

ASSESSING COVERAGE OF FOREST CERTIFICATION IN NATIONAL MEDIA AND
IMPACTS OF FIBER SOURCING STANDARD ON BIODIVERSITY AND FORESTRY
BEST MANAGEMENT PRACTICES IN THE SOUTHERN UNITED STATES

by

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(Under the Direction of PUNEET DWIVEDI)

ABSTRACT

This thesis assesses the position of forest certification in the United States. Understanding the coverage of forest certification by mass media (CH 2) is critically important because mass media shapes public opinion and discourse of certification schemes influences policy decisions, participation in certification schemes, and consumer behavior. Additionally, the impacts of the Sustainable Forestry Initiative Fiber-Sourcing Standard (FSS) on the biodiversity of three states in the North American Coastal Plain, a biodiversity hotspot and global leader in timber production, is also analyzed (CH 3). This research will better position forest certification as a tool for forest conservation in the United States and hopes to feed into current policy deliberations on the effectiveness of market-based tools in the conservation of natural resources in the United States and beyond.

INDEX WORDS: Sustainability, forestry, ATFS, FSC, SFI, media, biodiversity, Fiber-Sourcing Standard, FSS, coastal plain

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DEDICATION

To my family: my mother, Laurel; my father, Dean; my brother, Matthew; and my grandparents, Suzi, Glenn, and Marie; without whose endless love and support I could never have come half as far. I love you.

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

All goods, from agricultural products to advanced technology, are derived from natural resources (USGS, 2001). Because of our reliance on natural resources for economic prosperity, all economies are embedded within nature and not external to it (Dasgupta, 2021). However, a soaring human population and widespread unsustainable resource use threaten the ability of the environment to provide for current and future generations, and transformative change of our institutions is critical to sustain economic, environmental, and social wellbeing (Dasgupta, 2021). Since its conception in 1993, forest certification has spread to all corners of the globe and can therefore be part of the solution to the environmental degradation that threatens human and environmental prosperity.

Forest certification is a non-state, market-driven approach to sustainability that targets forest resources. It is designed to incentivize economically, environmentally, and socially responsible forest practices (Dwivedi et al., 2018a). It is both transnational and voluntary. Forest certification functions on the principle that consumers are willing to pay a premium for products from well-managed forests, and thereby relies on the free market, rather than state authority, to incentivize sustainable forest practices (Cashore and Van der Ven, 2018). Forestry operations seeking certification (ex. Chain of Custody or Forest Management) must be audited by independent third-party inspectors to verify their operation meets the forest certification scheme's pre-established standards. Groups granted these certifications display an eco-seal on their product packaging,

which communicates the product's responsible production to the consumer (Fig. 1.1). Since its inception, forest certification has become widely recognized and at least 25% of Fortune 500 companies preferentially purchase forest certified goods (SFI, 2021a).



Figure 1.1. Example eco-labels for FSC (left) and SFI (right)

Three major forest certification schemes operated in the United States. The American Tree Farm System (ATFS), founded in 1941, functions on the belief that recognizing good forestry encourages others to practice good forestry (ATFS, 2021). The Forest Stewardship Council (FSC) was founded by a coalition of environmentalists, businesspersons, and community leaders after the U.N. Earth Summit did not produce a deforestation accord (Forest Stewardship Council FSC, 2021). FSC operates in over 130 countries and has certified 221.9 million hectares globally (14.2 million in the United States) (Forest Stewardship Council FSC, 2021). Forestry professionals who agreed with the principle of forest certification but took issue with FSC's approach formed the Sustainable Forestry Initiative (SFI) in 1994 (SFI, 2020a). Unlike FSC, SFI exclusively operates the United States and Canada, where it has certified 147 million hectares (SFI, 2015).

Because 90% of the world's forests are uncertified (SFI, 2020a), the SFI implemented the Fiber-Sourcing Standard (FSS) in 2015 to broaden the reach of sustainable forestry. The FSS is for

businesses that do not own land but acquire forest products directly from forestland. FSS participants must demonstrate that the products in their supply chain are sourced from responsible sources regardless of whether the forest of origin is certified. Primary producers undergo third-party audits for certification and must adhere to a series of Principles, Objectives, Performance Measures, and Indicators designed to extend forestry best management practices, protect biodiversity, improve water quality, and provide outreach to landowners and other industry professionals (SFI, 2015). The FSS is especially important in the southeastern United States because the Southeast is the nation's leading producer of forest products, grossing \$49.5 billion USD in 2016 (Forest2Market, 2019), yet most Southeastern forestlands are family-owned and more likely to be uncertified due to forest certification costs. To compound the region's significance, the Southeast was recently recognized as the 36th biodiversity hotspot (CEPF, 2020).

Existing research on media studies of forest sustainability focused on policy debates (Arvai and Mascarenhas, 2001; Lindahl et al., 2017a; Sadath and Rahman, 2016), and found journalists, rather than scientists or experts, to be chief gatekeepers of information. Existing research on the Fiber Sourcing Standard is limited to one study by Dwivedi (2018a), which found best management practices (BMPs) to be 2% higher in FSS wood baskets. Other studies on BMPs and biodiversity have evaluated BMPs as biodiversity conservation tools for mammals (White et al., 2021), birds (Ritterson et al., 2021), and fishes (Fraker et al., 2020) at the community level, concluding that BMPs may be an effective conservation mechanism.

The goal of this thesis is to assess the position of forest certification in mainstream American media and evaluate the impacts of the FSS on biodiversity in a hotspot of biological diversity. Specifically, it evaluates the salient themes, schemes, tones, and authorships of articles across six regions of the United States to better situate forest certification's standing among the public. An understanding of mass media coverage of forest certification schemes is vital because mass media can shape public opinion and discourse of such schemes and influence related policy decisions, participation in certification schemes, and consumer behavior. It also analyzes the change over time in BMP implementation rates across wood basket overlaps and biodiversity value categories to determine the impact of the FSS on a highly productive, highly biodiverse area. Even though one of the FSS's key objectives is biological diversity conservation, a lack of understanding exists on the impact of FSS on the BMP implementation rate and biodiversity when taken together at a broader landscape level; therefore, it is critical to assess its impact to determine its effectiveness as a conservation tool.

CHAPTER 2: THE PORTRAYAL OF FOREST CERTIFICATION IN NATIONAL AND
STATE NEWSPAPERS OF THE UNITED STATES¹

¹ Karnatz, Caroline, P. Kadam, A. Pfeuffer, and P. Dwivedi. Submitted to *Forest Policy & Economics*

Abstract

Forest certification has emerged as a market-based tool to safeguard the sustainability of the world's forests. Since media can shape public opinion, this study examines media treatment of forest certification in the United States, the world's largest producer and consumer of forest products. This study utilizes 309 print and digital newspaper articles published in the United States between 1989 and 2019 to evaluate which aspects of certification are highlighted, which standards are favored, and how these vary by region. We found that coverage of forest certification is overwhelmingly positive at both the regional (85%) and national (90.7%) levels. Environmental themes are most discussed nationally (48.8%) and regionally (36%), but thematic emphasis differs regionally. Although the Forest Steward Council is the most covered certification scheme at the national level, the Sustainable Forestry Initiative certification scheme prevails in southern media outlets. The focus of articles related to the American Tree Farm System (ATFS) is mostly sociocultural. This was expected as the ATFS focuses on certifying forestlands of family forest landowners in the United States. Our findings suggest newspaper coverage of forest certification is geographically heterogeneous, with regions establishing their preferred themes and schemes. This research will better situate forest certification as a tool for sustainable forest management in the United States.

Keywords

Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC), American Tree Farm System (ATFS), Mass Media, United States

2.1 Introduction

Forest certification is a tool for ensuring the sustainability of forestry resources worldwide, including in the United States. It is a non-state, market-driven mechanism for recognizing the sustainability of forest management practices of forest management entities (Dwivedi et al., 2018b). Forest certification is also a transnational private governance that operates across state and national boundaries and enforces its performance standards on certificate holders on a voluntary basis (Bartley, 2007). The label on a certified product communicates to consumers that the product was produced in accordance with a shared set of environmental and social ethics (McDermott, 2012).

As of June 2020, 10.7% of the world's forests, or one billion hectares, have been certified (SFI, 2020a). These forests produce 31% of global industrial roundwood (U.S. Endowment for Forestry and Communities, 2017). Upward of 90% of certified forests occur in the Northern Hemisphere, 51% of which occurs within Canada and the United States (Yale School of Forestry & Environmental Studies, 2020). The widespread adoption of certification schemes by foreign markets, particularly in Europe, illustrates the value of international marketplaces driven by forest certification. Achieving certification, therefore, is a vital component for ensuring that American forest products can access competitive global markets. This is especially true as the United States

is one of the largest exporters of wood and wood-based products. In 2017, the United States exported US \$39.7 billion worth of wood and wood-based products, covering a total of 30% of the global market (Alvarez, 2020; Scott and Ireland, 2017).

Only a handful of studies have examined media influence on climate change policy, pest outbreaks, and forest management and policy (Ekayani et al., 2016a; Golcher et al., 2018; Keskitalo et al., 2016; Nhem et al., 2017). These studies have shown that media coverage holds the potential to create the perception of forest policy as an issue of public interest (Keskitalo et al., 2016) as well as to create public awareness about an issue (Ekayani et al., 2016a). Additionally, these studies illustrate how media coverage may influence policy decisions and public perceptions of policies (Golcher et al., 2018; Keskitalo et al., 2016; Nhem et al., 2017). An understanding of mass media coverage of forest certification schemes is vital because mass media can shape public opinion and discourse of such schemes and influence related policy decisions, participation in certification schemes, and consumer behavior.

To the best of our knowledge, no study has analyzed the media coverage of forest certification worldwide, in general, or the United States, in particular. It is essential to fill this critical knowledge gap for various reasons. First, the news media report on matters of public interest. Therefore, evaluating the portrayal of forest certification in mass media will better situate the attitudes promoted to the public towards forest certification. Second, an analysis of the portrayal of forest certification in mass media will help in identifying and addressing complex and diverse issues about forest certification across culturally and politically diverse regions. Finally, the

information obtained from such an analysis could directly feed into designing and communicating tailored, individualized solutions for each region's specific concerns, thereby promoting the adoption of forest certification, and ensuring the sustainability of forest resources in the United States. In this context, the overall goal of this study is to understand how state and national newspapers frame forest certification in the United States. The objectives of the paper are (1) to discover regional disparities in American news media coverage of forest certification, (2) determine which aspects of forest certification are highlighted by news media, and (3) discern which certification schemes are more covered or favored by news media. Results will better elucidate the successes or limitations of forest certification as a tool for sustainable forest governance in the United States, and hopefully, beyond.

Forest Certification in the United States

A total of three forest certification schemes are popular in the United States. The first popular forest certification scheme is American Tree Farm System (ATFS). Founded in 1941, the scheme operated on the idea that recognizing good forest management would encourage other forest landowners to manage their land sustainably. In 1990, the ATFS became part of the nonprofit American Forest Foundation. It adopted third-party certification in 2000 (ATFS, 2020). The ATFS operates under a series of criteria, which are updated every five years. As part of the 2015-2020 Standards, the ATFS has eight criteria guiding certified foresters on topics including timber harvest and management, forest and wildlife health, the quality of soil, water, and air, and the purpose of practicing sustainable forestry (Amberg, 2015; ATFS, 2015).

The second popular forest certification scheme in the United States is the Forest Stewardship Council (FSC) which was founded in 1993 by an active group of environmentalists and community leaders. The FSC enjoys support from environmental groups worldwide and is governed by three voting chambers (social, economic, and environmental interests), all equally-weighted (van der Ven and Cashore, 2018). The FSC employs global principles and criteria but mandates that locally nuanced standards, called indicators and their subsequent verifiers, be developed at the national level to encourage sustainable forest management. In the United States, the FSC offers three standards: Chain of Custody, Forest Management, and Controlled Wood standards. Its Chain of Custody Standard traces certified products through the supply chain, affirming FSC-certified items are identified or kept separate from non-certified materials. The Forest Management Standard verifies that the tract of the area from which the product was sourced complies with FSC principles designed to protect natural resources like water quality, soil health, habitat, and biodiversity. The Controlled Wood Standard is a sourcing focused standard that covers the risk of origin, as wood coming from certain categories of forests is not allowed. It also regulates the mixing of FSC-certified materials with non-certified materials (Forest Stewardship Council, 2020a).

The third popular forest certification scheme is the Sustainable Forestry Initiative (SFI) which only operates in North America (the United States and Canada). The SFI offers three certification standards: Chain of Custody, Forest Management, and Fiber Sourcing. The Chain of Custody standard tracks forest fiber from forest to end consumer (Sustainable Forestry Initiative, 2015). The SFI Forest Management standard requires the protection of natural resources such as biodiversity, habitat, at-risk species, water, and forests with exceptional conservation value. The

SFI Fiber Sourcing standard governs how certified mills obtain fiber from non-certified land and is thought to incentivize high levels of best management practices on non-certified forestlands. Importantly, the requirements of the SFI Fiber Sourcing Standard gave rise to state-level logger training programs for supporting the implementation of forestry best management practices (Dwivedi et al., 2018b).

Both ATFS (in 2008) and SFI (in 2002) were endorsed by the then Pan-European Forest Certification Program - now the Programme for the Endorsement of Forest Certification (PEFC) - a leading global alliance of national forest certification systems. By September 2020, the ATFS had certified almost 6.9 million hectares in the United States (PEFC, 2020). The FSC had certified almost 211 million hectares globally and 14 million in the United States (Forest Stewardship Council, 2020b). The SFI had certified over 147 million hectares of forestlands in North America (Sustainable Forestry Initiative, 2019a), making it the most used certification scheme in the United States covering 26 million hectares (PEFC, 2020). In total, around 47 million hectares are now certified in the United States under either FSC or PEFC standards (FAO, 2020).

