

ABSTRACT

FIELDING, DIANE COOPER. Perceptions of Biomass Harvesting Guidelines in North Carolina: A Qualitative Analysis of Forest Managers, Loggers and Landowners. (Under the direction of Dr. Frederick Cabbage).

In light of increasing interest in renewable energy, there has been recent focus on woody biomass as a renewable energy source. North Carolina has potential to be a large supplier for woody biomass in the future, as more than half of the state land cover is made up of forest land. North Carolina has forestry best management practices (BMPs) which are recommendations to minimize impacts on streamwater quality during timber harvesting and forest management. However, these guidelines do not currently address the harvesting of woody biomass. Several other U.S. states have adopted guidelines specifically for the harvesting of woody biomass, known as biomass harvesting guidelines (BHG), and there is a possibility that North Carolina will do the same. The objective of this study was to assess the economic and operational feasibility of BHGs. This was achieved by gaining insight into the perspectives of forest loggers, professional loggers, and forest landowners through semi-structured interviews. Results indicated that North Carolina forest managers, professional loggers, and forest landowners opposed the adoption of BHGs. Four main themes emerged from interviews with all groups which include: (1) current best management practices are successful in North Carolina, (2) woody biomass harvesting is only an additional component to harvesting with little or no modification to operations (3) lack of scientific research supporting claim that harvesting biomass leads to adverse effects on soil, water quality, timber productivity and wildlife habitat. Foresters and loggers suggested that BHGs may constrain the profitability of biomass harvesting, BHG implementation may prove to be difficult and BHGs are a result of the public's distrust of the forest industry and the public's

fear of a desolate site. The economic difficulties of the logging business permeated throughout the logger interviews. Themes that emerged from the landowner interviews included: (1) the need for a clear definition of biomass, (2) an interest in woody biomass as an additional forest product, (3) the need for government support of the woody biomass market and (4) the desire for fewer restrictions on private forest management. Respondents also cited a number of possible benefits that may arise from the implementation of BHGs which include: reduced site preparation costs, increased business for consulting foresters, increased proactive forest management, reduced fire hazard, soil stabilization and erosion control, and an increase in wildlife habitat. The findings from this qualitative study point to several recommendations in developing appropriate forest policies and incentives for practicing sustainable forestry on privately owned land.

Perceptions of Biomass Harvesting Guidelines in North Carolina: A Qualitative Analysis of
Forest Managers, Loggers and Landowners

by
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DEDICATION

To my parents, Robert and Debra Cooper, for their unconditional love and support.

BIOGRAPHY

Born and raised as an only child in South Louisiana, Diane spent her summers enjoying the surrounding forests and swamp lands. She graduated from Louisiana State University in 2007 and earned a B.S. in International Trade and Finance and Economics. She also spent time studying “abroad” at The University of Hawai’i at Hilo, where she took classes in Hawaiian ethno-botany, Hawaiian culture, and learned how to surf. After a travel stint to New Zealand and Australia, she took a position with a hospital in Baton Rouge, Louisiana as a financial analyst. The many days spent inside a cubicle inspired her to apply to graduate school. She enrolled in North Carolina State University’s natural resources policy and administration program and was very lucky to travel to Ecuador to participate in a travel seminar on sustainability with Harvard University, attend a forest conservation study tour in southern Chile, spend a month in Sweden learning about renewable energy and enjoy long afternoons chatting with landowners and loggers in the forests of North Carolina. Soon after graduation, Diane is moving to Denver, Colorado where she and her husband will be found hiking and camping in the Rocky Mountains.

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CHAPTER 1. INTRODUCTION

Background

The demand for renewable-based energy has increased as fossil fuel prices and concerns of climate change mitigation continue to rise. On August 20, 2007 with the signing of Session Law 2007-397, North Carolina became the first state in the Southeast to adopt a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) (North Carolina General Assembly 2007). Under this new law, investor-owned utilities in North Carolina will be required to meet up to 12.5% of energy needs through renewable energy resources or energy efficiency measures by the year 2020. (North Carolina Utilities Commission 2010). On a national level, the Energy Independence and Security Act of 2007 mandated increases in the production of biofuels with 60 percent to be derived from cellulosic fuel stock. In May 2009, President Obama issued a presidential directive to dramatically increase funding for biofuels.

