inside and outside of a 40-mile sourcing radius.
Yes: Within the fiber sourcing radius of at least one wood consuming mill certified to SFI Fiber Sourcing Standard.
No: Outside of the sourcing radius.

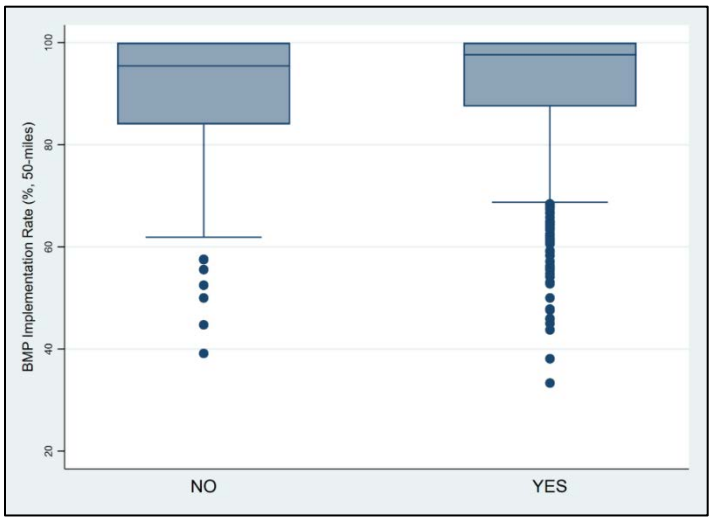

Figure 3.5: BMP implementation rates on survey sites located inside and outside of a 50-mile sourcing radius.
Yes: Within the fiber sourcing radius of at least one wood consuming mill certified to SFI Fiber Sourcing Standard.
No: Outside of the sourcing radius.

We used the Kruskal-Wallis test to compare the mean BMP implementation rates at survey sites across the different numbers of overlapping wood baskets at a 40-mile radius (Table 3.3) and a 50-mile radius (Appendix B). For a 40-mile sourcing radius, the test indicated that the mean BMP implementation rate across numbers of overlapping wood baskets statistically differs at the 95% confidence level [p-value = 0.0367]. Similarly, for a 50-mile sourcing radius, the test indicated that the mean BMP implementation rate across the number of overlapping wood baskets statistically differs at the 95% confidence level [p-value = 0.0206].

Table 3.3: Count of survey sites by year and number of overlapping wood baskets.
Average BMP implementation rates are reported in parenthesis.

Survey Year	0 Overlaps	1 Overlap	2 Overlaps	3 Overlap	4 Overlaps	5 Overlaps	Total Overlaps
2002	172 (85.5%)	120 (86.6%)	17 (93.1%)	5 (85.3%)			314 (66.4%)
2004	128 (90.4%)	160 (91.9%)	20 (90.0%)	4 (89.5%)			312 (91.1%)
2007	123 (94.6%)	152 (93.6%)	51 (90.1%)	7 (94.0%)			333 (93.4%)
2009	56 (95.6%)	73 (95.7%)	39 (92.7%)	32 (94.5%)	10 (93.6%)	1 (100.0%)	211 (94.9%)
2011	46 (97.1%)	54 (95.3%)	45 (95.0%)	26 (96.9%)	11 (96.1%)		182 (96.0%)
2013	38 (93.1%)	61 (90.2%)	47 (91.0%)	23 (93.4%)	14 (91.3%)	1 (89.7%)	184 (91.5%)
2015	25 (87.7%)	42 (93.2%)	60 (93.6%)	35 (91.4%)	13 (97.4%)	12 (92.0%)	187 (92.4%)
Total	588 (90.9%)	662 (92.0%)	279 (92.3%)	132 (93.4%)	48 (94.5%)	14 (92.4%)	1723 (91.9%)

In the Tobit regression model, we included additional variables (Table 3.4) to determine their effects on the BMP implementation rate of a survey site. The selected variables were obtained

from the GFC's Silvicultural BMP Implementation and Compliance Surveys. These surveys do not collect information on roundwood prices, logging crew training status, and final roundwood destination. As a result, we were unable to incorporate these variables into the developed regression model.

Table 3.4: Details of independent variables for Tobit regression models.
The data is summarized for all the survey years. The sign (*) shows the reference category within a given variable.