2.2 Theoretical Framing

The role of media in public opinion, discourse, and policy can be described by the mass communication theories of agenda-setting (McCombs and Shaw, 1972) and framing (Entman, 1993a). Agenda setting theory (McCombs and Shaw, 1972) describes how mass media attention to issues influences public perceptions of issue importance. A consistent finding of media agenda-setting research across a variety of contexts is that audiences, through a process of salience transfer

(Dearing and Rogers, 1996a), perceive issues that are covered by the media as more important than issues that are not present on the media agenda (Keskitalo et al., 2016; Kioussis and McCombs, 2004; McCombs and Shaw, 1993, 1972). Agenda setting effects have been examined across a variety of mass media, including print (McCombs and Shaw, 1972), television (Iyengar and Kinder, 1987), as well as online and social media (Roberts et al., 2002; Russell Neuman et al., 2014). It is important to note, however, that the mass media may not only shape perceptions of issue importance by the decision which issues to cover (Shaw and Martin, 1992) but also audience interpretation of these issues by assigning prominence to certain aspects of issues and, thus, framing the message (Scheufele and Tewksbury, 2007). Framing refers to the process of a media message's emphasis or construction influencing audience interpretation of that message (Entman, 1993b). In turn, message frames can affect cognitive, attitudinal, or behavioral audience responses, including public opinion, audience knowledge, and decision making (Scheufele and Tewksbury, 2007). Media framing is often a conscious choice of media gatekeepers, such as information sources, public relations practitioners, journalists, editors, etc., who mindfully select, organize, and present ideas to provide meaning to events (Gamson and Modigliani, 1987). Framing research has shown that, while certain frames are strictly context-specific (Chong and Druckman, 2007), others, such as gain versus loss frames (Kahneman and Tversky, 2013; Segev et al., 2015), ethical versus material frames (Cho et al., 2016; Domke et al., 1998), or episodic vs. thematic frames (Feezell et al., 2019; Iyengar, 1994), can transcend their immediate contexts, and insights on their effects on audience perceptions can be applied more widely. Through agenda setting and framing processes, mass media coverage can shape and reflect public opinion and discourse and, thus, influence policy decisions in three specific ways. First, increased media attention can raise public awareness of an

issue and its importance, thereby placing an issue on policymakers' agenda (Nhem et al., 2017). Second, understanding public opinion and perceptions of the importance and the nature of an issue can shape policy decisions (Keskitalo et al., 2016). Finally, public opinion on an issue and related policy can show a need for increased public relations work on a policy issue to influence the media agenda and, thus, public perception of the issue (Darmon et al., 2008; Ekayani et al., 2016b).

2.3 Literature Review

Typically, media agenda setting and framing can be evaluated through content analysis to determine the prevalence of an issue as well as salience of aspects of the issue in mass media coverage, respectively (Dearing and Rogers, 1996b). For example, in Europe, Fabra-Crespo and Rojas-Briales (2015) analyzed online news articles related to forest, bioenergy, and biodiversity in two leading newspapers in Spain from 2009 to 2012. They reported that forest wildfires were the most frequent issue mentioned in the media. It was also stated that the analysis of mass media is the most appropriate complement for perception studies as it provides relevant basic information needed to design a communication plan. A media study found the debate on international forestry issues is fragmented and conflicting in Germany (Logmani et al., 2016). A study in Czechia found that biased coverage of a national park was more common in political newspapers (Riedl et al., 2018). A similar study in Finland analyzed forest management discourse in mass media to conclude that the salience of sustainable forest policy was low (Takala et al., 2019). Ranacher et al. (2019) analyzed 613 news articles from national and local newspapers in Germany. They found that the online news media coverage on forest management concentrated on regional media, and the media representations were condensed to ten core topics: state of forests, forest conservation,

forest management, technology, workforce, forest products, economic performance, promotion and events, political issues, and recreation. It was also found that a substantial number of articles reported on ecological and economic aspects of forests, illustrating the challenge presented by the forest as a central raw material supplier that needs to be managed sustainably, especially in the light of growing demand for wood-based bioenergy development in the European Union. In Sweden, forest certification has been portrayed as a collaborative solution that more often pertains to protected areas than commercial forestry (Zachrisson and Lindahl, 2013), and that Sweden's response to forest sustainability has been to increase expansion, inclusion, and integration of forest policy (Lindahl et al., 2017b).

In studies of forest coverage across Asia, Sadath and Rahman (2016) reported that the forest discourses in the Bangladeshi print media between 1989 and 2009 were built around the crisis argumentation. Deforestation and wildlife conservation dominated the Bangladeshi forest media discourse, where events like illegal logging, forest destruction, wildlife poaching, and wildlife-human conflicts were the most prominent issues discussed in the mass media of Bangladesh. Nhem et al. (2017) analyzed 178 news articles from four media outlets in Cambodia and examined the media discourses on issues surrounding Reducing Emissions from Deforestation and Degradation (REDD+) between 2011 and 2016. They reported that the use of mass media helped in spreading the information about REDD+ nationwide, leading to a situation where journalists and governmental institutions jointly set the agenda. It was also mentioned that media framing is a preferred choice to gain the attention of policymakers. Park et al. (2016) analyzed 129 global print

newspaper articles on forest conservation and found journalists to be prime gatekeepers of information.

In North America, a study in British Columbia found that although neither number nor frequency of forestry and environmental articles in a Canadian newspaper (*Vancouver Sun*) altered over time, the newspaper did eventually shift framing forestry and environmental issues from environmentally-oriented concerns to those associated with the forest industry (Arvai and Mascarenhas, 2001). Bengston et al. (2009) analyzed more than 36,000 news articles in the United States about urban sprawl. They found that the environmental impacts of urban sprawl were the most salient concern, followed by concerns about the loss of open space and traffic problems. Conway and Jalali (2017) analyzed news coverage of urban forests in three Ontario newspapers focusing on farming of trees as providers of both ecosystem services and disservices. They reported that local coverage differed between newspapers in municipalities with and without other urban forests. Similar studies have analyzed media portrayal of human-wildlife interactions (Bornatowski et al., 2019; Lyngdoh et al., 2017; Stafford et al., 2018), as well as media treatment of charismatic or endangered species (Bhatia et al., 2013; Hendrickson, 2005; Killion et al., 2019; Sadath et al., 2013; Walker et al., 2019).

Although various forest certification schemes have emerged and been covered by mass media in the United States and internationally, research on the media coverage of such schemes, specifically their coverage in the United States, is still lacking. It is important to understand the media coverage of forest certification in the United States for contextualizing public opinions and discourses

regarding forest governance. Therefore, our study fills a critical gap in our understanding about the overall sustainability of forestry resources in the United States.

2.4 Methodology

Data Sources and Collection

Articles were selected from the five top-circulated national newspapers and from top-circulated state newspapers (August 2019) as determined by the media database and analytical firm Agility PR Solutions. Search terms were “forest certification” + “Sustainable Forestry Initiative” + “SFI” + “Forest Stewardship Council” + “FSC” + “American Tree Farm System” + “ATFS”. Not all newspapers yielded articles. Table 1 displays the newspapers sourced in this study.

Data Analysis

No official boundary exists for categorizing regions of the United States; therefore, for ease of categorization, the United States was partitioned into six geographic groups (Figure 2.1) based on the categories used by the United States Census Bureau: Northeast, South, Midwest, West, Pacific Northwest, and Alaska and Hawai'i (U.S. Census Bureau, 1985). The Pacific Northwest, though not a Census Bureau category, is its own region in this study because of the existence of a large wood-based industry.

Figure 2.1: The distribution of six geographical regions selected for the study.



A total of 309 articles containing at least one search term were hand-coded in the software NVivo 12. Following the typology of previous media studies (Bhatia et al., 2013; Siegner et al., 2018), articles were assigned one of three thematic categories based on in-text framing of forest certification: economic, environmental, or socio-cultural. Articles emphasizing values such as "profit," "industry," and "jobs" were categorized as economic. Articles emphasizing ecological values such as "habitat," "wildlife," or "stream/water quality" were categorized as environmental. Articles emphasizing values like "style," "trends", or "responsibility" were categorized as socio-cultural. Table 2 displays the full range of keywords used to determine an article's primary and secondary themes. To be classified under one of three primary themes, an article must devote most of its content ($\geq 51\%$ if two themes present, $\geq 34\%$ if three themes present) to discussing that primary theme. Articles discussing two or more themes were assigned a secondary theme by the same parameters.

Additionally, the tone of articles was categorized as positive, neutral, or negative based on the articles' language. As in theme, an article's tone was classified by how much the text it devoted to framing certification. To be designated "positive," an article had to demonstrate $\geq 51\%$ positive coverage if two attitudes were present or $\geq 34\%$ positive coverage if all three attitudes were present. Positive articles couched forest certification between supportive phrases (e.g., "job creation," "energy-efficient," and "clean air"). Neutral articles stated business or company proceedings (e.g., "company purchases land tract") with little to no additional exposition. Negative articles framed forest certification in detractive phrases (e.g., "empty promises," "jobs at risk," and "economic burden)." Table 3 reports the keywords used to determine the tone towards forest certification. Scheme preference was determined by the certification schemes discussed in the article. If an article discussed only one scheme, that scheme defaulted as the article's preferred scheme. If an article discussed multiple schemes equally, it was classified as "FSC and PEFC." If an article discussed multiple schemes but devoted much of its text to one scheme, it was classified as the most discussed scheme. Lastly, articles were reviewed to record articles' publication year, publication location, and authorship type.

2.5 Results

Geographic Distribution

Of 309 articles, 113 (36.6%) were produced by the Northeast, 64 (20.7%) by the South, 45 (14.6%) by the Midwest, 28 (9.1%) by the West, 54 (17.5%) by the Pacific Northwest, and 5 (1.6%) by Alaska and Hawai'i. National newspapers published 43 (13.9%) articles, while the remaining 266 (86.1%) were published by state newspapers. The mean of articles produced per state is 6.7; the

median is 28.99; the maximum is 42, and the minimum is 1, which is also the mode of the dataset. The standard deviation is 8.37. States producing article quantities in the third quartile and above have published seven or more articles and are Maine (42), New York (30), New Hampshire (26), Oregon (21), Washington (20), Georgia (13), Louisiana (13), Idaho (11), North Carolina (8), Florida (8), Minnesota (8), Illinois (7), Missouri (7), and Wisconsin (7). Delaware, Hawai'i, Massachusetts, North Dakota, and South Dakota produced zero articles. Maine is the state responsible for producing the most articles (13.5%). Figure 2 illustrates the allocation of articles published by each state.

Table 2. 1: The list of top-circulated national and state-level newspapers used in the study. The top-circulated papers from each state and at the national level were selected based on the rankings published by Agility PR Solutions in 2019 (“Agility PR Solutions | Media Relations, Streamlined,” 2019). National level newspapers are denoted with an asterisk. Not all newspapers produced relevant articles for this study.

STATE	NEWSPAPER(S)
Alabama	<i>The Birmingham News</i>
Alaska	<i>The Anchorage Daily News</i>
Arizona	<i>The Arizona Republic</i>
Arkansas	<i>The Jonesboro Sun</i>
California	<i>The Los Angeles Times*</i>
Colorado	<i>The Denver Post</i>
Connecticut	<i>The Hartford Courant</i>
Delaware	<i>Wilmington News Journal</i>
District of Columbia	<i>The Washington Post*</i>
Florida	<i>The Sun Sentinel, The Tampa Bay Times*</i>
Georgia	<i>The Atlanta Journal-Constitution</i>
Hawai'i	<i>Midweek Oahu</i>
Idaho	<i>The Idaho Statesman</i>
Illinois	<i>The Chicago Tribune</i>
Indiana	<i>The Indianapolis Star</i>
Iowa	<i>The Cedar Rapids Gazette</i>

Kansas	<i>The Wichita Eagle</i>
Kentucky	<i>The Courier-Journal</i>
Louisiana	<i>The Advocate</i>
Maine	<i>The Portland Press Herald</i>
Maryland	<i>The Baltimore Sun</i>
Massachusetts	<i>Metro Boston</i>
Michigan	<i>The Detroit News</i>
Minnesota	<i>The Star-Tribune</i>
Mississippi	<i>The Meridian Star</i>
Missouri	<i>The St. Louis Post Dispatch</i>
Montana	<i>The Billings Gazette</i>
Nebraska	<i>The Omaha World Herald</i>
Nevada	<i>The Las Vegas Review-Journal</i>
New Hampshire	<i>The Union-Leader</i>
New Jersey	<i>The Star Ledger</i>
New Mexico	<i>The Albuquerque Journal</i>
New York	<i>The New York Times, The New York Post* The New York Daily News*, The Economist</i>
North Carolina	<i>The Charlotte Observer</i>
North Dakota	<i>The Williston Daily Herald</i>
Ohio	<i>The Plain Dealer</i>
Oklahoma	<i>The Oklahoman</i>
Oregon	<i>The Oregonian</i>
Pennsylvania	<i>The Philadelphia Inquirer</i>
Rhode Island	<i>The Providence Journal</i>
South Carolina	<i>The Post and Courier</i>
South Dakota	<i>The Argus Leader</i>
Tennessee	<i>The Knoxville News Sentinel</i>
Texas	<i>The Houston Chronicle</i>
Utah	<i>The Deseret News</i>
Vermont	<i>Seven Days</i>

Virginia	<i>The Virginia Pilot</i>
Washington	<i>The Seattle Times</i>
West Virginia	<i>The Herald-Dispatch</i>
Wisconsin	<i>The Milwaukee Journal-Sentinel</i>
Wyoming	<i>The Casper Star-Tribune</i>

Table 2.2: Articles discussed "sustainability" using one of three themes: economic, environmental, and socio-cultural. Articles were hand-coded for theme keywords and received a primary theme based on their content. Articles that discussed a second theme in less detail received secondary theme categorization using the same method.