These policies are likely to put pressure on energy producers to consider woody biomass, a renewable feedstock, as a source of energy (Aguilar 2009). In this study, woody biomass includes small diameter trees, tops, limbs, or otherwise non-merchantable forest products which are used for energy production and have not been utilized previously. The REPS have increased the opportunity of forest products to be used in energy production. According to La Capra Associates (2006), biomass is expected to be the largest contributor of renewable energy sources to REPS. North Carolina's Strategic Plan for Biofuels Leadership of 2007 established a goal of 10 percent of North Carolina's liquid fuels to be derived from in-state biofuels by the year 2017.

The woody biomass from North Carolina is expected to contribute greatly to electricity and fuel production. A likely increase in the demand for woody biomass has led to growing concern about the impact this may have on the natural environment. North Carolina has required forest practice guidelines (FPGs), which are linked to recommended forestry best management practices (BMPs)—voluntary guidelines that aim to protect water quality. However, these guidelines do not specifically address the harvesting of woody biomass. This project aims to understand and assess the perceptions and attitudes of forest managers, loggers, and landowners regarding biomass harvesting guidelines and biomass removal strategies.

U.S. Energy Consumption

In 2009, 24 percent of the energy consumed in the United States was imported (EIA 2010). With increasing concerns of climate change, carbon emissions and rising costs of energy, the United States has heightened interest in reducing reliance on imported fossil fuels and establishing energy independence. This sentiment of energy independence has been expressed continually in the media and particularly in political rhetoric. A great deal of the renewable energy focus has been on utilizing forest products for energy, otherwise known as woody biomass. In the United States, 30 percent of renewable energy needs in the United States can be met from biomass sources and 27 percent of that amount can be met by products from the forest (Perlack 2005). Other sources, such as the International Energy Agency, believe that biomass has the potential to meet 50 percent of the world's energy demands. Woody biomass can produce several forms of energy such as electricity, thermal

energy or heat, combined heat and power (CHP) and liquid biofuels including ethanol and biodiesel. The use of woody biomass can potentially reduce the dependence on foreign oil and fossil fuels, which may lessen carbon emissions by using renewable fuel sources or “home-grown” fuel (Megalos 2009). In the United States, eight percent of energy consumption is derived from renewable sources and wood and wood waste provides about 24 percent of this total (Figure 1) (EIA 2010).

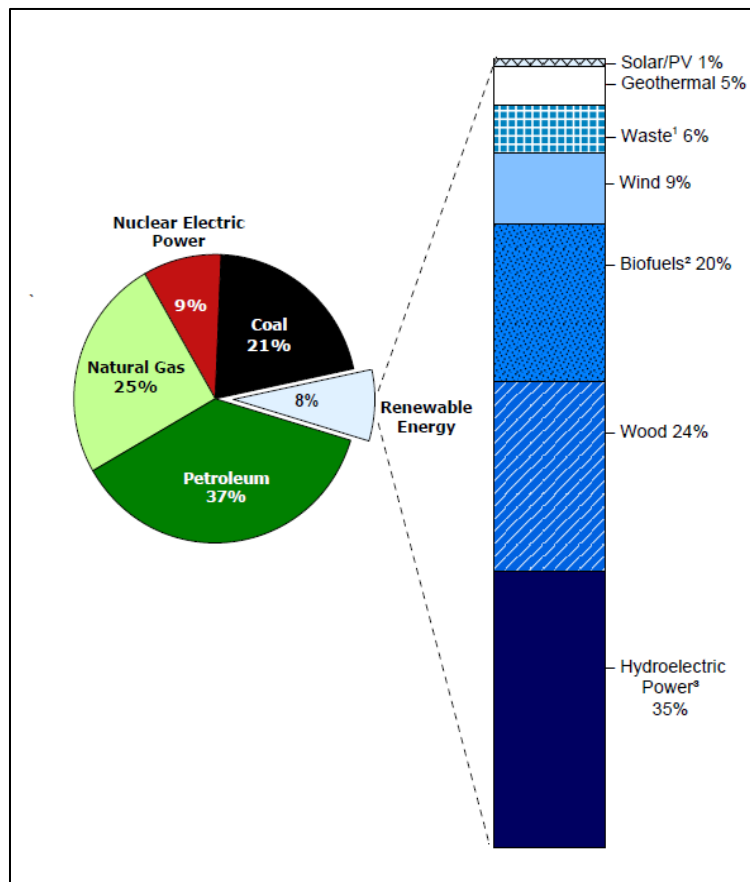


Figure 1: U.S. Renewable Energy as Share of Total Primary Energy Consumption in 2009 (EIA 2010)