Variables	Variable Type	Harvested Sites (#)	Mean BMP Implementation Rate
Ownership			
Non-Industrial Private Forest landowner	Dummy	1179	90.4%
Public*	Dummy	104	94.9%
Corporate/Forest Industry	Dummy	440	95.1%
Physiographic Region			
Lower Coastal Plain	Dummy	643	92.8%
Mountains*	Dummy	126	91.2%
Piedmont	Dummy	585	90.7%
Ridge and Valley	Dummy	20	92.0%
Upper Coastal Plain	Dummy	349	92.3%
Terrain			
Flat*	Dummy	712	93.7%
Rolling	Dummy	953	90.5%
Steep	Dummy	58	91.9%
Slope			
Slight*	Dummy	1134	92.6%
Moderate	Dummy	459	90.3%
Severe	Dummy	130	90.8%
Overlapping Wood Baskets @ 40-Miles			
0*	Dummy	588	90.9%
1	Dummy	662	92.0%
2	Dummy	279	92.3%
3	Dummy	132	93.4%
>=3	Dummy	62	94.0%
Overlapping Wood Baskets @ 50-Miles			
0*	Dummy	303	90.5%
1	Dummy	703	91.6%
2	Dummy	340	92.5%
3	Dummy	189	92.7%
>=3	Dummy	188	92.9%

The results for a 40-mile sourcing radius (Table 3.5) suggest that the expected BMP implementation rate would be lower by 8.3% on survey sites located on non-industrial family forestlands relative to survey sites on public forestlands. Similarly, the expected BMP implementation rate would be lower by 7.0% and 8.8% on survey sites with rolling and steep terrain relative to flat survey sites, respectively. The number of overlapping wood baskets had a positive effect on the dependent variable (implementation rate), as the expected BMP

implementation rate goes up with rising numbers of overlapping wood baskets relative to the case when a survey site does not fall under the wood basket of any mills certified to the SFI Fiber Sourcing Standard. For example, the expected BMP implementation rate was higher by 7.5% on survey sites having four or more overlapping wood baskets than survey sites which had zero overlapping wood baskets. We found similar results for a 50-mile sourcing radius (Appendix C). For a 40-mile sourcing radius, the average marginal effect analysis suggests the BMP implementation rate is higher by 3.8% for a survey site located within the wood baskets of four or more wood consuming mills certified to the SFI Fiber Sourcing Standard than a survey site not located within the wood basket of any mill certified to the same. Similar results were obtained for a 50-mile sourcing radius (Table 3.6).

Table 3.5: Tobit regression model for assuming a 40-mile sourcing radius.

Variables	Coefficient	Standard Error	T	P>|t|	[95% Conf. Interval]	
Ownership_NIPF	-8.274	1.061	-7.800	0.000	-10.356	-6.193
Terrain_Rolling	-7.006	1.008	-6.950	0.000	-8.983	-5.028
Terain_Steep	-8.802	2.613	-3.370	0.001	-13.928	-3.676
Number of Overlaps						
1	3.101	1.125	2.760	0.006	0.895	5.308
2	3.278	1.436	2.280	0.023	0.462	6.094
3	5.183	1.967	2.640	0.008	1.325	9.042
> 3	7.541	2.754	2.740	0.006	2.140	12.943
Constant	106.164	1.262	84.130	0.000	103.688	108.639
var(e.Implementation Rate)	321.398	16.657			290.333	355.786

Number of observations 1723, Uncensored 907, Left-censored 0, Right censored 816
LR 122.95, prob > $\chi 2$ 0.000, Pseudo R2 0.0136

Table 3.6: Average marginal effect of numbers of overlapping wood baskets of wood consuming mills certified to the SFI Fiber Sourcing Standard on the probability of BMP implementation rate.

Number of Overlaps	Coefficient	Standard Error	T	P>|t|	[95% Conf. interval]	
40-mile Sourcing Radius						
1	1.693	0.616	2.750	0.006	0.486	2.899
2	1.783	0.764	2.330	0.020	0.286	3.280
3	2.714	0.961	2.820	0.005	0.831	4.597
> 3	3.759	1.197	3.140	0.002	1.414	6.105
50-mile Sourcing Radius						
1	2.518	0.802	3.140	0.002	0.946	4.090
2	3.114	0.880	3.540	0.000	1.391	4.838
3	3.322	1.001	3.320	0.001	1.360	5.283
> 3	3.398	1.000	3.400	0.001	1.437	5.358

Note: Changes in factor levels is the discrete change from the base level.

We also estimated the average marginal effect of sites located or not located within a sourcing radius of 40-mile and 50-mile on the implementation rate of BMPs. We found that the BMP implementation rate is higher by 1.94% for a survey site located within the 40-mile sourcing radius of wood-consuming mills certified to the SFI Fiber Sourcing Standard than a survey site not located within the wood basket of any mill certified to the same standards for the same sourcing radius. The same effect for a 50-mile sourcing radius was about 2.89%.