Theme	Value Keywords
Economic	Economy, economic gains, losses Job creation, job loss Industry, industrial Profit, profitability, ROI Yield, harvest Financial, finances, monetary, cost Consumer demand Premium; certification as a competitive edge Tourism, skiing/hiking/fishing business.
Environmental	Habitat, critical habitat Fish, wildlife, endangered species Stream, river, water quality Soil quality, erosion Air quality, air purification Pesticides, herbicides, spraying Pollution (nonpoint, point, noise, light); POPs, VOCs Environmental, human health Other ecosystem services (carbon sequestration, flood control, etc.).
Socio-cultural & political	Customer value(s) Trendy, stylish, "earth-friendly" Tradition, traditional Responsible, responsibility ("the right thing") Generational/family attachment (ex. "land is important because belonged to grandfather") Preservation, esp. for future generation(s) Political/governmental involvement Political gridlock, decisionmaker(s) Debate.

Table 2.3: Key phrases used for defining the tone of published articles. For determining an article's tone, "positive" terms refer to any phrase that suggests forest certification is beneficial to people, businesses, and/or the environment. "Negative" terms refer to any phrase that suggests forest certification is harmful to people, businesses, and/or the environment. "Neutral" terms report proceedings with little to no additional text or spin.

Tone	Key Phrases
Positive	"job creation" "profit in certification/being green" "long-term revenue generation" "certification creates premium" "building green energy efficient, desirable" "promote biodiversity" or "clean water" or "clean air" "protects/preserves habitat/wildlife/endangered species" "high/growing customer demand for certified wood products" "certification is responsible" "protects resource for future generation(s)".
Neutral	"company purchases/sells/certifies land tract" "forestry division offers workshop" "forester/farmer recognized for practice" "certification considered for state forest".
Negative	"expensive to start/maintain" "overreach/meddling by radical/uninformed environmentalists" "over-regulation" "harmful to environment" "certification out of touch with reality" "severe/significant economic burden on small/family forestry" "prohibit profit" or "prohibit quality wood products from entering market" "puts jobs at risk" "little/minimal/no economic return".

Total articles (n=309) featured 32.7% economic coverage, 38.2% environmental coverage, and 29.4% socio-cultural coverage. National articles (n=43) featured 40% economic coverage, 48.8% environmental coverage, and 14% sociopolitical coverage. State articles (n=266) produced 35% economic, 36% environmental, and 32% cultural coverage. The Northeast produced equal amounts of environmental and economic content (72.4% region total), the South primarily produced socio-cultural content (39.1% region total), the Midwest and West primarily produced environmental content (42.2% and 68% region totals respectively), and the Pacific Northwest and Alaska and Hawai'i primarily produced economic content (48.1% and 80% region totals respectively). Alaska and Hawai'i did not produce any socio-cultural coverage. Secondary themes occur in 75.4% of articles (n=233). Of articles with secondary themes, 29.6% (n=69) favored economic coverage, 32.3% (n=76) favored environmental coverage, and 37.8% (n=88) valued socio-cultural coverage. Figure 3 illustrates the relationship between themes and regions.

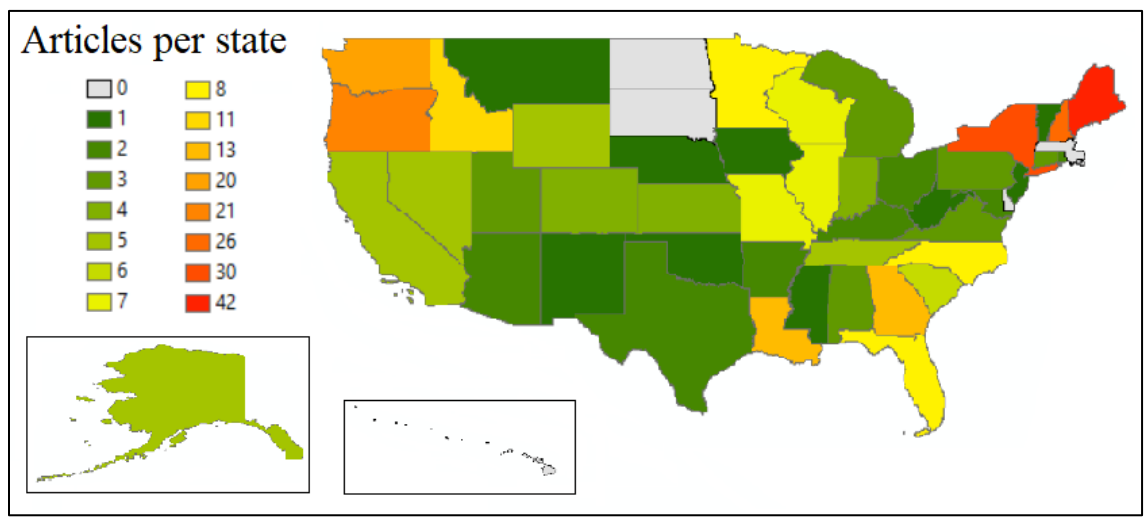


Figure 2.2: Number of articles published per state over the 30-year study period.

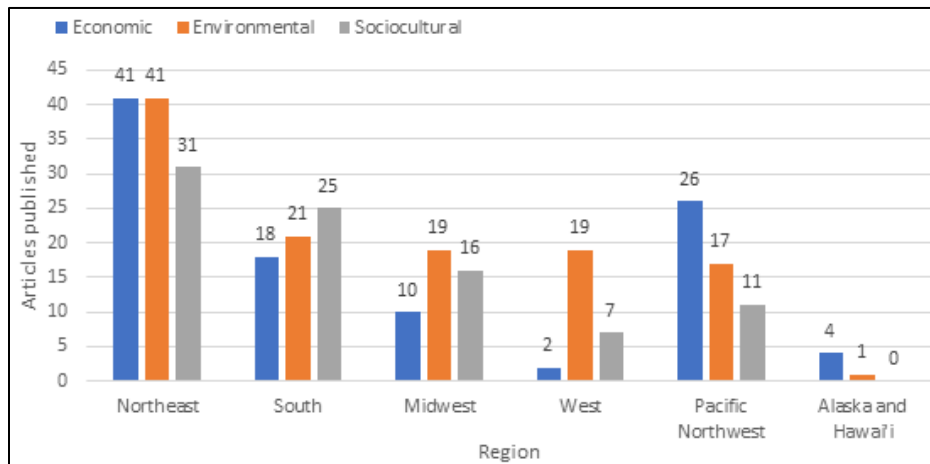


Figure 2.3: Regional breakdown of articles per themes.

Temporal Distribution

Media coverage rose in the late 1990s and peaked in 2000, during which 25 articles were published nationwide. The 2000s-decade averages 15.7 articles published/year. The average for the 1990s was 4.7, and the average for the 2010s was 11.2. Figure 4 displays the total number of articles produced by each state over the 30-year study period.

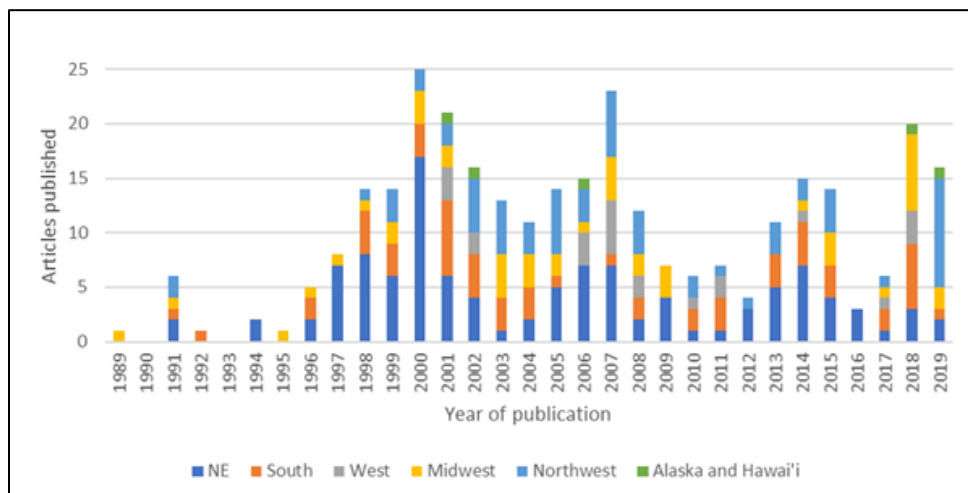


Figure 2.4: Temporal and geographic distribution of articles published per year between 1989 and 2019.

Media Attitude Toward Certification

Analysis of 309 articles found total 85.4% positive coverage, 11.3% neutral coverage, and 3.2% negative coverage. National newspaper articles (n=43) presented 90.7% positive coverage, 7% neutral coverage, and 2.3% negative coverage. State newspaper articles (n=266) presented 85% positive coverage, 11.1% neutral coverage, and 3.9% negative coverage.

Positive coverage (n=264) is most associated environmental coverage (42%), followed by economic (31.1%) and socio-cultural (27.27%) concerns. The ATFS receives 15% of all positive coverage, the FSC receives 28.8%, the SFI receives 20.8%, the FSC and PEFC together receive 26.9%, and unspecified forest certification receives 7.9%. In descending order, most positive coverage originates in the Northeast (37.5%), South (19.3%), Pacific Northwest (18.2%), Midwest (14.4%), West (9.4%), and Alaska and Hawai'i (1.1%). Neutral coverage (n=35) focuses equally on economic (42.5%) and socio-cultural (42.5%) concerns. Of neutral press coverage, the ATFS receives 17%, the FSC receives 14%, the SFI receives 37%, the FSC and PEFC together receive

29%, and unspecified forest certification receives 3%. Most neutral coverage originates in the South (37%) and Northeast (34%). The Midwest produced 17%, the West produced 6%, and Pacific Northwest and Alaska and Hawai'i each produced 3% of neutral coverage. Negative coverage (n=10) emphasizes mostly economic concerns (40%) but pays almost equal attention to environmental (30%), and socio-cultural (30%) concerns. Unfavorable press coverage is equally distributed to all schemes, with SFI receiving 30%, FSC receiving 30%, FSC and PEFC together receiving 30%, and unspecified forest certification receiving 10%. ATFS received no negative coverage. Half of all negative coverage originated in the Pacific Northwest, 20% in the Northeast, and 10% each in the Midwest, West, and Alaska, and Hawai'i.

Authors of Certification-Related News Articles

Seven categories of authors were identified: professional journalists, businessperson, nonprofits, private citizen, government, multiple writers, and unspecified writers. Staff writers were individuals employed by the newspaper; corporate or business writers wrote on behalf of a company; nonprofit writers wrote on behalf of a nonprofit; private citizens wrote without affiliation to an organization, often in response to previously published articles; multiple authors indicate a combination of any of the above, and unspecified writers were those individuals whose identity and affiliation could not be located by the authors of this paper. Professional journalists (n=210) are the most common author type and represent 68% of all authors. They demonstrate an even distribution of themes, writing 34.4% on economic, 37.1% on environmental, and 28.6% on socio-cultural concerns. Table 2.4 displays the cross-section of all author classes, themes, and tones.

Table 2.4: Relationships between article authors' affiliations and the theme and tone of published articles.

Affiliation	Articles (#)	Economics	Environmental	Social	Positive	Negative	Neutral
Journalist	210 (68%)	72 (34.3%)	78 (37.1%)	60 (28.6%)	178 (84.8%)	7 (3.3%)	25 (11.9%)
Businessperson	15 (4.9%)	6 (40.0%)	5 (33.3%)	4 (26.7%)	14 (93.2%)	0 (0.0%)	1 (6.66%)
Nonprofit	12 (3.9%)	2 (16.7%)	6 (50.0%)	4 (33.3%)	11 (91.7%)	1 (8.3%)	0 (0.0%)
Private citizen	14 (4.5%)	6 (42.9%)	5 (35.7%)	3 (21.4%)	14 (100%)	0 (0.0%)	0 (0.0%)
Government	3 (0.97%)	0 (0.0%)	2 (66.7%)	1 (33.3%)	2 (66.7%)	0 (0.0%)	1 (33.3%)
Multiple	8 (2.9%)	3 (37.5%)	3 (37.5%)	2 (25%)	8 (100%)	0 (0.0%)	0 (0.0%)
Unspecified	47 (15.2%)	13 (27.7%)	18 (38.3%)	16 (34.0%)	38 (80.9%)	1 (2.1%)	8 (17%)
Total	309 (100%)	102 (33%)	117 (37.9%)	90 (29.1%)	265 (85.8%)	10 (3.2%)	35 (11.3%)

Certification Scheme Preference

FSC + PEFC together, as well as FSC alone, tied as the newspapers' most discussed certification scheme overall, with both scheme categories accounting for 27.2% of total coverage each. More heterogeneous coverage of scheme type occurs at the regional level: In the Northeast, most articles featured FSC (28.3%), in the South, the SFI (35.9%), in the Midwest, both SFI and FSC *separately* (28.9% each), in the West, FSC (46.4%), in the Pacific Northwest, FSC + PEFC (53.7%), and in Alaska and Hawai'i, FSC (60%). The matrix of media dominant schemes and regions is given in Table 2.5.