Woody Biomass as Energy Source

The direct combustion of wood is one of the earliest forms of renewable energy (Perlin 1989). Woody biomass is also known as “dirty chips” or “hog fuel”. Dirty chips are a low-value product that consists of logging residues such as limbs, tops, snags, and any small diameter material may be used for energy production. The woody biomass material is harvested using a chipper during conventional timber harvesting operations. Paper mills and energy production facilities purchase this material based on the green ton and utilize the material, as well as mill waste, as an energy source. In 2007, the woody biomass market was estimated to be worth \$6.5 billion and rising (Summit Ridge Investments 2007). There are approximately 8.3 million green tons of harvestable biomass from logging residues in North Carolina (North Carolina Extension Forestry 2009) and 25 to 45 percent of logging residue is left on site after a timber harvest (Megalos 2008).

Converting woody biomass to energy in North Carolina is not a new concept and has been used in the industrial sector for a number of years. However, legislation such as REPS and programs like the Biomass Crop Assistance Program (BCAP), which provides financial assistance to the harvesting of biomass feedstock, have increased opportunities for using wood products as an energy source. The expansion of woody biomass-based energy raises concerns of forest sustainability, environmental degradation, and negative impacts on biodiversity (Benjamin 2010).

Best Management Practices

In the United States, forests are regulated at the state level. All 50 states have forestry best management practices (BMPs) in place to minimize impacts on streamwater quality during harvesting operations. Forestry BMPs were adopted in response to the Federal Water Pollution Control Act Amendments in 1972 and the Clean Water Act in 1977 to control nonpoint source of pollution. Nonpoint sources of pollution include pollution from diffuse sources, and are reported as the leading cause of water quality problems (EPA 1994). Forest practices have the potential of degrading water quality due to the changing of the temperature and decreasing concentrations of oxygen, increasing nitrate-N and suspended sediment (Binkey and Brown 1993) which may have significant impacts on the sustainability of forest ecosystems. Since nonpoint sources of pollution are difficult to monitor and quantify, impacts are usually measured by BMP implementation and effectiveness (Ice et al. 2010). Secondary goals of BMPs include the maintaining of site productivity, wildlife habitat, protection of historical sites, and aesthetics (Aust and Blinn 2004). BMPs incorporate the best known science (Blinn and Kilgore 2001) and have become widely accepted as a means to protect water quality and reduce soil erosion (Cubbage 2004). BMPs primarily advise recommendations of the establishment of buffer zones, also known as streamside management zones. Several studies have shown that BMPs are effective when implemented correctly and water quality impacts are reduced (Aust and Blinn 2004; Ice 2004, Jackson et al. 2004). However, costs of implementation can reduce gross harvest revenue by one to five percent (Cubbage 2004).

BMPs are either voluntary or mandatory, depending on the state. BMPs are voluntary in North Carolina but provide strategies to ensure compliance with Forest Practice Guidelines (FPGs), which are mandatory requirements. FPGs were developed to protect water quality as part of the North Carolina Sedimentation Pollution Control Act of 1973 (SPCA). The North Carolina Division of Forest Resources (NCDFR) recommends using BMPs as the primary method of adhering to the FPGs. Although BMPs are voluntary, these “soft laws” still widely influence forestry practices and have high compliance rates since social pressures often have more influence than government regulations (Kilgore and Blinn 2004).