Discussions and Conclusion

Most discourse about the sustainability of forestland revolves around total acreage under sustainable forestry management certification. It is typically assumed that certified forestland is the hallmark of sustainable forestry. Though we do not necessarily disagree with this argument, we do believe that this line of reasoning has led to a general perception that non-certified forestlands are not sustainably managed. In this regard, the role of the SFI Fiber Sourcing Standard becomes critical as this standard is helpful in promoting sustainable forestry practices on non-certified forestlands, typically owned by families who do not have sufficient financial and technical resources to go through the formal process of certifying their forestlands. Through the SFI Fiber Sourcing Standard, a family forest landowner can access the market, a wood mill can source sufficient wood from nearby forestlands, and most importantly, the sustainability of forest resources can be ensured without any, or very little, financial burden on a forest landowner. However, very little information is available about the influence of the SFI Fiber Sourcing Standard at a landscape level over space and time. For instance, there was no evidence linking the SFI Fiber Sourcing Standard with forestry BMP implementation rates in the United States. Therefore, we developed this case study in the context of Georgia to answer critical questions for ensuring sustainable management of forestry resources in Georgia and beyond.

Our results clearly demonstrate that, with respect to time, the total land (and forestland) affected by the SFI Fiber Sourcing Standard has gone up considerably in Georgia. This can be attributed to the rising number of wood consuming mills certified to the SFI Fiber Sourcing Standard in Georgia. We also found that total land (and forestland) affected by the SFI Fiber Sourcing Standard is uniformly distributed across the state. This could be attributed to the fact that forestland in Georgia is well distributed across the state, and therefore, wood consuming mills certified to the SFI Fiber Sourcing Standard are also well dispersed.

Our results indicate that the average BMP implementation rate is higher on survey sites located within the wood baskets of mills certified to the SFI Fiber Sourcing Standard versus survey sites located outside of the wood baskets of certified mills. This could be easily attributed to the fact that a mill certified to the SFI Fiber Sourcing Standard could discontinue roundwood sourcing from a logger who does not follow BMPs. Additionally, the BMP implementation rate is closely monitored not only by the third-party auditors at the time of inspection, but also by mill foresters. In the case of any non-compliance, suitable remediation measures are taken. Therefore, our results are supportive of anecdotal evidence and existing perceptions among forestry stakeholder groups about how the SFI Fiber Sourcing Standard has helped increase forestry BMP implementation rates in Georgia.

The overall BMP compliance rate of survey sites within the wood baskets of mills certified to the SFI Fiber Sourcing Standard was higher by about 2% relative to surveyed sites located outside of the wood basket of non-certified mills at a 40-mile sourcing radius. This low percentage difference can be explained by two major factors. First, we did not include GFC's survey data for 1991, 1992, and 1998 in this analysis because of missing data (1991 and 1992) and comparability issues (1998). There were no mills in Georgia certified to the SFI Fiber Sourcing Standard until

the late 1990s and the average BMP implementation rate in the state was less than 80% prior to the 2000s. The three missing survey years (1991, 1992, 1998) would have provided pre- and post-certification perspectives as well as covered a period during which the most dramatic implementation rate increases were occurring. Second, Georgia started tracking BMP implementation rates in the early 1990s which itself could have had promoted higher BMP compliance rates prior to the introduction of the SFI Fiber Sourcing Standard. Therefore, our observed difference of 2% since 2002 between survey sites located within and outside of a 40-mile sourcing radius of mills certified to the SFI Fiber Sourcing Standards is reasonable. This difference is clear evidence in support of the influence that primary wood-using mills certified to the SFI Fiber Sourcing standard have had on increasing BMP implementation rates within their wood baskets, particularly because the mills that have been certified are among the largest in the state of Georgia.

We acknowledge that a high rate of forestry BMP implementation is not the absolute, but only a robust, indicator of forest sustainability. More research is needed in identifying similar measurable indicators to ascertain the influence of the SFI Fiber Sourcing Standard in ensuring sustainable forest management. Since the SFI Fiber Sourcing Standard requires the use of loggers trained in forestry BMPs and provides for such training, the extensive footprint of fiber sourcing is likely to have resulted in generally greater utilization of trained loggers across the state. In this study, we have only focused on mills certified to the SFI Fiber Sourcing Standard and located within Georgia. In the future, it would be beneficial to take a region-wide approach to further explore the efficacy of the SFI Fiber Sourcing Standard in increasing forestry BMP implementation rates. Additionally, further research should consider the perceptions of various stakeholder groups about forestry BMPs to identify any potential conflicts. This information could

further feed into policy making and updating of SFI standards, thereby ensuring the long-term sustainability of forest resources in Georgia and beyond.

We expect that our results will bring much-needed clarity about the role of the SFI Fiber Sourcing Standard in increasing BMP implementation rates in Georgia. We believe that our results will also help other southern states sharing similar forest landownership patterns, forest policy landscapes, and roundwood market conditions. We also hope that our results will be helpful to other forested regions in the United States and Canada where the SFI Fiber Sourcing Standard is prevalent.