Table 2.5: The prevalence of selected certification systems across regions in the United States. The most prevalent standard for each region is bolded. SFI: Sustainable Forestry Initiative. FSC: Forest Stewardship Council. ATFS: American Tree Farm System. PEFC: Programme for the Endorsement of Forest Certification.

Region	Articles (#)	FSC	SFI	ATFS	FSC + PEFC	Unspecified
Northeast	113 (36.6%)	32 (28.3%)	21 (18.6%)	22 (19.5%)	29 (25.7%)	9 (7.9%)
South	64 (20.7%)	12 (18.8%)	23 (35.9%)	14 (21.9%)	9 (14.1%)	6 (9.4%)

Midwest	45 (14.6%)	13 (28.9%)	13 (28.9%)	6 (13.3%)	10 (22.2%)	3 (6.7%)
West	28 (9.1%)	13 (46.4%)	5 (17.9%)	1 (3.6%)	7 (25%)	2 (7.14%)
Pacific Northwest	54 (17.5%)	11 (20.4%)	9 (16.7%)	3 (5.6%)	29 (53.7%)	2 (3.7%)
Alaska & Hawai'i	5 (1.6%)	3 (60%)	0 (0.0%)	1 (20%)	0 (0.0%)	1 (20%)
Total	309 (100%)	84 (27.2%)	71 (23%)	4 (15.2%)	84 (27.2%)	23 (7.4%)

Themes and Certification Schemes

Coverage of FSC was evenly distributed among the three themes, with 30.4% economic, 34.8% environmental, and 34.8% socio-cultural coverage. Coverage of SFI was dominated by 52.1% environmentally themed coverage, and coverage of ATFS was dominated by 53.2% socio-culturally themed coverage. Table 2.6 illustrates the relationship between schemes and the themes associated with them.

Table 2.6: Themes used for framing a certification scheme. The most prevalent theme(s) for each scheme is bolded. SFI: Sustainable Forestry Initiative. FSC: Forest Stewardship Council. ATFS: American Tree Farm System. PEFC: Programme for the Endorsement of Forest Certification.

Scheme	Economic	Environmental	Socio-cultural
ATFS	34%	12.8%	53.2%
FSC	30.4%	34.8%	34.8%
SFI	22.5%	52.1%	25.4%
FSC and PEFC	39.3%	39.3%	21.4%
Unspecified Scheme	30.4%	34.8%	34.8%

2.6 Discussions

Geographic Distribution

The southern region is the largest producer of forest products nationwide, but it did not produce most of the forest certification articles. Maine leads the nation with 42 forest certification articles

(5.25 times the national average of 8). This abundance of articles may be explained by Maine's wood products industry, which creates 33,538 jobs, employs >10% of the workforce, and has an economic impact of \$8.5 billion (Anderson III and Crandall, 2016; United States Department of Agriculture, 2020). However, it is Georgia, rather than Maine, that is the country's leading producer of forest products; yet Georgia produced less than half as many articles as Maine, despite employing 55,089 workers for an economic impact of \$21.5 billion (Georgia Forestry Commission, 2018). This insinuates that the economic impact of the forestry sector is not a reliable estimator of media coverage at the state level (Figure 5a). This also suggests that the economic impact of the forestry sector in relation to other sectors (e.g., agriculture) might be a better indicator of the extent of media coverage of issues related to the forestry sector, in general, and forest certification, in particular. We found that the percentage of total land under forestry cover is a better indicator of number of articles published in each state on forest certification (Figure 5b). However, more research is needed for defining the relationship between the media coverage of forest certification in each state.

Temporal Distribution

The deliberations on forest certification started in 1992 Earth Summit, as a result we see emergence of some articles covering forest certification around the same time. Articles discussing forest certification begin consistent publication in 1994, the year in which the FSC was established. Similarly, the SFI was established in 1995. It is likely that the creation and subsequent activities and competition of these two schemes helped spur certification into the media spotlight. The 2000s saw the highest levels of forest certification media coverage and this spike in salience coincided

with concurrent global events in sustainable forestry and concurred with rising competition between FSC and PEFC. In the year 2000, when the greatest number of articles were published, the United Nations established the International Forum on Forests, a global initiative aimed at the preservation of forests across the world. In 2001, the United Nations Millennium Declaration incorporated natural resource sustainability into its manifesto. The following years saw dozens of global initiatives emphasizing sustainability and forests, including the World Summit on Sustainable Development (2002), FSC's winning of the ALCAN prize (2004) for sustainable forest management, the implementation of the Kyoto Protocol (2005), and the endorsement of SFI by the PEFC (2005). Other topical events that propelled forest certification into the media spotlight were the approval of the ISEAL Code-compliant FSC Project Certification Standard (2006), the adoption of a Non-Legally Binding Instrument on forests by the United Nations (2007), the endorsement of ATFS by the PEFC (2008), and the building of the 2010 Olympic/Paralympic Centre using FSC-certified products (2009). The greatest factor is the competition between FSC and PEFC in addition to interactions between NGOs and industry.

The decline in articles in the 2010s occurred despite numerous global sustainability and forest events, such as FSC certifying 180 million hectares (2013), FSC's twentieth anniversary (2014), Paris Agreement/COP21 (2016), the PEFC recognizing SFI's fiber sourcing standard (2017), SFI surpassing 121 million certified hectares (2017), and the Global Climate Strike (2019). In 2017, the number of articles published sank to 1994 levels (n=2). However, one year later, 11 articles were published, almost double the decadal average. The underlying cause of these dramatic oscillations is difficult to identify, but to some extent, they are likely due to whistleblower

complaints, fierce competition between certification bodies, and the 2018 merger between NEPCo and the Rainforest Alliance, which created the largest forest certifier in the world (The Rainforest Alliance, 2018).

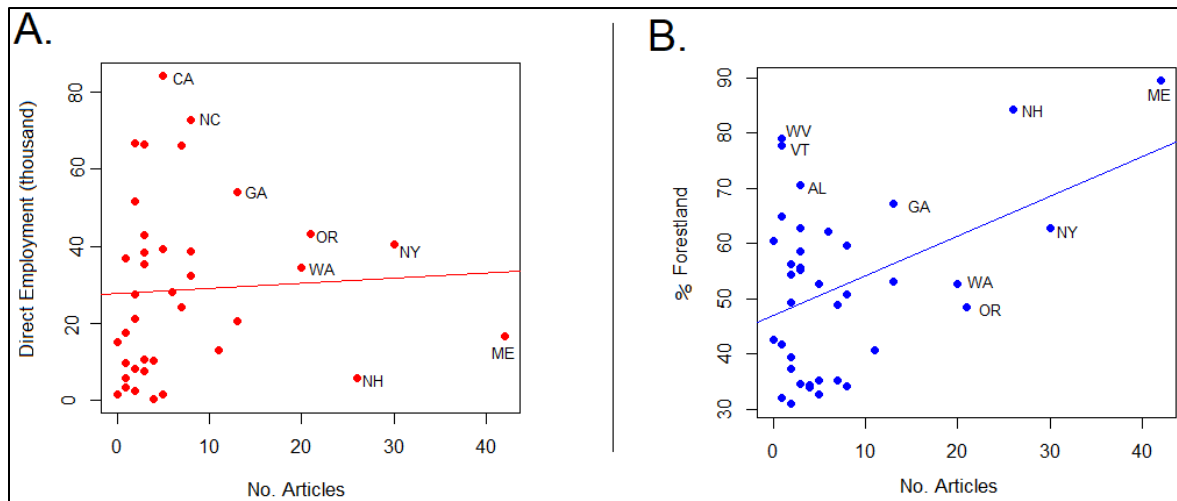


Figure 2.5: Relationship between number of articles published from each state on forest certification relative to direct employment (A; $p=0.749$, $t=0.321$, $df=36$) and the percentage of total land under forest cover (B; $p=0.007$, $t=2.836$, $df=36$). We removed all the states with less than 30% forestry cover from the analysis for clarity purposes. Data from direct employment is from Pelkki (2020). The data on the percentage of total land under forestry cover is obtained from the USDA (Oswalt et al., 2017).

Media Attitude Toward Certification

Forest certification enjoys widespread support at both regional and national levels, although national newspapers present more positive coverage than state newspapers. This may occur because the brunt of the effects of certification—such as cost of certification—are first felt regionally, and state newspapers provide an accessible, locally-oriented venue for residents to voice site-specific concerns. Respected national newspapers like *The New York Times* or *The Washington Post* have the potential to reach larger audiences nationwide than do state newspapers, so the role of national newspapers setting trends of topic and theme (in this case, environmental)

may trickle down to state papers. Overall, economic and environmental themes occurred far more frequently than socio-cultural themes.

Most positively toned articles originated in the Northeast and South regions. Positive coverage discusses the first environmental, then economic concerns and represents 80% of total coverage, indicating widespread media portrayal of forest certification as a positive concept. Over half of all negatively toned articles originated in the Pacific Northwest, Alaska, and Hawai'i. Alaska and Hawai'i are particularly noteworthy as this region possesses the smallest sample size ($n=5$), but negatively toned articles account for 20% of all articles in the region and 10% of all negative coverage in the study overall. Negatively toned coverage focuses chiefly on economic concerns, mostly due to higher costs related with forest certification. Additionally, the equal distribution of negative coverage to all certification schemes suggests disapproval of certification is not tied to a specific scheme but depends upon the overall finances.

Professional journalists, rather than industry experts or nonprofits, are responsible for providing the brunt of forest certification articles in mainstream newspapers and author the most negative coverage of certification. The overwhelmingly positive content written by private citizens indicates either the general public's support for certification or the news source's biased selection of articles in favor of certification.

Certification Scheme Preference

Some schemes are more common in some regions than in others. Patterns identified in the results section suggest the FSC is dominant in the Northeast, accepted in the South, Midwest, West, and Pacific Northwest, but less welcome, so far, in Alaska and Hawai'i. The SFI's distribution suggests a strong presence in the South, Northwest, and Midwest, but less so in the West and Pacific Northwest. Its absence from Alaskan and Hawai'ian newspapers indicates that the scheme, so far, has not gained traction in the media of those states. Even though most of ATFS's articles occurred in the Northeast, ATFS is still discussed less than any other certification scheme in the region, indicating coverage of other schemes outnumbers ATFS there. The ATFS fares better in the South, where it represents the second-greatest quantity of scheme coverage type, and accounts for a greater percentage of the region's total discussed schemes. Outside these two regions, however, the coverage of the standard appears limited. The FSC and PEFC schemes (including both SFI and ATFS) discussed together enjoyed widespread coverage.

Themes and Schemes

Different regions of the country demonstrate distinct preferences for scheme and theme. FSC demonstrates a very even split between themes, suggesting existing coverage evenly balances economic, environmental, and socio-cultural concerns. This distribution echoes the FSC's tripartite pseudo-democratic governance model, which allocates equal weight to economic, environmental, and social concerns; if this is the case, FSC follows through on its mission to address all concerns surrounding certification. However, FSC is not unique in its governance, as SFI also has a balanced

government structure that addresses multiple facets of certification (Sustainable Forestry Initiative, 2019a).

Despite the schemes' similar missions and structure, the SFI's coverage focuses more heavily on environmental concerns. SFI's expanded environmental media coverage likely results from the standard's growing environmental stewardship programs, such as biodiversity, water, and carbon conservation initiatives, in addition to its plan to achieve zero net deforestation (Sustainable Forestry Initiative, 2020, 2019b). ATFS is the only standard with majority socio-cultural coverage, mostly the standard targets family forest landowners in the United States. It is also the standard with the least environmental coverage. This trend suggests most media coverage surrounding ATFS focuses on social responsibility and other "feel good" values rather than on the economic or environmental concerns that characterize national trends in certification portrayal.

The codominant themes of FSC/PEFC's joint coverage imply economic and environmental concerns are weighted equally when the schemes are discussed side by side. This is due to comparisons of the standards' financial obligations, return on investments, and environmental protections and regulations, part of the push and pull between industry and nonprofits. Most articles in this category posit both schemes as sustainable solutions to deforestation. Unspecified forest certification articles discuss forest certification as an idea or future endeavor but cite no specific scheme. Authors might draw on all three themes equally because unspecified schemes offer no concrete economic, environmental, or socio-cultural benefits or drawbacks. Discussion of

unspecified forest certification might present an equal array of themes to gauge readers' interest in each before selecting a theme to flesh out in more detail.

2.7 Conclusion

Media portrayal of forest certification is highly heterogenous; regions demonstrate differences in standard preference and primary theme. Though both state and national newspapers focus first on the environment and then on economics, regional coverage oscillates primarily between environmental and economic.

Forest certification enjoys a warm reception throughout the country. The most common standard discussed was not a single standard but FSC and PEFC side-by-side, indicating the American media's validation of both schemes. The FSC alone took second place in terms of quantity of coverage, and SFI received third. The ATFS was the least written about. Regions demonstrate a distinct preference for the theme and scheme type, although environmental coverage is most common. The ATFS represented the smallest sample size and was not the dominant standard in any region.

The current study does not assess the acceptance of forest certification schemes by consumers. Future studies on mass media coverage of forest certification may also evaluate whether coverage affects consumers' perceived importance, understanding, and opinion of certification schemes and subsequent behavior. It is possible that if consumers understand forest certification policies and believe them to be effective and important, they may adjust their purchase decisions to support

such schemes. Future studies drawing on signaling theory in economics (Spence, 1973) could also assess whether forest certification seals on products can signal ethical practices and reduce information asymmetry between sellers and buyers of certified products. Such seals may then serve as cues for trust (Wang, 2001), resulting in a more favorable consumer reception of products sourced from certified farming and stronger support for forest certification schemes through purchase decisions.