The development and implementation of BMPs in North Carolina have been successful. In 2003, the NCDFR completed a study that reported the implementation of BMPs in North Carolina as 82 percent. BMPs in North Carolina do not specifically address the harvest of woody biomass, which is a concern of many forest policy stakeholders. An increase in demand for wood to be used for energy has the potential to affect soil productivity, water quality, and forest biodiversity and could negatively affect forest health (SGSF 2009; Benjamin 2010). There is also anxiety over harvesting whole trees for energy rather than stem only harvests since the leaves and branches retain considerably more nutrients (Pierce 1993). In March 2010, the North Carolina Environmental Management Commission reported, regarding the emerging woody biomass industry,

Without proper protections, significant impacts are possible in the areas of land use (e.g. conversion of old growth forests to plantation), soil nutrient deterioration, water quality degradation, destruction of wildlife habitat, ecosystem disruption, air quality, and ash deposition (EMC 2010).

Various environmental non-governmental organizations (ENGOS) such as the Forest Guild, Environmental Defense Fund, the National Wildlife Federation and the Pinchot Institute for Conservation have expressed concern of harvesting woody biomass and the effect on sustainability. As an example, the National Wildlife Federation (2010, 20) recently published a report that states,

Harvesting biomass from forests, if overdone, can expose soil to drying and erosion, reduce biodiversity, reduce organic matter, reduce stored carbon, eliminate habitats, pollute water and harm pollinators.

These organizations echo many of the same fears that the public has over maintaining the sustainability of woody biomass harvests in the event of market expansion.

Biomass Harvesting Guidelines

The increase in attention on renewable energy has led to a growing concern regarding the sustainability of harvesting of woody biomass (Damery 2009; Benjamin 2010; Pinchot Institute 2010). The states of Maine, Minnesota, Missouri, Pennsylvania and Wisconsin currently have drafted or published biomass harvesting guidelines (BHG) and more are under consideration (Evans and Perschel 2009). These guidelines are not mandates but rather recommendations. The removal of biomass may affect site productivity, wildlife habitat or biodiversity (SGSF 2009). BHGs are established to maintain diversity, protect soil and water quality and provide wildlife habitat. However, there is no consensus of whether or not biomass harvesting has the ability to affect nutrient cycling in the forest (Pinchot Institute 2010).

To minimize the impact of biomass removal, BHGs generally recommend leaving 15 to 30 percent of harvestable coarse woody debris (CWD) on the site following a harvest (Evans and Perschel 2009). BHGs typically provide guidance on the form of debris retention, either spreading out or piling the woody debris that remains on a harvesting site. Minnesota established BHGs in 2007, which recommend that fine woody debris should be spread out relatively evenly across the site, rather than left in piles. Minnesota BHGs also recommend retaining 33 percent of the residual tops and limbs following a harvest. Wisconsin recommends retaining and scattering the tops and limbs from 10 percent of trees harvested on the site (one tree of every 10 trees harvested). The province of New Brunswick, in Canada, has biomass harvesting guidelines which take the geography and nutrient levels of the site into consideration to determine whether or not biomass material is harvested (DNR New Brunswick 2008).

There are challenges in these guidelines such as the feasibility of implementation, particularly when applying BHGs developed in other states for harvesting system different than those typically used in the Southeast. There are also challenges in the formation of guidelines. BHGs tend to borrow guidelines from existing recommendations in other states (Evan and Perschel 2009) which may or may not be similar in geography and site index. Other challenges include mode of estimation and retention of CWD and methods of enforcement. There are also opportunities that may be provided with an increase in biomass harvesting guidelines such as reduced site degradation, reduced fire hazard, improvement of soil quality, reduction in erosion and enhancement of wildlife habitat and biodiversity.

Forest Certification

Forest certification programs such as the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI) have requirements similar to BMPs for the protection of water quality. These certification systems have considered providing guidance similar to BHGs and these programs are likely to have influence over biomass harvesting operations on both certified forests and the BHGs of individual states. However, currently neither certification system has guidelines specifically for the harvesting of woody biomass.

Human Dimensions

Adaptations in forest communities are usually driven by “engines of social change” (Force 2000). Understanding the attitudes of stakeholders in the forestry community is crucial in making beneficial changes in management. The Forest Service’s National Human Dimensions of Ecosystem Management Task Team has defined the term “human dimensions” as:

An integral component of Ecosystem Management recognizing that people are part of ecosystems, that people’s pursuits of past, present, and future desires, needs, and values (including perceptions, beliefs, attitudes, and behaviors) have influenced and will continue to influence ecosystems, and that ecosystem management must include consideration of the physical, emotional, mental, spiritual, social, cultural, and economic well-being of people and communities (USDA Forest Service 1994, 4).