CHAPTER 4

CONCLUSION

The degree to which forestry best management practices (BMPs) are followed is a useful quantitative indicator for assessing the overall sustainability of forest resources. Georgia has experienced a dramatic increase in implementation rates over the past three decades, but our understanding about the drivers of this increase had not previously been explored. BMPs are clearly established as having a positive impact on water quality, but as a non-regulatory, voluntary policy Georgia, the support of forestry stakeholders who implement them is necessary for on the ground success. However, perceptions of forestry stakeholders about BMPs were not fully understood. In addition, the Sustainable Forestry Initiative (SFI) Fiber Sourcing Standard had been anecdotally discussed as a factor influencing increased BMP compliance, but no study existed to establish this quantitatively. The research outlined in this thesis addressed these research gaps, contributing to our understanding of BMPs and the SFI Fiber Sourcing Standard in Georgia.

Using SWOT-AHP analysis, we determined that perceptions about forestry BMPs vary noticeably between Georgia forestry stakeholder groups. In general, loggers place most importance on economic factors, while landowners prioritize education and intrinsic benefits of forests. Agency stakeholders tend to hold similar priorities as landowners but share some priority factors with loggers as well. While all stakeholder groups had a generally positive perspective about forestry BMPs and recognized that they contribute to forest based-benefits, landowner and agency stakeholder groups reported sustainable forestry as a top five factor while the logger stakeholder group gave this factor a low rank. The highest ranked positive factor for loggers was that following

BMPs have improved the reputation of the logging community. All three groups gave high priority to the need for more education and training. Landowner education was important across the board, but the logger stakeholder group was also concerned about technical on the job training for new personnel. Cost sharing concerns and economic incentives were also important to the logger group.

These results were unsurprising given the narrow profit margins of for loggers in the U.S. south. It is also commonly known that landowners generally value forest stewardship, but they are largely unware about BMPs and how they can help them realize their desire to manage their forests sustainably. Georgia Forestry Commission BMP Foresters (agency stakeholder group) work with loggers and landowners to educate and promote correct BMP implementation practices and therefore prioritize factors that are important to both groups. Our findings identified a desire for more education and educational programs that better fit the needs of stakeholders. Having a platform for stakeholders to discuss their needs and concerns could help identify the best ways to go about this and facilitate future improvements to BMP policy in Georgia.

Because protecting water quality is such an important aspect of sustainable forest management, the SFI mandates compliance with BMPs in their Fiber Sourcing Standard. Over the years, participation in the Fiber Sourcing Standard has increased in pace with rising implementation rates of BMPs in Georgia, but no evidence previously existed to link the two together. Through our analysis, we found that the percentage of forestland within a 40-mile sourcing radius of SFI Fiber Sourcing Standard certified primary wood-using mills nearly doubled from 2002 to cover over 80% of forestland in Georgia in 2015. This increase was the result of an increasing number of mills evenly distributed across the state adopting the SFI Fiber Sourcing Standard. Over the same period, BMP implementation rates increased from 85.9% to 91.1%. We also found that the average BMP implementation rates on surveyed harvest sites within a 40-mile

roundwood sourcing radius of an SFI certified primary wood-using mill was about 2% higher than sites outside of this radius. Similar patterns are observable for a 50-mile sourcing radius. These results support the notion that the SFI Fiber Sourcing Standard has had a measurable impact on the increase in BMP implementation rates in Georgia.

Replication of these studies in other areas of the country would be helpful in broadening our understanding of the trends in stakeholder perception and SFI's influence on forestry BMPs. In addition, continuing these projects in Georgia will be helpful for understanding stakeholder perceptions related to BMP compliance, particularly as BMP policies and SFI standards are updated over time.

REFERENCES

Anderson, C.J., Lockaby, B.G., 2011. The effectiveness of forestry best management practices for sediment control in the southeastern United States: A literature review. South. J. Appl. For. 35, 170–177. https://doi.org/10.1093/sjaf/35.4.170

ATFS (American Tree Farm System), 2018. The history of the American Tree Farm System [WWW Document]. URL https://www.treefarmsystem.org/the-history-of-the-american-tree-farm-system

Auld, G., 2014. Constructing private governance: The rise and evolution of forest, coffee, and fisheries certification, Yale Agrarian Studies Series. Yale University Press, New Haven.