Alternatively, studies could contrast the themes media uses to frame certification with implementation rates of certification to determine whether and where a specific type of framing is more effective. Our study will better situate forest certification as a tool for sustainable forest management in the United States and inform the current debate on the role of forest certification as a tool for sustainable forest management.

CHAPTER 3: MEASURING IMPACTS OF THE SUSTAINABLE FORESTRY INITIATIVE
FIBER-SOURCING STANDARD² ON FORESTRY BEST MANAGEMENT PRACTICES
IMPLEMENTATION RATE AND BIODIVERSITY IN THE SOUTHEASTERN UNITED
STATES

² Karnatz, Caroline, P. Kadam, and P. Dwivedi. Submitted to *The Journal of Conservation Biology*

Abstract

The Sustainable Forestry Initiative (SFI) Fiber Sourcing Standard (FSS) aims to extend the reach of sustainable forest management onto uncertified forestlands through the use of Best Management Practices (BMPs). Conservation of biological diversity is one of the pillars of the SFI FSS, but no study has examined its effect on biodiversity conservation at the landscape level. We analyzed the BMP implementation rates (inside, outside, and within overlapped wood baskets of certified wood-consuming mills) across five very high, high, medium, low, and very low biodiversity categories to measure the impact of the SFI FSS in four states (Alabama, Florida, Georgia, and South Carolina) located in the SE United States. We found BMP implementation rates to be generally high (>90%) and that BMP compliance rate was unlikely to be significantly different regardless of location inside, outside, or within multiple wood baskets. High compliance rates across the region indicate that all tracts of land, regardless of biodiversity categories, typically receive the same strict level of conservation attention. In this context, the SFI FSS is perhaps broadening the reach of sustainable forest management beyond certified forests in the SE United States.

Keywords

Forest Certification, Sustainable Forest Management, Southern United States

3.1 Introduction

All economies, regardless of nation, state, or region, are irrevocably and concretely embedded within nature and the resources it provides (Dasgupta, 2021). Even the most advanced technologies are ultimately derived from natural resources (USGS, 2001). Human economies, therefore, are not external or distinct from natural resources but entirely dependent on them (Dasgupta, 2021). Despite this critical linkage, unsustainable resource use has overtaxed many ecosystems to the verge of total destruction, and the natural world's ability to provide crucial, life-giving resources for current and future generations is grievously imperiled (United Nations, 2019).

Biological diversity, or biodiversity, is the variety of living organisms. The activities of millions of unique species govern climate cycles, nutrient cycles, hydrology, soils, and energy flows (Dasgupta, 2021). Loss of biodiversity thus hamstring the natural world's ability to meet critical needs for humanity. Biodiversity loss has become so extreme that the situation has been deemed a "biodiversity crisis" (United Nations Commission on Environment and Development, 1986), and both legislated and market-based initiatives to preserve biodiversity have emerged.

The concept of forest certification arose following the 1992 United Nations Earth Summit, in which member states failed to formulate a solution to deforestation. Forest certification is a market-based approach to forest sustainability that encourages socially and environmentally responsible business by recognizing sustainable forest entities with a certification, for which consumers may pay a premium (Cashore et al., 2004). The Sustainable Forestry Initiative (SFI) is a prominent certification scheme in the United States and Canada, where it has certified over 147 million

hectares (Sustainable Forestry Initiative, 2019). The SFI offers three standards: the Forest Management Standard, which certifies working forestlands that protect natural resources; the Chain of Custody Standard, which tracks forest products through the supply chain to ensure the end product is sustainably made; and the Fiber Sourcing Standard (FSS), which extends the reach of sustainable forestry beyond certified forestlands.

The SFI FSS is for organizations that do not own land but procure wood directly from certified and uncertified forestlands. The SFI FSS participants must demonstrate that the products in their supply chain are sourced from responsible sources regardless of whether the forest of origin is certified. Primary producers undergo third-party audits for certification and must adhere to a series of Principles, Objectives, Performance Measures, and Indicators designed to broaden forestry Best Management Practices (BMPs), protect biodiversity, improve water quality, and provide outreach to landowners and other industry professionals (Sustainable Forestry Initiative, 2015). Even though one of the FSS's key objectives is biological diversity conservation, a lack of understanding exists on the impact of the SFI FSS on the BMP implementation rate and biodiversity conservation when taken together at a broader landscape level. Most existing studies focus on water resources and analyze the impact of forestry BMPs on soil and water quality, specifically the effectiveness of BMPs on reducing sedimentation and disrupted nutrient cycles (Bombino et al., 2021; Boufala et al., 2021; Risal et al., 2021; Tavankar et al., 2021). There are few data-specific studies linking forestry BMPs to wildlife, and existing studies have evaluated BMP effectiveness at protecting specific groups (Warrington et al., 2017), such as birds (Ritterson et al., 2021), furbearers (White

et al., 2021), amphibians (Guzy et al., 2019), or freshwater fishes (Fraker et al., 2020), usually at the community level.

In this context, the overall goal of this study is to assess the efficacy of the SFI FSS as a conservation tool for biodiversity management in the SE United States through the implementation of forestry BMPs. It is essential to fill the critical knowledge gap in the practical use of the SFI FSS to determine whether this existing and widely adopted measure delivers on its promise of sustainably managing wildlife resources, safeguarding crucial ecosystem services, and responsibly growing the forest-based economy. Therefore, we first explored the impact of the SFI FSS on the BMP implementation rates over time on at-risk habitats in the four SE states of Alabama, Florida, Georgia, and South Carolina. Then, we evaluated any differences in BMP implementation rate in zones of critical habitat versus zones of non-critical habitat within the wood baskets of certified mills. We hope that results of this study will better situate forest certification as a tool for biodiversity conservation in the United States, in general, and in the SE United States, in particular.

3.2 Literature Review

Threats to Biodiversity

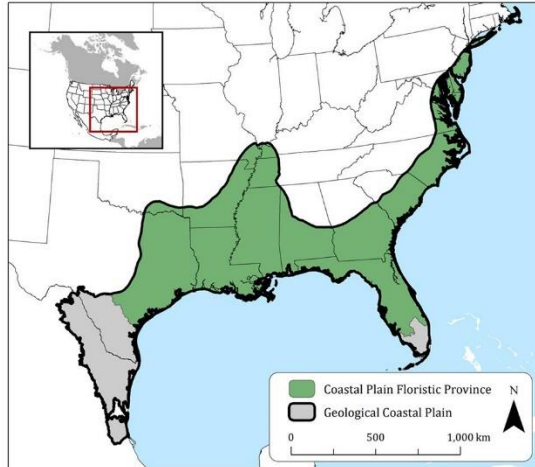
The United Nations Integrated Platform on Biodiversity and Ecosystems Services (IPBES) Report warns that biodiversity loss erodes the foundations of human health by imperiling global economies, livelihoods, quality of life, and food security in multiple, complex ways (United Nations, 2019). The 2021 Economics of Biodiversity Dasgupta Review charges that ecosystems, which form the basis of all economies, should be viewed as an asset like produced and human

capital, and that unsustainable use of natural resources gravely threatens the prosperity of current and future generations (Dasgupta, 2021).

However, despite human reliance on the environment for human wellbeing, human activity is now the chief cause for most environmental change (Lewis and Maslin, 2015), and anthropogenic factors like habitat loss and climate change have accelerated the rate of extinction so much that in 1986 biologists coined the phrase “biodiversity crisis” to describe global species loss and proposed that the Earth had entered its sixth mass extinction (United Nations Commission on Environment and Development, 1986). Current extinction rates are approximately 100 to 1,000 times greater than the historical average and are projected to increase (Dasgupta, 2021). Habitat loss specifically is commonly regarded as the chief driver of biodiversity loss. The United Nations reports that 75% of terrestrial environments and 66% of marine environments to be “severely altered” by anthropogenic activity (United Nations, 2019). From 1990 to 2015, 290 million hectares of native forest cover were lost to harvesting. Over 85% of wetlands present in 1700 C.E. had vanished by 2000 C.E., and food production has increased by 300% since 1970, correlating with the 100 million hectares of agricultural expansion in the tropics from 1980 to 2000 (United Nations, 2019). In 2015, about 33% of global marine fish stocks were unsustainably harvested, and over half the ocean is covered by industrial fishing (United Nations, 2019). Existing research on the effects of terrestrial habitat loss has found that over 500,000 species do not have sufficient habitat for long-term survival, and the average abundance of native species in terrestrial biomes has declined by 20% since 1900 (United Nations, 2019).

Globally, a high concentration of threats to biodiversity occur in handfuls of highly diverse areas (Gonçalves-Souza et al., 2020), or “hotspots.” Extensive analysis of species distribution in the contiguous United States asserts that protected areas are mismatched with biodiverse areas and fail to adequately cover the nation’s unique species (Jenkins et al., 2015). This study also found that the North American Coastal Plain biodiversity hotspot hosts the greatest levels of biodiversity in the contiguous United States, and a similar study concluded that gains in protecting natural areas do not satisfactorily protect or encompass the full range of American biodiversity (Pimm et al., 2014). Another study analyzed biodiversity hotspots and found despite hotspot designation, endemic hotspot flora and fauna will likely become extinct or threatened as a result of habitat loss (Brooks et al., 2002). Additionally, analysis of species distribution by Jenkins et al. (Jenkins et al., 2015) reveals that the SE United States hosts the highest levels of endemic mammals, birds, amphibians, reptiles, freshwater fishes, and trees in the contiguous United States, rendering the region a clear high-value conservation priority. In 2016 the Critical Ecosystem Protection Fund (CEPF) designated the North American Coastal Plain (Fig. 1) the world’s 36th biodiversity hotspot (CEPF, 2020). A biodiversity hotspot possesses at minimum 1,500 endemic species of vascular plants and less than 30% original native vegetation remaining. The North American Coastal Plain hosts over 270 bird species, 306 native mammal species, 293 reptile species, 122 amphibian species, and 424 freshwater fish species. Of these, six bird species, 114 native mammal species, 113 reptile species, 57 amphibian species, and 138 freshwater fish species are endemic (CEPF, 2020). The SE United States is especially diverse: the U.S. Fish and Wildlife Service (USFWS) reports 143 federally endangered or threatened species in Alabama, 133 in Florida, 73 in Georgia, and 67 in South Carolina (USFWS, 2020).

Figure 3. 1: The 36th biodiversity hotspot, the North American Coastal Plain; image by CEPF (Noss, 2016).



Forest Certification in the United States

While some natural resource protections are formally legislated and enforced by government bodies (e.g., the U.S. Endangered Species Act or ESA; the Convention on International Trade in Endangered Species of Wild Fauna and Flora or CITES), forest certification is a non-state, market-driven mechanism for safeguarding forest sustainability (Dwivedi et al., 2018) that began with the advent of the Forest Stewardship Council (FSC) in 1992, which aimed to conserve primarily tropical forests and biodiversity (FSC, 2021a). The FSC possesses a tripartite governance model comprised of three equally-weighted voting chambers representing environmental, economic, and social interests, which are further divided into northern and southern sub-chambers to ensure Global North and South share equal authority (FSC, 2021a). Certifications are based upon pre-established principles and criteria designed to ensure forest and human wellbeing, and forest entities seeking certification are evaluated by third-party certifiers (FSC, 2021b). As of August 2020, the FSC has certified 626 million hectares in the United States and Canada, 14.2 million of

which are in the United States. Globally, the FSC has certified 221.9 million hectares in over 130 countries (FSC, 2021b).

In 1995, organizations supporting the intent behind forest certification but taking issue with the FSC's approach established the SFI (Cashore et al., 2004). Like FSC, the SFI's governance is trifold, incorporating environmental, economic, and social issues, and its mission is to sustain both forest resources and economic growth. Unlike FSC, the SFI exclusively operates in North America, where it offers a Forest Management Standard, Chain of Custody Standard, and FSS (SFI, 2021a). Standards are revised every five years and certification requires a third-party, independent auditor. The SFI FSS specifically requires program participants to support research into forestry-related issues (SFI, 2020). Additionally, the SFI was endorsed by the largest forest certifier entity in the world, the Programme for the Endorsement of Forest Certification (PEFC), in 2005 (PEFC, 2021a). As of 2019, it had certified 147 million hectares in the United States and Canada and reports "tens of millions more" hectares positively impacted by its FSS (Sustainable Forestry Initiative, 2019).

Another significant forest certification scheme operating in the United States is the American Tree Farm System (ATFS). The ATFS pre-dates both SFI and FSC by some fifty years, having been founded in 1941 on the basis that recognizing food forestry practices would encourage others to practice sustainable forestry too (ATFS, 2021). Like FSC and SFI, the ATFS certifies forest entities with third-party certification according to one or more of its standards, which are updated every five years. The ATFS operates exclusively in the United States, where it has certified 7.7

million hectares and is the largest forest certification scheme (PEFC, 2021b). It joined PEFC in 2001 and received endorsement in 2008 (PEFC, 2021b).