Policy decisions regarding the conservation or utilization of natural resources often leads to contentious communication between stakeholders. This lack of consensus between groups escalates environmental conflicts (Webb 2008) and makes it difficult to implement policy (Mills and Clark 2001). Policy decisions are often made without the discretion or trust

of natural resource managers (Mills and Clark 2001) and therefore, the disputes are ongoing. The implementation of human dimensions research has led to improved relations and increased cooperation between land managers and private landowners (Decker et al. 1992).

Literature Review

Previous studies have explored the perceptions of the general public (Plate et al. 2010; Susaeta 2010) and forestry stakeholders (Stidham 2010) regarding the industry of converting woody biomass to energy. There has been previous research which examined perspectives of forestry professionals related to best management practices. Husak and colleagues (2004) gathered the perspectives of forest landowners, forestry consultants, and timber industry professionals in consideration of BMPs. They found all groups to have positive perceptions of benefits received from the implementation of BMPs. Alden and colleagues (1997) surveyed timber harvest business owners and loggers in Minnesota to learn more about the overall costs and benefits of BMPs and found that timber harvesters were well acquainted with the guidelines and a majority (85 percent) believed that costs of implementing BMPs substantially exceeded benefits.

Forest Managers

A few studies have analyzed foresters' perspectives of harvesting woody biomass. Schulte and colleagues (2008) conducted interviews with foresters in the U.S. Midwest to learn more about the market for woody biomass. Forester respondents suggested leaving 33 to 55 percent of residues on site following a harvest for the improvement of soil quality and

wildlife habitat. Enrich and colleagues (2009) conducted surveys of foresters across the U.S. to gather perspectives of opportunities and challenges of harvesting wood for energy. According to respondents, the primary method of harvesting biomass was in conjunction with a conventional harvest. Aguilar and Garrett (2009) surveyed foresters and found that the main opportunities from utilizing woody biomass were considered to be increased business for loggers and harvesters and an increase in commercial thinnings. Labriole and Luzadis (2011) investigated the perspectives of New York foresters concerning climate change and how their views could affect forest management decisions. Seventy-six percent of foresters “felt strongly” that climate change is occurring and 70 percent believed that it could affect the forest products industry in the future.

Loggers

There have been previous studies which explore logger attitudes towards the forest industry (Keefer 2001; Keefer 2002; Grado 2002; Habig et al. 2005), logging and safety training programs (Bihun and Jones 1993; Smidt 1994; Reeb 1996; Egan 1997) and environmental problems (Dunk 1994). Keefer (2002) surveyed loggers in Pennsylvania and found they were an average age of 43 years and had been logging for an average of 19 years. Egan and Taggart (2004) studied loggers in Maine, New Hampshire and Vermont and found that the average logger had 11.8 years of education and only 51 percent believed they would still be employed in the logging sector in five years. Sixty-nine percent of respondents did not encourage their children to become loggers. Milauskas and Wang (2006) surveyed loggers in West Virginia and found 89 percent of loggers to “always” comply with BMPs.

Mehmood and colleagues (2009) conducted a survey of Arkansas loggers concerning the costs and training durations of BMPs and Sustainable Forestry Initiative standards. More recently, Bolding and colleagues (2010) surveyed Virginia loggers regarding harvesting methods, BMP implementation and overall challenges of the logging business.

Communication analyses of the forestry community, particularly the perspectives of loggers regarding environmental policy, have been rare (Peterson 1995). At present, there is very little literature about North Carolina logger perspectives.

Landowners

Several studies have addressed landowner perspectives regarding forest management (Bliss et al. 1994; Bliss 1997; Dutcher 2004; Measells 2005). Londo (2004) examined Mississippi forest landowners and found that NIPF landowners had a low level of knowledge regarding BMPs. Many studies have been conducted to determine the effectiveness of forest landowner financial incentive programs (Kluender et al. 1999; Kilgore and Blinn 2003; Kilgore et al. 2007; Jacobson 2009). Paula and colleagues (2011) surveyed forest landowners in Alabama and found the majority willing to supply timber residues for energy purposes.