Aust, W.M., Blinn, C.R., 2004. Forestry best management practices for timber harvesting and site preparation in the eastern United States: An overview of water quality and productivity research during the past 20 years (1982-2002). Water, Air, Soil Pollut. Focus 4, 5–36. https://doi.org/10.1023/B:WAFO.0000012828.33069.f6

Bartley, T., 2003. Certifying forests and factories: States, social movements, and the rise of private regulation in the apparel and forest products fields. Polit. Soc. 31, 433–464. https://doi.org/10.1177/0032329203254863

Blinn, C.R., Alden, A.-M., Ellefson, P. V, 2001. Timber harvester perceptions of costs and benefits from applying water quality BMPs in north-central USA. J. For. Eng. 12, 39–51. https://doi.org/10.1080/08435243.2001.10702761

Butler, B.J., Hewes, J.H., Butler, S.M., Lindsay, M., Kittredge, D.B., 2015. The new face of America's family forest owners: Results from the 2011-2013 USDA Forest Service,

national woodland owner survey, in: Pushing Boundaries: New Directions in Inventory Techniques and Applications: Forest Inventory and Analysis (FIA) Symposium 2015, General Technical Report PNW-GTR-931. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, p. 290.

Butler, B.J., Leatherberry, E.C., 2004. America's family forest owners. J. For. 102, 4–14.

Carter, M.C., Kellison, R.C., Wallinger, R.S., 2015. Forestry in the U.S. south: A history, 1st ed. Louisiana State University Press, Baton Rouge.

Cashore, B.W., Newsom, D., Auld, G., 2004. Governing through markets: Forest certification and the emergence of non-state authority. Yale University Press, New Haven.

Cristan, R., Aust, W.M., Bolding, M.C., Barrett, S.M., Munsell, J.F., Carolina, N., Carolina, S., 2016a. Status of state forestry best management practices for the southeastern United States, in: Proceedings of the 18th Biennial Southern Silvicultural Research Conference, E-General Technical Report SRS-212. U.S. Department of Agriculture Forest Service, Southern Research Station, Ashville, p. 614.

Cristan, R., Aust, W.M., Bolding, M.C., Barrett, S.M., Munsell, J.F., Schilling, E., 2016b. Effectiveness of forestry best management practices in the United States: Literature review. For. Ecol. Manage. 360, 133–151. https://doi.org/10.1016/j.foreco.2015.10.025

Cubbage, F.W., 2004. Costs of forestry best management practices in the South: A review. Water, Air, Soil Pollut. Focus 4, 131–142. https://doi.org/10.1023/B:WAFO.0000012822.20500.ae

Dwivedi, P., Alavalapati, J.R.R., 2009. Economic feasibility of electricity production from energy plantations present on community-managed forestlands in Madhya Pradesh, India. Energy Policy 37, 352–360. https://doi.org/10.1016/j.enpol.2008.08.024

Dwivedi, P., Jagadish, A., Schelhas, J., 2016. Perceptions of stakeholder groups about the participation of African American family forest landowners in federal landowner assistance programs. J. For. 114, 89–96. https://doi.org/10.5849/jof.14-152

Ebeling, J., Yasué, M., 2009. The effectiveness of market-based conservation in the tropics: Forest certification in Ecuador and Bolivia. J. Environ. Manage. 90, 1145–1153. https://doi.org/10.1016/j.jenvman.2008.05.003

Ellefson, P. V., Kilgore, M.A., Phillips, M.J., 2001. Monitoring compliance with BMPs: The experience of state forestry agencies. J. For. 99, 11–17. https://doi.org/10.1093/jof/99.1.11

FSC (Forest Stewardship Council), 2017. FSC facts & figures: December 2017. FSC International, Global Development, Bonn.

Germain, R., Bick, S., Kelly, M., Benjamin, J., Farrand, W., 2016. Case study of three high-performing contract loggers with distinct harvest systems: Are they thriving, striving, or just surviving? For. Prod. J. 66, 97–105. https://doi.org/10.13073/FPJ-D-15-00010

GFC (Georgia Forestry Commission), 2017. Georgia wood-using industries directory 2017 [WWW Document]. URL http://www.gfc.state.ga.us/resources/directories/wood-using-industries/

GFC (Georgia Forestry Commission), 2015. Results of Georgia's 2015 silvicultural best management practices implementation and compliance survey. Water Quality Program, Georgia Forestry Commission, Macon.

GFC (Georgia Forestry Commission), 2009. Georgia's best management practices for forestry. Macon.

Ghazinoory, S., Abdi, M., Azadegan-Mehr, M., 2011. SWOT methodology: A state-of-the-art review for the past, a framework for the future. J. Bus. Econ. Manag. 12, 24–48.

https://doi.org/10.3846/16111699.2011.555358

Grace, J.I., 2005. Forest operations and water quality in the South. Trans. ASAE 48, 871–880. https://doi.org/10.13031/2013.18295

Gulbrandsen, L.H., 2004. Overlapping public and private governance: Can forest certification fill the gaps in the global forest regime? Glob. Environ. Polit. 4, 75–99. https://doi.org/10.1162/152638004323074200

Howe, J., Bowyer, J.L., Guillery, P., Fernholz, K., 2005. Chain-of-custody certification: What is it, why do it, and how? Dovetail Partners, Inc.