Biodiversity Protection and Forest Certification

Evidence of forest certification as a solution to biodiversity loss has thus far been inconsistent. A study in Tanzania observed that species biodiversity oscillates among different management regimes and concluded forest certification might be a sustainable approach to species conservation (Kalonga et al., 2016). A similar study of the Peruvian Amazon found FSC certification promoted significant biodiversity protections absent from non-certified forests (Brotto et al., 2010). On the Iberian Peninsula, researchers evaluated two certified streams and concluded streams associated with certification hosted substantial aquatic biodiversity (Oliveira et al., 2019), and FSC certification was found to play a key role in protecting biodiversity (Sanchez-Almedro et al., 2018). However, an examination of Lithuanian forests found FSC was only sufficient to protect species with small habitats (Elbakidze et al., 2016), and another FSC case study of Sweden and Russia concluded better understanding of FSC was necessary before biodiversity impacts could be measured (Elbakidze et al., 2011). A separate team of researchers examined dieback and tree cover loss and concluded Russian FSC standards are not reducing ecological risk (Blumroder et al., 2020), and another team examined FSC's ability to conserve biodiversity in the tropics and concluded certification costs must be reduced and incentives increased to make a meaningful impact (Gullison, 2003). Similarly, a Finnish case study asserted current certification requirements do not credibly protect biodiversity (Kuuluvainen et al., 2019). Another team of researchers examined the Nepalese government's forest management strategy and concluded that, despite

lacking certification, the strategy improved biodiversity and might benefit from synchronizing with a certification scheme (Bhattarai et al., 2019). A study of mammal conservation in Borneo found aboveground biomass was greatest in and around certified areas and correlates with high levels of mammal density (Sollmann et al., 2017). Meanwhile in Canada, a survey of SFI-certified land indicated biodiversity receives different levels of priority based on regional geography and policy, and tree diversity was among the lowest ranked values (Todgham, 2016). In Costa Rican coffee agroforestry systems, some species were present on non-certified farms but absent from certified farms despite certified farms reporting greater levels of ecosystem services (Pico-Mendoza et al., 2020).

In the United States, a review of biodiversity conservation concluded that although FSC comprehensively addresses biodiversity, its stringent requirements may hamstring its coverage of small land areas (Suzuki and Olson, 2008). Conversely, in the SE United States, a team of researchers concluded that because forest certification offers a formal, standardized approach to quantifying biodiversity conservation, it may be palatable to stakeholders (Miller et al., 2009). A separate study of the same region evaluated endangered tree distributions and concluded that in addition to large protected areas, small, satellite protected areas (such as those generated by certification) are necessary to protect endemic species (Sorrie and Weakley, 2006). A separate study analyzed the effectiveness of the SFI FSS in Georgia, United States and found that the SFI FSS has the potential to promote landscape-level conservation through higher BMP implementation rates (Dwivedi et al., 2018).

The Fiber Sourcing Standard and Best Management Practices

The SFI FSS, introduced in 2015, is for entities in the United States and Canada that do not own or manage land themselves but accept wood from forests. The SFI FSS mandates that program participants (i.e. certified mills) demonstrate their wood products come from legal and sustainable sources, regardless of whether the source forest is certified. This standard is especially important in the context of the SE United States, where only 19.7% of total forestland is certified (U.S. Endowment for Forestry and Communities, 2017). The SFI FSS incorporates 13 Objectives, 21 Performance Measures, and 5 Indicators intended to broaden sustainable forest management and promote biodiversity alongside human wellbeing and economic growth (SFI, 2021b); objectives encompass broad goals, such as “Biodiversity in Fiber-Sourcing” or “Community Involvement and Landowner Outreach,” while Performance Measures nested under Objectives expand upon facets of achieving Objectives. Indicators, nested beneath Performance Measures, offer concrete expectations and directions for program participants, e.g., Indicator 1 of Performance Measure 1.1 mandates that “program participants shall address conservation of biodiversity, individually or collaboratively, through a program which includes one or more of the following approved nonprofits or agencies, such as the Nature Conservancy (SFI, 2015).” The success of adhering to Objectives, Performances Measures, and Indicators is quantified using forestry BMPs.

Forestry BMPs are voluntarily adopted, scientifically based recommendations designed to minimize damage to the system of interest, and though they were developed to protect water quality and reduce sedimentation, they have positive externalities for wildlife (Warrington et al., 2017). In other words, forestry BMPs can assert wide-reaching effects on multiple aspects of an

ecosystem, including biogeochemical cycles, pollution inputs, and species recruitment, which all impact biodiversity. Forestry BMPs are continuously evolving, informed by rigorous research. Existing research indicates that forestry BMPs can be beneficial in managing for conservation objectives, including biodiversity protection; scientifically informed forestry BMPs can establish practices that protect freshwater stream health, including riparian and drinking water resources (Dwivedi et al., 2018; Ice et al., 2021; McEachran et al., 2020) and mitigate point and nonpoint pollution (Abimbola et al., 2021; Krimsky et al., 2021; McEachran et al., 2020). Importantly, forestry BMPs have been shown to support biodiversity conservation and species assemblages across taxa (Demchik et al., 2018; Guzy et al., 2019; Ritterson et al., 2021; Warrington et al., 2017; White et al., 2021). For example, research in the Southern United States has found that forestry BMPs reduce sedimentation (Cristan et al., 2019; Pokhrel and Paudel, 2019) and are cost-effective (Khare et al., 2019).

Although previous studies contain promises, none considers the relationship between forestry BMP implementation rate and biodiversity at the landscape level in the context of existing forest certification standards like the SFI FSS. It is important to establish link between the implementation rate of forestry BMPs and the SFI FSS to care for the rich biodiversity found in the region that enables human wellbeing.

3.3 Methodology

BMP Calculation

BMP implementation rate data were collected for each state from the state’s respective forestry agency (Alabama Forestry Commission, Florida Forest Service, Georgia Forestry Commission, South Carolina Forestry Commission). Surveys were conducted on randomly selected sites which were harvested recently (typically between two survey years). States did not synchronize survey years, but most occurred on a bi- or triannual basis (Table 3.1).

Table 3. 1 Survey years for Alabama, Florida, Georgia, and South Carolina.

State	Survey Years
Alabama	2009, 2010, 2013, 2016, and 2019 (five years)
Florida	2011, 2013, 2015, 2017, and 2019 (five years)
Georgia	2002, 2004, 2007, 2009, 2011, 2013, 2015, 2017, and 2019 (nine years)
South Carolina	2008, 2012, 2014, 2016, and 2019 (five years)

Overall BMP implementation was calculated for each individual surveyed site based on questionnaires originally used by respective state agencies for assessing BMP implementation rate. The number and content of questions varied from year to year and state to state; however, answers were always reported in Yes/No format. The BMP implementation rate was thus calculated for each survey site in each year in each state with the equation:

$$BMP \% COMPLIANCE = \frac{Y}{Y + N} \times 100$$

In which Y = number of “yes” responses and N = number of “no” responses. If the BMP implementation percent was calculated differently by the state agency, it was recalculated by researchers involved in this study using the above formula. This was necessary for ensuring

consistency across selected states in this study. The number of survey sites in all states increased with time.

The coordinates of each survey site were also obtained and imported into ArcMap for spatial analysis using Geographic Coordinate System GCS_WGS_1984 and Projected Coordinate Systems WGS_1984_UTM_16N (Alabama) and WGS_1984_UTM_17N (Florida, Georgia, and South Carolina). Separate Projected Coordinate Systems were utilized because Alabama falls entirely within UTM Zone 16N while Georgia and Florida fall under UTM Zone 17N. TIGER line shapefiles were utilized to delineate state area and boundaries (US Census Bureau, 2021).

Wood Baskets & Overlaps

The names and coordinates of mills certified to the SFI FSS were obtained through the SFI database and cross-verified with state agencies. The year of mill certification was also documented. Once mill locations were imported to ArcMap, buffers were created to represent each mill's wood basket, or the surrounding area from which the mill received wood products. Coastal mills received buffers with a radius of 65 miles (104.6 km) and inland mills received buffers with a radius of 45 miles (72.4 km). Using each mill's year of certification, temporally explicit maps were created to illustrate the locations of certified mills and their wood baskets over time. Spatial analysis was then undertaken to determine how many survey sites fell inside and outside the wood baskets of certified mills each year. Additionally, wood baskets were analyzed to determine how many baskets overlapped with one another (one overlap, two overlaps, three overlaps, three + overlaps), and how many survey sites sat within each overlap category. The average BMP implementation

rate of each overlap was calculated by taking the mean of all survey point BMPs lying within that overlap category in a given year.

Wood Baskets & Overlaps

The names and coordinates of mills certified to the SFI's Fiber Sourcing Standard were obtained through the SFI online database and cross-verified with state agencies. The year of mill certification was also documented. Once mill locations were imported to ArcMap, buffers were created to represent each mill's wood basket, or surrounding area from which the mill received wood products. Coastal mills received buffers with a radius of 65mi (104.6km) and inland mills received buffers with a radius of 45mi (72.4km). Using each mill's year of certification, temporally-explicit maps were created to illustrate the locations of certified mills and their baskets over time.

Spatial analysis was then undertaken to determine how many survey sites fell inside and outside the wood baskets of certified mills each year. Additionally, wood baskets were analyzed to determine how many baskets overlapped with one another (ex. one overlap, two overlaps, three overlaps), and how many survey sites sat within each overlap category. The average BMP implementation rate of each overlap was calculated by taking the mean of all survey points lying within that overlap category in a given year.

Biodiversity and the Map of Biodiversity Importance (MoBI)

Habitat suitability models were developed by NatureServe for 2,216 species. The Map of Biodiversity Importance (MoBI) consisted of all vertebrates, vascular plants, freshwater mussels, crayfish, and selected pollinators with a global conservation status rank of critically imperiled (G1) or imperiled (G2) (Table 3.2). Species selection was based on NatureServe’s accepted taxonomic names and conservation status as maintained in the Biotics database as of September 5, 2019. NatureServe Biodiversity Location Data (BLD) is the primary source of training data for the MoBI.

The MoBI essentially functions as a “heat map” of biodiversity richness, indicating areas used by multiple threatened or endangered species with bright colors and areas used by fewer threatened or endangered species with cool colors. Vascular plants constitute 73% of total taxa represented by the MoBI, and as a result, the MoBI is functionally an index of vascular plant biodiversity that places high importance on land critical to conifers, ferns, and flowering plants (Table 3.2). It may therefore suggest the shared critical habitats of threatened and species like the gopher tortoise (*Gopherus polyphemus*), indigo snake (*Drymarchon couperi*), and frosted flatwoods salamander (*Ambystota cingulatum*) to be “low-value”. It is within the confines of this model that we discuss “biodiversity richness”.

Table 3. 2 Count of imperiled species included in the NatureServe Map of Biodiversity Importance (MoBI) by taxonomic group.

Group	Count of Species
Aquatic Invertebrates	228
Crayfishes	120
Freshwater Mussels	108
Pollinating Invertebrates	43
Bumble Bees	6
Butterflies, Skippers	37
Vascular Plants	1,636
Conifers and relatives	9
Ferns and relatives	21

Flowering Plants	1,606
Vertebrates	309
Amphibians	66
Birds	15
Crocodilians	1
Freshwater and Anadromous Fishes	168
Mammals	24
Reptiles	24
Turtles	11

Modeling extents were developed for each species based on range. For terrestrial species, we independently obtained range information from published sources (IUCN, BONAP) and intersected these data with the HUC10 layer to make a consistent modeling area. For aquatic species, we determined the modeling area automatically by a hierarchical intersection with training data (e.g., if an observation occurred in two HUC8 watersheds, we used the HUC6 watershed that encompassed both).

It was clear from the start that some species were not good candidates for inductive modeling due to a lack of training data or environmental affinities not well captured by available predictor data (e.g., cave species). Our overall approach followed standard modeling methods: attribute presence and background records, variable removal, model validation, final model development, predict model to modeling area, model review, and output final spatial representation of predicted suitable habitat based on review. All data analysis was performed using R Statistical Software, RStudio V 4.0.2. (RStudio Team, 2020). Variable removal, model validation, and the final models (below) were all built using the randomForest package (Liaw and Wiener, 2002) in R. The number of variables randomly drawn to test at each split was chosen to minimize out-of-bag (OOB) error.

Terrestrial species records were grouped by the polygon-based Element Occurrence Record. For species with additional point-based observation data, we defined groups as all records occurring within 1000 m of each other. We placed random points within each polygon using a logistic function where small polygons received points on a per-area basis but the total number of points asymptotes as polygons increase in size (Howard and Schlesinger, 2013). The points maintained their grouping attributions, allowing us to sub-select points while modeling, minimizing pseudo-replication while maximizing our ability to capture the environmental heterogeneity within each presence polygon. Aquatic species were prepped into groups by assigning species occurrence locations to flowlines and grouping all those occurrence flowlines within a specified separation distance into the same group. We manually removed extraneous stream reaches (e.g., tributaries).

For each species, the number of background records drawn from the full pool of background points was set equal to the number of presence points. Thus, for each tree in the forest, a different set of presence and background points were drawn from the full pool of available presence and background points (using the 'sampsize' argument in the randomForest call). The random forest models used for variable removal and model validation used 1000 trees, while the final model built out 2000 trees in the forest. We used leave-one-out validation (Fielding, 2002) as external validation of the modeling process and compiled the mean and error (SD, SEM) for overall accuracy, specificity, sensitivity, true skill statistic, kappa, and area under the curve (Fielding and Bell, 1997) for all the jackknifing runs combined.

The final model utilized all input groups, 2,000 trees in the forest, and the same by-tree sampling method. Once a model of the relationship between presence and background points was built, we predicted the probability the environment at each raster cell or stream reach throughout the modeling area is similar to the environment at known locations. The result is a continuous raster surface or stream network of probability values within the modeling area. We converted the continuous representation to a binary representation of habitat/non-habitat for review by experts by selecting a probability threshold above which all values were classified as habitat.

To define areas of biodiversity importance, we used summed range-size rarity for imperiled species from the MoBI. These data depict summed range-size rarity for Critically Imperiled, Imperiled, and ESA-listed species. High values identify areas where species with very small ranges (and thus fewer places where they can be conserved) are likely to occur; the presence of multiple imperiled species contributes to higher scores. Range-size rarity is the inverse of the species range size. Values range from 0 (no imperiled species) to 1.47 across CONUS. To use these data for analysis of the relationship between forestry practices and areas of high biodiversity value, data was sorted into one of five classes (Table 3.3).