Most of the previous studies regarding woody biomass have focused on the costs of harvesting biomass, rather than the experiences and anecdotal evidence from the individuals directly involved in the market for woody biomass. Han (2004) found that transportation costs may account for 40 percent of total biomass harvesting costs.

A review of the literature resulted in a small but growing number of studies that explore the perspectives of the forestry community related to the harvesting of woody biomass. There was no known previous research which examined attitudes and perceptions of biomass harvesting guidelines. This study addresses the research gap in understanding the opinions of forest stakeholders who would be directly affected by woody BHGs if implemented in North Carolina.

Study Objectives

As previously noted, BHGs have been proposed as a means to ensure that biomass harvests do not cause excessive environmental damage by removing too much woody debris, creating excessive soil damage, harming wildlife, or causing other detrimental effects. These potential damages might be mitigated by remediation during timber harvests, but would require participation and compliance by forest managers, forest landowners and professional loggers. Thus I wanted to obtain the opinions of these key groups about the feasibility and willingness to implement BHGs. The primary objective of this study is to understand the perceptions of forest managers, loggers, and forest landowners regarding the economic and operational feasibility of biomass harvesting guidelines and their willingness to adopt such standards. The communication gap between environmental groups and the forest community is addressed by gaining knowledge of the attitudes of these stakeholders who are directly affected by forest policy. Understanding the attitudes of these individuals towards the creation of new policy is essential for successful forest management and improved communication between stakeholders.

CHAPTER 2. METHODS

Study Area

North Carolina Forests

North Carolina is abundant in forest resources. The state has a total of 18.3 million acres in forestland, which accounts for 58 percent of the land cover in the state (NC DENR 2006). Hardwoods comprise 72 percent of the state's timberland while the remainder is made up of softwoods and mixed stands (NC DENR 2006). Forest Residues are estimated to be 2.8 million dry tons in North Carolina (Galik 2009).

Forest Managers

Forest managers include consulting foresters which are registered by the State Board of Registration for Foresters, procurement foresters, employees of forestry government agencies and forest managers of private industries such as pulp and paper mills. The North Carolina Forestry Association (NCFA) is an industry trade association made up of more than 4,200 business professionals in the state. The NCFA has substantial influence regarding forest regulations within North Carolina. In 2008, the NCFA announced its position statement on BHGs on stating,

The board does not believe that additional harvesting guidelines restrictions, mandates or BMPs for biomass are warranted or necessary at this time. Note: this could change over time depending on research findings or field operations that point to a need for additional actions (NCFA 2008).

The other professional organizations such as the North Carolina Society of American Foresters and the Association of Consulting Foresters do not have policy positions on BHGs to date.

Professional Loggers

In North Carolina, there is no licensing requirement for loggers although approximately 1,400 loggers participate in the North Carolina ProLogger program, which is a statewide certification program owned and operated by the North Carolina Forestry Association (North Carolina Forest Service 2011). The North Carolina Association for Professional Loggers (NCAPL) is a professional association which is affiliated with the American Loggers Council, which currently has more than 10,000 members. The logging industry is currently facing poor economic conditions. Approximately 200 logging establishments were closed during the time period of 1999 to 2008 which was a “33 percent decline from an average of 703 establishments in the decade from 1990 to 2000” (North Carolina Forest Assessment 2010, 153).

Forest Landowners

Seventy- five percent of forests in North Carolina are owned by non-industrial private forest (NIPF) landowners (Brown 2002), accounting for approximately 15.5 million acres. North Carolina's NIPF population is estimated at 479,000 (Brown et al. 2006). North Carolina NIPF landowners are an average of 62 years old and typically own more than 90 acres of land (Megalos 2000). Family forest landowners primarily own forestland for aesthetics and nature purposes, privacy, home or farm purposes, and family legacy (Butler and Leatherberry 2004). However, objectives vary based on geography as mountain landowners are more likely to own their forestland for green space and private residence

while in the coastal plains, forestland is more likely to be held for timber-related objectives (Megalos 2000).