Husak, A.L., Grado, S.C., Bullard, S.H., 2004. Perceived values of benefits from Mississippi's forestry best management practices. Water, Air, Soil Pollut. Focus 4, 171–185. https://doi.org/10.1023/B:WAFO.0000012820.88013.88

Ice, G.G., Schilling, E., Vowell, J., 2010. Trends for forestry best management practices implementation. J. For. 108, 267–273. https://doi.org/10.1093/jof/108.6.267

Jackson, C.R., 2014. Forestry best management practices: A mitigated water pollution success story. J. For. 112, 47–49. https://doi.org/10.5849/jof.JF-12-898

Knoot, T.G., Rickenbach, M., 2011. Best management practices and timber harvesting: The role of social networks in shaping landowner decisions. Scand. J. For. Res. 26, 171–182. https://doi.org/10.1080/02827581.2010.545827

Kukrety, S., Dwivedi, P., Jose, S., Alavalapati, J.R.R., 2013. Stakeholders' perceptions on developing sustainable Red Sanders (Pterocarpus santalinus L.) wood trade in Andhra Pradesh, India. For. Policy Econ. 26, 43–53. https://doi.org/10.1016/j.forpol.2012.08.014

Kurttila, M., Pesonen, M., Kangas, J., Kajanus, M., 2000. Utilizing the analytic hierarchy process (AHP) in SWOT analysis—A hybrid method and its application to a forest-certification

case. For. Policy Econ. 1, 41–52. https://doi.org/10.1016/S1389-9341(99)00004-0

Ma, Z., Butler, B.J., Kittredge, D.B., Catanzaro, P., 2012. Factors associated with landowner involvement in forest conservation programs in the U.S.: Implications for policy design and outreach. Land use policy 29, 53–61. https://doi.org/10.1016/j.landusepol.2011.05.004

Maker, N.F., Germain, R.H., Anderson, N.M., 2014. Working woods: A case study of sustainable forest management on Vermont family forests. J. For. 112, 371–380. https://doi.org/10.5849/jof.13-003

Mawapanga, M.N., Debertin, D.L., 1996. Choosing between alternative farming systems: An application of the analytic hierarchy process. Rev. Agric. Econ. 18, 385–401. https://doi.org/10.2307/1349623

McGill, D.W., Pierskalla, C.D., Jennings, B.M., Grushecky, S.T., Lilly, D., 2006. Landowner satisfaction with timber harvesting on West Virginia forest stewardship program properties. North. J. Appl. For. 23, 6–10. https://doi.org/10.1093/njaf/23.1.6

Measells, M.K., Grado, S.C., Hughes, H.G., Dunn, M.A., Idassi, J.O., Zielinske, R.J., 2006. Educational needs of southern forest landowners. J. Ext. 44.

Munsell, J.F., Germain, R., Bevilacqua, E., Schuster, R.M., 2006. Voluntary best management practice implementation by nonindustrial private forestland owners in New York City's water supply system. North. J. Appl. For. 23, 133–140.

Newsom, D., Bahn, V., Cashore, B., 2005. Does forest certification matter? An analysis of operation-level changes required during the SmartWood certification process in the United States. For. Policy Econ. 9, 197–208. https://doi.org/10.1016/j.forpol.2005.06.007

Oswalt, S.N., Smith, W.B., Miles, P.D., Pugh, S.A., Brad, W., Smith, W.B., Miles, P.D., Pugh, S.A., 2014. Forest resources of the United States, 2012: A technical document supporting

the Forest Service update of the 2010 RPA Assessment, General Technical Report WO-91, General Technical Report WO-91. U.S. Department of Agriculture, Forest Service, Washington Office, Washington, DC.

Owari, T., Juslin, H., Rummukainen, A., Yoshimura, T., 2006. Strategies, functions and benefits of forest certification in wood products marketing: Perspectives of Finnish suppliers. For. Policy Econ. 9, 380–391. https://doi.org/10.1016/j.forpol.2005.10.005

PEFC (Programme for the Endorsement of Forest Certification), 2017. PEFC global statistics: SFM & CoC certification - December 2017 [WWW Document]. URL https://www.pefc.org/about-pefc/who-we-are/facts-a-figures

PEFC (Programme for the Endorsement of Forest Certification), 2016. PEFC annual review 2016 [WWW Document]. URL https://www.pefc.org/resources/brochures/organizational-documents/2361-pefc-annual-review-2016-highlighting-the-achievements-of-the-pefc-alliance

PEFC (Programme for the Endorsement of Forest Certification), 2011. PEFC and FSC: Global sustainable forest management certification schemes [WWW Document]. URL https://www.scribd.com/document/28666212/PEFC-and-FSC-Global-Sustainable-Forest-Management-Certification-Schemes

PEFC (Programme for the Endorsement of Forest Certification), FSC (Forest Stewardship Council), 2018. Double certification continues to grow, joint PEFC/FSC data shows [WWW Document]. URL https://www.pefc.org/news-a-media/general-sfm-news/2494-double-certification-continues-to-grow-joint-pefc-fsc-data-shows

Perera, P., Vlosky, R.P., 2006. A history of forest certification, Working paper #71. Louisiana Forest Products Development Center, School of Renewable Natural Resources, Louisiana

State University Agricultural Center, Baton Rouge.