Table 3. 3. Biodiversity data was classified into five categories to facilitate analysis.

Category	Threshold	Percent of CONUS	Reasoning
Very Low	<0.000001	51%	Represents areas highly unlikely to be critical for imperiled species. Lands falling into this category had no habitat for imperiled species or only contained habitat for species with extremely large (>100,000 km ²) range, i.e., wide-ranging bats and small-whorled pogonia, a species for which mapped potential habitat significantly over-represents occupied habitat.
Low	0.000001 – 0.00001	14%	Represents areas highly unlikely to be critical for most imperiled species. Lands falling in this category had no habitat for imperiled species or only contained habitat for species with large (>10,000sqkm) ranges. Some species of conservation significance (ex. red cockaded woodpeckers, southern hognose snakes) have rabbitat predicted in this range.

Medium	0.00001 – 0.0001	18%	Species with RSR values in this threshold include most imperiled vertebrates, plants, freshwater invertebrates, and pollinators occurring in CONUS (99% MoBI species). Areas however contain species with larger ranges and thus more conservation opportunities, and/or fewer imperiled species occurring at the same location than areas classified as <i>high</i> or <i>very high</i> .
High	0.0001 – 0.001	13%	Includes imperiled species with relatively small ranges (<1,000sqkm). 95% MoBI species score at or above this threshold when occurring alone, yet areas represent a relatively small percentage of the project area and a very small percent of total area of CONUS.
Very High	>0.001	5%	Includes imperiled species with very small ranges (<100sqkm) that are thus at very high risk and/or areas where multiple species with relatively small ranges co-occur. These are by far the most critical areas for maintaining biodiversity and preventing species extinctions. 70% MoBI imperiled species score at or above this threshold when occurring alone, but these species have very small ranges and so occupy a small geographic area. While these areas are the “biodiversity gems” on the landscape, because they occupy such little area, small sample sizes of BMP data within this category may complicate analysis.

3.3 Results and Discussion

Influence of the SFI FSS

Spatial analysis illustrates the location of certified mills and the area within their wood baskets (Fig. 3.2). The land area covered by FSS wood baskets has expanded over time in all study states and now covers almost the entirety of Alabama, Georgia, South Carolina, and the working forestlands of Florida. It is clear the reach of the SFI FSS encompasses most of the study region and has steadily increased overtime (Tables 3.4 and 3.5; Fig. 3.3)

Figure 3. 2 Locations of certified mills (A) and the area within wood baskets of certified mills (B) as of 2019.

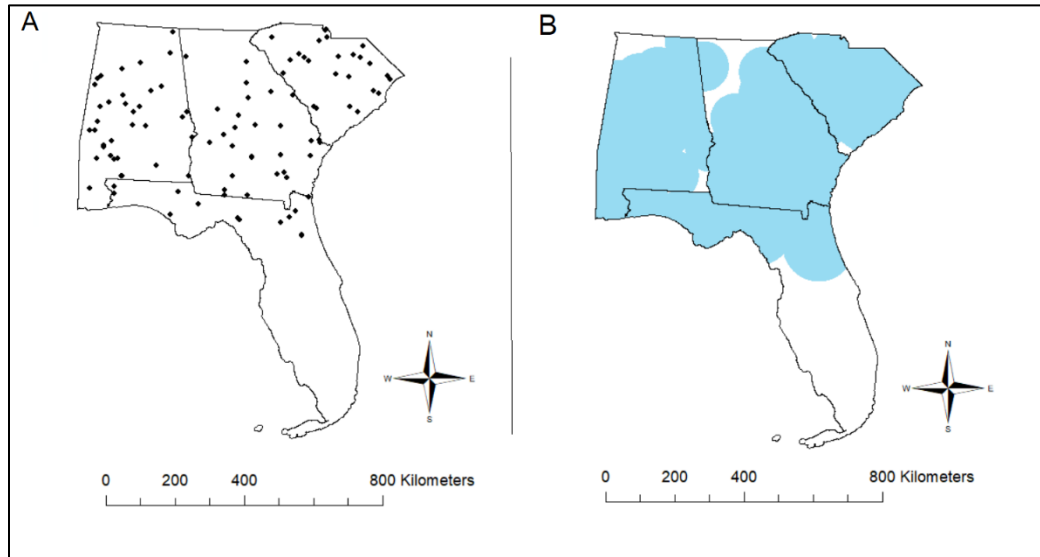


Table 3. 4 Influence of the SFI FSS over time per state per year.

State	Year	Certified Mills (#)	Certified Land (million ha)	% of State	Certified Land (% Change)
Alabama	2009	16	9.01	66.39%	-
	2010	16	9.01	66.39%	0%
	2013	24	11.73	86.44%	+23.18%
	2016	31	12.12	89.13%	+3.22%
	2019	34	12.7	93.59%	+4.57%
Florida	2011	8	7.05	41.37%	-
	2013	9	7.79	45.72%	+9.49%
	2015	11	7.81	45.83%	+0.25%
	2017	11	7.81	45.83%	0%
	2019	14	7.81	45.83%	0%
Georgia	2002	7	8.37	54.35%	-
	2004	8	9.99	64.87%	+ 16.22%
	2007	11	11.43	74.22%	+ 12.6%
	2009	19	13.12	85.19%	+ 12.89%
	2011	22	13.65	88.64%	+ 3.89%
	2013	24	13.71	89.03%	+ 0.44%
	2015	28	13.94	90.52%	+ 1.65%
	2017	33	14.23	92.4%	+ 2.04%
	2019	30	13.98	90.78%	- 1.79%
South Carolina	2008	10	6.15	74.19%	-
	2012	16	6.89	83.11%	7.42%
	2014	18	7.19	86.73%	3.14%
	2016	21	7.31	88.18%	1.28%
	2019	25	8.16	98.43%	10.09%

Figure 3. 3 Progression of the total area covered by the SFI FSS over time for all the selected states.

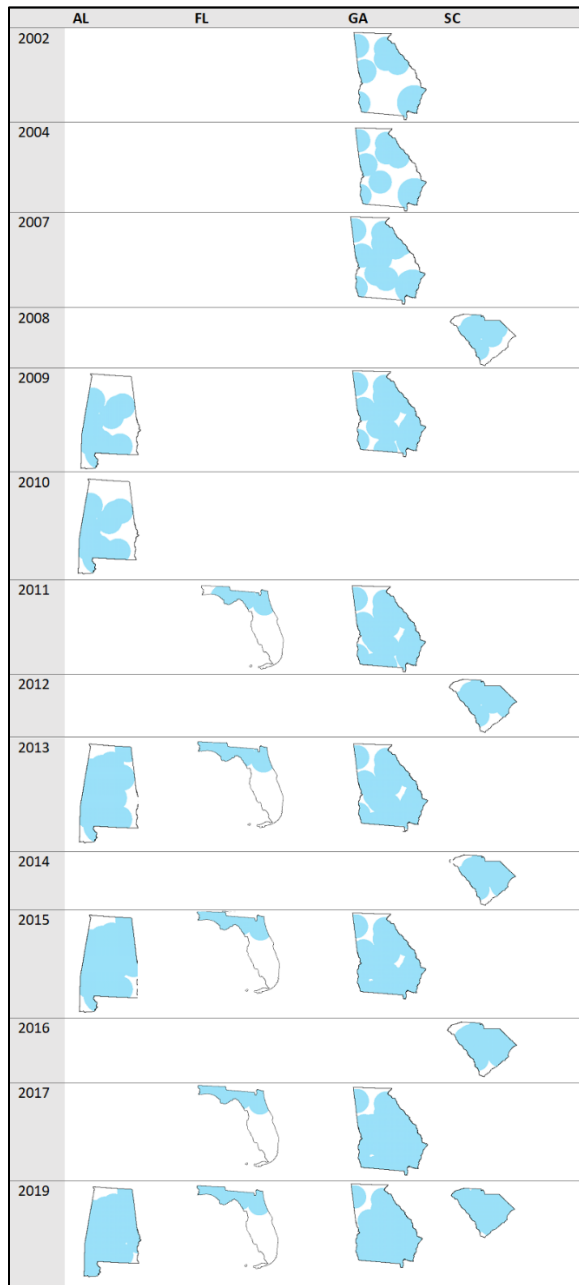


Table 3. 5 Percent of each state under each wood basket overlap category over time in hectares.

State	Year	% 0 Overlaps	% 1 Overlap	% 2 Overlaps	% 3 Overlaps	% 3+ Overlaps
Alabama	2009	34.1	18.1	17	16.7	14.1
	2010	34.2	18.3	16.8	16.8	13.9
	2013	17.3	19	15.4	18.3	30

	2016	11.5	16.8	19	11	41.7
	2019	7.8	14.6	18.3	16.1	43.2
Florida	2011	43.8	30	7.3	16.1	2.8
	2013	32	45.2	7.6	12.9	2.2
	2015	29	32.7	22.9	10	5.2
	2017	29	32.7	22.9	10	5.2
	2019	26	22.9	27.6	15.3	8.2
Georgia	2002	50.7	42.3	5.9	1.2	0
	2004	35.1	57.1	6.5	1.3	0
	2007	26	51.3	18.8	3.4	0.5
	2009	14.3	33.8	22.7	16.9	12.3
	2011	10.4	29.2	26	18.2	16.2
	2013	11	22.7	30.5	12.3	23.4
	2015	9.8	18.8	22.1	17.5	31.8
	2017	7.2	13.6	24	13	42.2
	2019	9.1	13.6	20.1	17.5	39.6
South Carolina	2008	59.6	15.6	11.7	5.3	7.8
	2012	17	10.7	26.5	10.7	34.9
	2014	12.1	10.6	20.5	14.5	42.2
	2016	12.4	3.4	21.7	9.5	53.1
	2019	1.6	7.1	11.5	11	68.8

The data in Fig. 3.3 and Table 3.5 demonstrate that as of 2019, in all the cases except Florida, over 90% of each state sits within at least one wood basket. The northern half of Florida, where most of the state’s forest industry is based, is the focal point of FL mills certified to the SFI FSS. Because most of the working forests of these states are situated within at least one FSS-certified mill wood basket, the impact of the SFI FSS should be proportionally widespread. It is evident the FSS has experienced expansion since the earliest reported survey years.

BMP Implementation Rate

BMP implementation rates were found to be high across space and time. The lowest yearly average was 87.4% (Georgia, 2002) and the highest was 99.94% (Florida, 2016). Our reported BMP implementation rates differ from reports published by the state forestry agencies by an average of 0.13% in Alabama (Alabama Forestry Commission, 2021), 0.9% in Florida (Vowell et al., 2017), 2% in Georgia (Georgia Forestry Commission, 2021), and 1.6% in South Carolina (SCFC, 2021). Differences in reported BMP implementation rates likely arise as we did not include some

questions while estimating BMP implementation rate, as they were not relevant, though state forestry agencies would have used the same in their analysis. For example, Georgia’s 2004 BMP questionnaire included specific questions about trout stream presence/absence on harvest sites and whether Georgia Forestry Commission foresters conducted site surveys.

A preliminary inspection of overall BMP implementation rates over time demonstrates a weak increasing trend with nearly all BMP implementation rates in the latter half of survey years being higher than compliance rates in the first half, suggesting some level of observed improvement. While Wilcoxon tests were run to evaluate whether overall BMP implementation rates significantly varied from year to subsequent survey year and whether the most recent data significantly differed from the earliest reported data, Table 3.6 shows results are not statistically significant at $\alpha = 0.05$. Florida years 2009 and 2011 and Georgia years 2007 and 2009 reported significant differences at $\alpha = 0.1$. The reported significance at 10% for comparison of Florida’s first and last survey years indicate that Florida’s BMP implementation rate has significantly risen since the first recorded survey year. In the case of Georgia years 2007 and 2009, a significant difference at 10% may indicate a critical jump in adherence within a short period. In all cases, BMP compliance rates demonstrate a positive, but generally nonsignificant, trend.

Table 3. 6 Average BMP compliance rate for each year and state.

State	Year	Av. BMP
Alabama	2009	96.8
	2010	97.4
	2013	98.1
	2016	96.9
	2019	98.2
Florida	2011*	99.1
	2013	99.5
	2016	99.6

	2019*	99.9
Georgia	2002	87.4
	2004	90.8
	2007*	93.7
	2009*	94.5
	2011	92.7
	2013	92.6
	2015	92.5
	2017	96
	2019	95.8
South Carolina	2008	92.9
	2012	93.6
	2014	93.8
	2016	96.4
	2019	96.8

* = $p < 0.1$

To determine whether the difference in BMP implementation rate inside and outside wood baskets was significant, Wilcoxon tests comparing the average BMP implementation rate of harvest sites inside and outside at least one wood basket were conducted (Table 3.7). Florida was the only state to report significance ($p = 0.03$), suggesting that in Florida, the FSS's mandate to comply with BMPs has resulted in significant compliance differences inside and outside FSS wood baskets, with BMPs being generally lower inside wood baskets than outside. The expansion of the FSS may facilitate greater adherence to BMPs, broadening the reach of sustainable forest management beyond certified forests (Dwivedi et al., 2018).

Table 3. 7 Average BMP implementation rates inside and outside the wood baskets.