Qualitative Approach

This study attempted to understand the perspectives of forest managers, professional loggers and forest managers so a qualitative approach was taken. The individual participants in the study were identified based on key initial contacts and subsequent follow ups. Five key informants were recommended through sources including the North Carolina Professional Logging Association, the State Board of Registration for Foresters, the Association of Consulting Foresters of America, the North Carolina Tree Farm Program, and the North Carolina Forestry Association. I also attended a North Carolina Forestry Association's ProLogger meeting in October 2010, which allowed for interaction with several loggers who were later interviewed. The group of key informants included one professional logger, three professional foresters and one landowner. The remaining respondents were identified through the snowball sampling method and interviewed to gain insight into the forest industry (Miles & Huberman 1994). I established rapport with interview subjects while meeting at their homes, places of employment, various logging sites, and at public places such as coffee shops and restaurants.

Instrument Design and Content

The researcher created a preliminary interview guide for each of the three groups and pre-tested the guides by interviewing the five key informants and refining the survey

instrument based on the feedback and suggestions. The responses from the pre-testing process are included in the results. The survey instruments used in this study were approved by North Carolina State University Institutional Review Board's regulations for research on human subjects (Appendix B) prior to conducting research. Participants were able to choose not to participate or to stop participating at any time without penalties. The written protocol was designed to be completed in approximately one hour. The interviews were informant-directed and as a result the respondent was allowed to control the trajectory of the interview and decide which topics of conversation were of importance to them.

Consistent with recommended qualitative research practice, the interview guides were allowed to evolve continually throughout the interview process after hearing respondents' answers and eliminating the questions that were not considered useful and by adding questions that were not thought of previously by the researcher and arose after the initial interview guides were constructed. The constant emergent design of the interview guide was used due to the indeterminacy between the interviewer and the context of the conversation as part of a "naturalistic" approach (Lincoln and Guba 1985). This process is to ensure that new topics are expanded upon that may not have been previously known to the researcher and the content of the responses will not be limited by protocol (Lincoln and Guba 1985; Fossey 2001; Gray 2004).

All three groups were asked about their opinions of current forest guidelines as well as possible biomass harvesting guidelines which have been adopted in other states. Particular questions included in the interview protocols were not asked if the respondent did not have previous experience with harvesting woody biomass or was not familiar with the market. As

the semi-structured interviews came to a close, the interviewer asked a series of demographic questions, which included age and highest level of education. The preliminary interview guides did not include demographic information but were added after feedback from key informants.

The preliminary forest manager interview guide (Appendix C) was composed of 17 questions, which included questions about previous experience with biomass harvesting and the difficulties in the operations, if any. Respondents were also asked about the guideline of retaining 15 to 20 percent of harvestable CWD following a harvest and if the recommendation was necessary and possible and if so, how it could be implemented in logging operations. The final forest manager interview guide included 23 questions (Appendix D). Questions were added to gather opinions on current forest guidelines including the BMPs and FPGs and if there was a preferred method of piling woody debris compared to spreading the material across the site.

The logger interview guide (Appendix E) was initially composed of 12 questions which were used to learn about the participant's experience with woody biomass harvesting, the current market for woody debris as well as operational barriers of harvesting. These questions also addressed the practicality of BHGs and the effect that biomass harvesting methods may have on a site. The final logger interview guide (Appendix F) consisted of 24 questions and was adapted to include questions about the effect of biomass harvesting on soil quality, wildlife habitat, timber productivity and the influence of biomass harvesting with regards future site preparation.

The preliminary landowner interview guide (Appendix G) included 15 questions including total acreage of woodland ownership, primary objectives as a forest landowner and opinions of possible BHGs and how it would affect their forest management. The final landowner interview guide included 19 questions and three questions were added to address the landowner's level of familiarity with current forest guidelines as well as specific and their likelihood of welcoming BHGs (Appendix H).

Data Collection

I conducted semi-structured interviews with 60 informants from May 2010 to April 2011. I spoke with a total of 20 forest managers, 20 loggers, and 20 landowners. While this was not set as a fixed number, 20 interviews per group seemed to achieve that goal and fit within the time and funding available. By employing the snowball sampling technique, saturation of the data was reached, which is when additional interviews do not contribute new information about the topic (Miles and Huberman 1994; Corbin and Strauss 2008).