Phillips, M.J., 1992. Impact of the Clean Water Act on state forestry programs to control nonpoint source pollution. J. Contemp. Water Res. Educ. 88, 34–42.

Phillips, M.J., Blinn, C.R., 2007. Practices evaluated and approaches used to select sites for monotoring the application of best management practices: A regional summary. J. For. 105, 179–183.

Phillips, M.J., Blinn, C.R., 2004. Best management practices compliance monitoring approaches for forestry in the eastern United States. Water, Air, Soil Pollut. Focus 4, 263–274. https://doi.org/10.1023/B:WAFO.0000012814.22698.ef

Provencher, M.A., McGill, D.W., Grushecky, S.T., 2007. Timber harvesting characteristics on Forest Stewardship properties and non-Forest Stewardship properties in central West Virginia. North. J. Appl. For. 24, 265–270.

Rametsteiner, E., 2002. The role of governments in forest certification—A normative analysis based on new institutional economics theories. For. Policy Econ. 4, 163–173. https://doi.org/10.1016/S1389-9341(02)00004-7

Ramirez, S., Dwivedi, P., Bailis, R., Ghilardi, A., 2012. Perceptions of stakeholders about nontraditional cookstoves in Honduras. Environ. Res. Lett. 7, 44036. https://doi.org/10.1088/1748-9326/7/4/044036

Saaty, T.L., 1993. The analytic hierarchy process: A 1993 overview. Cent. Eur. J. Oper. Res. Econ. 2, 119–137.

Saaty, T.L., 1977. A scaling method for priorities in hierarchical structures. J. Math. Psychol. 15, 234–281. https://doi.org/10.1016/0022-2496(77)90033-5

Saaty, T.L., Vargas, L.G., 2012. Models, methods, concepts & applications of the analytic

hierarchy process, 2nd ed, International Series in Operations Research & Management Science. Springer US, New York. https://doi.org/10.1007/978-1-4614-3597-6

SFI (Sustainable Forestry Initiative), 2015. SFI 2015-2019 fiber sourcing standard [WWW Document]. URL https://www.sfiprogram.org/sfi-standards/

Shaffer, R.M., Haney Jr., H.L., Worrell, E.G., Aust, W.M., 1998. Forestry BMP implementation costs for Virginia. For. Prod. J. 48, 27–29.

Shaffer, R.M., Meade, G.S., 1997. Evaluation of harvest planning training. For. Prod. J. 47, 69–71.

Shrestha, R.K., Alavalapati, J.R.R., Kalmbacher, R.S., 2004. Exploring the potential for silvopasture adoption in south-central Florida: An application of SWOT-AHP method. Agric. Syst. 81, 185–199. https://doi.org/10.1016/j.agsy.2003.09.004

Southern Group of State Foresters, 2017. Primary Forest Products Network [WWW Document]. URL http://primary.forestproductslocator.org

Sun, C., 2006. Welfare effects of forestry best management practices in the United States. Can. J. For. Res. 36, 1674–1683. https://doi.org/10.1139/x06-052

TimberMart-South, 2017. Logging rates report. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA.

Tobin, J., 1958. Estimation of relationships for limited dependent variables. Econometrica 26, 24. https://doi.org/10.2307/1907382

U.S. EPA (United States Environmental Protection Agency), 2016. Decision not to regulate forest road discharges under the Clean Water Act; Notice of decision. Fed. Regist. 81, 43492–43510.

U.S. EPA (United States Environmental Protection Agency), 2000. National water quality

inventory report to Congress, EPA-841-R-02-001. United States Environmental Protection Agency, Office of Water, Washington, DC.

Vanbrakle, J.D., Germain, H., Munsell, J.F., Stehman, S. V., 2013. Do forest management plans increase best management practices implementation on family forests? A formative evaluation in the New York city watershed. J. For. 111, 108–114. https://doi.org/10.5849/jof.12-034

APPENDIX A

EXPLANATIONS OF FACTORS UNDER THE SWOT CATEGORIES

Strengths

Promotes Sustainable Forestry

BMPs protect water quality, prevent soil erosion, and support biodiversity.

Maintains/Increases Access to Markets

Following BMPs is a contractual requirement for doing business with many mills.