State	Year	Inside Av.	Outside Av.
Alabama	2009	97.6	96.8
	2010	97.6	97.3
	2013	97.6	98.5
	2016	97.6	96.4
	2019	98.4	98
Florida**	2011	98.7	99.4
	2013	99.1	100
	2015	99.1	100
	2017	99.8	100
	2019	99.8	100
Georgia	2002	87.7	87.1
	2004	91.7	89.8
	2007	93.1	94.2
	2009	94.7	94.4
	2011	90.5	94.9

	2013	92.6	92.5
	2015	92.6	92.4
	2017	93.1	99
	2019	94.7	96.9
South Carolina	2008	91.7	93.1
	2012	93.6	93.3
	2014	93.8	94.1
	2016	96.3	98.3
	2019	96.8	n/a

** = $p < 0.05$

Spatial analysis in ArcMap then elucidated the average BMP implementation rate for each overlap category (0 overlaps — 3+ overlaps) across all survey years (Table 3.8). Wilcox tests in R compared the average BMP implementation rate for 3+ Overlaps against all other overlap categories. Florida wood baskets 0 and 3 barely escape 5% level significance ($p = 0.057$).

Table 3. 8 BMP implementation rate average for overlap categories.

State	Year	0 Overlaps	1 Overlap	2 Overlaps	3 Overlaps	3+ Overlaps
Alabama	2009	96.8	97.8	98	97.3	97.2
	2010	97.3	97.5	98.7	96.7	97.7
	2013	98.5	95.6	98.8	98.5	97.6
	2016	96.4	98.2	97.1	97.4	99.2
	2019	98	99.5	95.9	99.8	97.9
Florida	2011	99.4*	98.43	99.3	98.4*	99.7
	2013	100*	97.9	99.6	99.7*	99.7
	2015	100*	99.1	99.3	98.9*	99.9
	2017	100*	100	100	99.7*	99.7
	2019	100*	100	99.7	99.8*	99.8
Georgia	2002	87.1	87.1	91.73	88.5	n/a
	2004	89.8	91.9	89.72	94.1	n/a
	2007	94.2	94.1	91.2	91.6	88
	2009	94.4	95.2	93.5	94.4	95.9
	2011	94.9	89.6	91.1	92	89.8
	2013	92.5	92.4	89.9	93.3	89.7
	2015	92.4	91.4	92.1	92.6	93.4
	2017	99	95.7	95.1	93.9	91.5
	2019	97.5	96.6	95.2	95.6	93.4
South Carolina	2008	91.7	92.5	92.5	93.3	94.6
	2012	93.3	96.3	94.8	89.8	93.9
	2014	94.1	100	98.1	86.2	93.1
	2016	98.3	98.9	96.7	96.9	95.8
	2019	n/a	83.9	98.8	95.7	97.3

* $p < 0.1$

Because significance was reported in only one case, BMP implementation rates are unlikely to vary significantly among overlap categories. In other words, the SFI FSS appears to produce consistently high BMP implementation rates across space and time. Florida represents the exception to this finding, in which the average BMPs for 0 Overlaps are significantly higher than BMPs for 3 Overlaps ($p = 0.057$). Florida also demonstrated an unusual result in that the average BMP implementation rate was higher outside wood baskets. Taken together, these findings may suggest an especially widespread focus on sustainable forestry management in the state. The FSS’s influence and mission may have successfully expanded beyond its wood baskets, or a trend toward sustainable forest management could be gaining traction in the forestry sector regardless of the SFI FSS.

Biodiversity Impacts

Spatial biodiversity analysis yielded the mean BMP implementation rate for each year, state, and biodiversity value “BioValues” (ex. “Medium Biodiversity Value, 2 Wood Basket Overlaps, Alabama, 2019”). Full results are given in the Supplementary Information document and an abbreviated version showcasing total BioValue percent per state is given in Table 3.9.

Table 3.9 Average BMP implementation rates for each Biodiversity Value class per state

	Non-natural Land Cover	Very Low	Low	Medium	High	Very High
Alabama	98	96	98	98	97	98
Florida	99	100	100	100	99	99
Georgia	93	91	94	93	93	94
South Carolina	95	94*	94	93	95	89*

* $p < 0.1$

The only significant finding comparing BioValue classes of the same state against each other occurred in South Carolina, in which Wilcoxon tests compared “Very Low” and “Very High” values of biodiversity. This result indicates that South Carolina is the only state in which BMP implementation rates vary significantly in critical versus noncritical habitat, and more specifically, the average BMP implementation rates for “Very High” BioValues are significantly lower than those in “Very Low” BioValue. However, because South Carolina is the only state to register any significance ($p = 0.057$), it is possible that it is the exception rather than the rule. Regardless, the data demonstrate critical biodiversity habitat in South Carolina generally receives significantly lower BMP implementation than noncritical biodiversity habitat.

Additionally, Wilcoxon tests were conducted to compare the average BioValue of each state against all others, and significant differences were reported in all cases ($w=36$, $p \leq 0.05$) except in the Georgia-South Carolina test ($w=36$, $p > 0.1$). Given that the Southeast is already the nation’s most biodiverse region (Pimm et al., 2014), these results suggest the biodiversity value of these already biodiversity-rich states is significant even when compared to each other. In other words, the data signal that the biodiversity value of the Southeastern United States is especially critical with particular emphasis on vascular plants.

Specific analysis found the total percent BMP compliance rate for each BioValue class inside the overlap categories of each state per survey year. Full results are given in the Supplementary Information and an abbreviated version of the difference in percentage points over time for average

BMP compliance rates in each BioValue class per state is given in Table 3.10. Wilcox tests on this data found no significant difference between overlap classes and BioValues for any state.

Table 3. 10 Changes in average BMP implementation rates over time comparing the earliest and most recent years of data. Shaded cells indicate there were either no survey points in that category present in the earliest survey year (light grey) or latest survey year (dark grey). The earliest survey year for each state is given in parentheses.

	BioValue	0 Overlap	1 Overlap	2 Overlaps	3 Overlaps	3+ Overlaps
Alabama (2009)	Very Low	+100	+92	n/a	-100	-8
	Low	0	0	-2	+1	-10.01
	Medium	-2	+2	+3	+5	0
	High	+6	0	-1	+1	+2
	Very High	+1	-1	0	+15	+3
Florida (2011)	Very Low	0	0	0	0	+100
	Low	+100	-100	0	+1	0
	Medium	+1	+1	+1	+1	0
	High	+1	+3	0	+1	0
	Very High	-100	-100	0	+4	+1
Georgia (2002)	Very Low	-92	-84	9	+24	+95
	Low	+10	+6	-1	+95	+91
	Medium	-84	-2	+19	n/a	+97
	High	+10	+11	+4	+96	+94
	Very High	+7	-96	+93	-8	+97
South Carolina (2008)	Very Low	-93	-94	-93	-93	+6
	Low	n/a	-95	+97	-8	+2
	Medium	-94	-93	+5	+16	+0
	High	-89	-19	+10	+16	-1
	Very High	-91	-6	-90	+1	+1

Because Wilcox tests found no significance among average wood basket BMP implementation rates across BioValue, a tract of forestland is statistically unlikely to experience environmental degradation as a result of lying within multiple wood baskets or outside any wood basket. The data suggest all forestland, regardless of biodiversity value, typically receives the same level of scrutiny when harvested. Together, these findings imply that the FSS facilitates the same level of adherence to sustainable forest practices in all cases across critical and noncritical habitats alike for the species included in the MoBI.

3.5 Conclusion

Urgent transformative change of institutions to protect biodiversity is critical to safeguarding the prosperity of future generations (Dasgupta, 2021), and our data suggest the ecological protections extended by the SFI FSS could constitute part of the solution.

Spatial and statistical analyses conducted in ArcMap and R indicate the SFI FSS has expanded over time to encompass over 90% of Alabama, Georgia, and South Carolina, and almost 50% of Florida clustered around its timber-producing northern half. Compliance rates demonstrate a slight but generally insignificant increasing trend over time and now average >90% for all states in all wood basket overlap categories (Table 3.8), expressing a widespread adoption of BMPs throughout the Southeastern United States. BMPs are not likely to vary significantly in any overlap category except in Florida among overlap categories zero and three ($p = 0.052$), suggesting special observation may be warranted in harvests in this category to ensure maximum compliance. Florida, however, reports the highest BMP implementation rate for harvest sites both inside and outside wood baskets, and its averages are greater than those of other states, suggesting that even though the BMP implementation rate inside wood baskets is lower than outside wood baskets, it still consistently delivers high implementation rates.

The widespread nonsignificance of all other statistical tests of wood basket overlaps and BMPs indicates that in general, no emphasis exists for critically biodiverse regions; rather, all forestland is afforded the same level of environmental protection. Our findings indicate widespread excellent average adherence to BMPs in all biodiversity categories, not just areas of conservation priority.

The exception to this finding was South Carolina, in which critical biodiversity habitat reported significantly lower BMP implementation when compared to noncritical biodiversity habitat at level 10% significance. Particular care should be taken in the future to ensure that South Carolina's high-value biodiversity habitats receive stringent conservation attention. BioValues "High" and "Very High" were above 90% in all the cases except South Carolina, which suggests critical habitat indeed receives rigorous protection in most areas in the Southeastern United States. This is especially critical given that the Southeast region is the most biodiverse in the nation (Jenkins et al., 2015; Pimm et al., 2014) and is the United States' leading producer of forest products and forest-based jobs (GFA, 2021). These consistently high BMP implementation rates within wood baskets indicate due care is generally applied during timber harvests regardless of how many wood baskets a harvest site lays within, and high compliance outside any SFI FSS wood basket suggests the trend of sustainable forestry is spreading beyond wood baskets.

The chief finding of this research is that high BMP adherence rates across the Southeast, with very little perceived difference in adherence occurring between across various categories of biodiversity areas, suggest the SFI FSS's mandate to comply with BMPs in exchange for certification equally protects forestland across the biodiversity value spectrum. Cases that demonstrate otherwise appear to be exceptions rather than the rule.

Because BMPs and forest certification are voluntary, increased adoption of the FSS indicates the market plays an increasingly important role in environmental regulation. This stands in contrast to the traditional governmental or legislative approach to environmental protections. The success of

FSS may indicate that forest certification and other nongovernmental, market-based tools could reduce or preempt the need for formally legislated protections. Growth of the FSS label on products may also trigger an increase in consumer awareness of benefits of forest certification and contribute to its future success. Operations opting out of certification programs may then find themselves at a disadvantage in the marketplace.

It is important to interpret these findings in the context of the MoBI, which functions as a heat map of biodiversity richness and is heavily influenced by vascular plants, which account for 73% of species. These findings, therefore, primarily discuss “biodiversity” in the context of vascular plants. Areas of “low” biodiversity value should not be written off as areas of low biodiversity value in general, but rather areas not critical to most vascular plants but potentially critical to numerous amphibian, avian, insect, and/or aquatic species, which do not have weighed representation on the MoBI. In addition, this study does not establish causality, but rather explains how BMP implementation rates may correlate with areas of high biodiversity value.

It is evident from the data that BMPs are successfully being implemented across space and time in a critically biodiverse region. BMPs could be a practical and effective tool for biodiversity preservation because of this. However, to deliver on the promise of environmental protection, the BMPs being implemented must be informed by rigorous scientific study. Therefore, it is critical to pair the SFI FSS and its reliance on BMP implementation with well-studied BMPs that effectively promote environmental wellbeing. Future research on FSS and biodiversity could identify the most critical BMPs for specific biodiversity hotspots or endangered or threatened

species, examine the SFI FSS at the community or ecosystem level, or examine the FSS at the landscape level in additional highly biodiverse, ecologically distinct regions, e.g., the temperate rainforests of Washington. For studies focusing explicitly on fauna, additional research might also incorporate weighted measures of taxa richness to account for the abundance of vascular plants in proportion to other taxa.

CHAPTER 4: CONCLUSION

The intent of this thesis was to evaluate the sustainability of forest resources in the United States. Within that context, it sought to elucidate the ways in which mass media portrays forest certification across different regions of the country, as mass media can be a significant shaper of public opinion and channel of discourse. It also modeled the reach of the Fiber Sourcing Standard over time and space, including in critical habitats, to evaluate the effectiveness of the FSS to protect biological diversity. It is the first study to examine the relationship between the FSS and biodiversity at the landscape level.

This study evaluated 309 print and digital news articles published from 1989 to 2020 and analyzed their content to detect economic, environmental, and social overtones toward forest certification, positive, neutral, and negative attitudes toward forest certification, and prevalence of three certification schemes across six U.S. regions. It also evaluated the impact of the Fiber Sourcing Standard on three ecologically and economically significant Southeastern states by comparing BMP implementation rates across wood basket overlaps and biodiversity value categories over space and time.

Our first major finding is that media portrayal of forest certification varies highly by region and that the number of articles published in a state does not reflect the contribution of forestry to its economy. Economic and environmental facets of forest certification were the most discussed both nationally and at the state level. FSC and FSC+PEFC were the most dominant schemes in media

coverage, although some regions preferred SFI. The Northeast was the leading regional publisher of forest certification news articles. The second significant conclusion from this thesis is that because BMP implementation rates are not likely to differ based on location inside, outside, or within multiple wood baskets, and because BMP implementation rates are high in all biodiversity value categories, the FSS is likely successfully extending environmental protection to uncertified forestlands across the biodiversity value spectrum, including high and very high biodiversity value areas. The FSS and biodiversity should be interpreted within the confines of the MoBI, which is heavily weighted toward vascular plants (73%).

We expect results of this research to help situate forest certification as a tool for forest resource conservation. Results from the media study can directly feed in to crafting specific solutions to address the concerns about certification raised by each U.S. region. Results from the FSS study can establish the FSS as an effective conservation measure that delivers on its promise of broadening the reach of sustainable forest management and encourage its implementation across other U.S. or Canadian regions, facilitating biodiversity conservation in more uncertified working forests.

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