Promotes a Culture of Safety

Following BMPs helps in promoting the safety of logging employees.

Improves Reputation of Logging Community

By following BMPs, the public's perception of the logging community is improved.

Weaknesses

Lack of Landowner Education

Some landowners may have limited knowledge about the relevance of BMPs which can result in conflicting forest management and harvesting goals.

No Economic Incentives

The cost of BMP implementation is not recognized by the market or regulatory agencies.

Lack of Trained Personnel

Newer logging employees are not receiving thorough hands-on training.

Inconsistent Interpretation of BMP Guidelines

BMP guidelines can be interpreted in different ways which lead to conflicts between stakeholder groups.

Opportunities

Improved Training and Educational Opportunities

Training opportunities for loggers should include hands-on/field training. Additional educational opportunities for forestry workers, regulators, and enforcement officials could improve consistency in interpretation of BMP guidelines.

Better Interagency Coordination

Coordination between local and state agencies could be improved to better report, monitor, and coordinate compliance related issues especially with tightening state budget.

Maintenance of Forest-Based Environmental Benefits

BMPs help in maintaining environmental benefits (e.g., soil conservation, biodiversity, water quality, air quality, wood supply) which improve the overall well-being of people across regions.

Threats

More Regulations and Restrictions

More regulations and restrictions could place extra burdens and costs on stakeholders.

Insufficient Accounting of Cost Sharing

It is unclear exactly how much of the cost of implementing BMPs is shared amongst players in the forest products supply chain. Inequity can lead to discontent within groups who feel they are paying more than their fair share.

Increasing Urban Populations

Increasing urban populations with little or no exposure to working forests and BMPs could lead to less representation of forestry interests in the legislative process.

APPENDIX B

COUNT OF HARVESTED SITES BY YEAR AND TOTAL NUMBER OF OVERLAPPING WOOD BASKETS ASSUMING A 50-MILE SOURCING RADIUS OF EACH WOOD CONSUMING MILL CERTIFIED TO THE FIBER SOURCING STANDARD IN GEORGIA

Survey Year	Overlaps # 0	Overlaps # 1	Overlaps # 2	Overlaps # 3	Overlaps # 4	Overlaps # ≥ 5	Total Overlaps
2002	119 (86.3%)	149 (85.6%)	35 (88.9%)	11 (89.1%)			314 (86.3%)
2004	67 (91.3%)	194 (90.9%)	34 (91.2%)	17 (92.8%)			312 (91.1%)
2007	64 (95.2%)	155 (94.1%)	81 (92.4%)	24 (88.6%)	9 (92.2%)		333 (93.4%)
2009	20 (94.1%)	75 (95.9%)	46 (95.0%)	38 (92.7%)	20 (94.7%)	12 (95.9%)	211 (94.8%)
2011	10 (96.2%)	50 (96.8%)	50 (96.9%)	37 (96.1%)	20 (91.1%)	15 (95.7%)	182 (95.9%)
2013	14 (92.6%)	44 (92.8%)	56 (90.1%)	27 (92.5%)	28 (90.9%)	15 (91.2%)	184 (91.4%)
2015	9 (90.0%)	36 (92.2%)	38 (91.8%)	35 (93.1%)	25 (95.5%)	44 (91.5%)	187 (92.4%)
Total	303 (90.5%)	703 (91.6%)	340 (92.5%)	189 (92.7%)	102 (92.9%)	86 (92.8%)	1723 (91.8%)

Average forestry BMP implementation rates are reported in parenthesis.

APPENDIX C

TOBIT REGRESSION MODEL FOR DETERMINING THE EFFECTS OF THE NUMBER OF OVERLAPPING WOOD BASKETS ON THE BMP IMPLEMENTATION RATES ALONG WITH OTHER VARIABLES ASSUMING A 50-MILE SOURCING RADIUS

Variables	Coefficient	Standard Error	T	P>|t|	[95% Conf. Interval]	
Ownership_NIPF	-8.300	1.062	-7.820	0.000	-10.383	-6.217
Terrain_Rolling	-7.355	1.021	-7.200	0.000	-9.357	-5.352
Terain_Steep	-9.531	2.622	-3.630	0.000	-14.674	-4.387
Number of Overlaps						
1	4.414	1.364	3.240	0.001	1.739	7.089
2	5.580	1.564	3.570	0.000	2.513	8.646
3	5.999	1.853	3.240	0.001	2.364	9.633
> 3	6.154	1.863	3.300	0.001	2.500	9.808
Constant	104.563	1.433	72.990	0.000	101.753	107.372
var(e.Implementation Rate)	321.005	16.636			289.980	355.349

Number of observations 1723, Uncensored 907, Left-censored 0, Right censored 816

LR 122.95, prob > χ^2 0.000, Pseudo R^2 0.0138