The informants were initially contacted through email and telephone and then an in-person or telephone interview was arranged. Before the interview began, the interviewee reviewed and signed or orally agreed to an informed consent form (Appendix I) which explained the nature of the research and the confidentiality of participating in the study. The majority of the interviews were conducted in person but several of the logger and landowner interviews were conducted over the telephone. The interviews ranged from a 15 minute telephone conversation to an entire afternoon with one interviewee at a logging operation. The duration of most interviews was approximately 30 minutes to one hour.

Interviews were recorded after requesting permission from the respondent and the audio file was later transcribed. Personal notes were also taken during interviews. All audio files were transcribed into QSR International's NVivo™ 8 qualitative data analysis software. After the transcription of an interview was completed, a pseudonym was assigned to the speaker to ensure anonymity to remain in accordance with North Carolina State University Institutional Review Board standards of confidentiality. For example, a quotation identified as (Peter, 4) was spoken by an interviewee identified with a pseudonym of Peter during interview number four.

Data Analysis

Data for this paper was analyzed using the grounded approach which allows common themes to emerge from data gathered from interviews and field work. (Fossey 2002). Peterson and others (1994) explain the five steps of thematic analysis as: (1) identifying emerging themes in individual transcripts, (2) developing these themes, (3) determining significance of themes, (4) searching for conflicts and relations among themes and (5) comparing relationships of themes across transcripts. Through this inductive approach, the data is reviewed and analyzed for emerging themes or patterns that make it possible to form generalizations from the meanings of particular consistencies (Gray 2004; Corbin and Strauss 2008). Major themes were identified through repetitions of particular subjects during each interview. These reoccurring themes were categorized and later classified into developing themes.

Transcripts of each interview were coded into different categories using QSR International's NVivo™ 8 qualitative data analysis software. Transcriptions allowed the researcher to analyze the respondent's exact words which reduces the opportunity for bias in the comparative analysis. A naturalistic approach is used to report results. The naturalistic approach aims to explore the construction of realities from the language and context in social circumstances. In using this approach, the researcher is able to provide a "rich description" of the realities of loggers, landowners, and foresters which are used to provide a "grounded assessment of context" (Lincoln and Guba 1985, 360).

CHAPTER 3. RESULTS

Stakeholder Characteristics

Forest Managers

The 20 forest manager respondents for the study were comprised of consulting foresters, employees of forestry government agencies and forest managers of private industries (Table 1). The average age of the forest managers was 50 and all respondents had a college degree or higher level of education (Table 2). Eighteen of the 20 forest managers interviewed were male.

Table 1
North Carolina Forest Manager Interview Respondents' Affiliation (n=20)

Affiliation	<i>n</i>	%
Consulting	9	45
Private Industry	8	40
Government	3	15

Table 2
North Carolina Forest Manager Interview Respondents' Highest Level of Education (n=20)

Highest Level of Education	<i>n</i>	%
4 year college degree	13	65
Graduate degree	7	35

Forest managers were the most educated group and all respondents had at least a Bachelor’s degree, which is expected since all are professionals within the forestry field. Forest Managers generally believed that current practices and guidelines were adequate to protect harvest sites during woody biomass harvests with few exceptions.

Professional Loggers

The 20 logger respondents were all male and an average age of 52. Most of the loggers had at least a high school education (Table 3). The average size of the logging business that loggers were employed with was made up of 16 employees. Thirteen of the 20 interview respondents were involved in the market for woody biomass which entails the harvesting and delivery of dirty chips (Table 4). The logging businesses with which interviewees were employed primarily operate in 36 different counties across the state (Figure 2).

Table 3
North Carolina Logger Interview Respondents’ Highest Level of Education (n=20)

Highest Level of Education	<i>n</i>	%
Less than high school	1	5
High school	9	45
Some college/ technical college/ trade school	5	25
Four year college degree	4	20
Graduate school	1	5

Table 4
North Carolina Logger Interview Respondents' Participation in Woody Biomass Market (*n*=20)

Involvement in Woody Biomass Market	<i>n</i>	%
Currently harvesting woody biomass	13	65
Not currently harvesting woody biomass	7	35

Counties in which Logger Participants Primarily Work

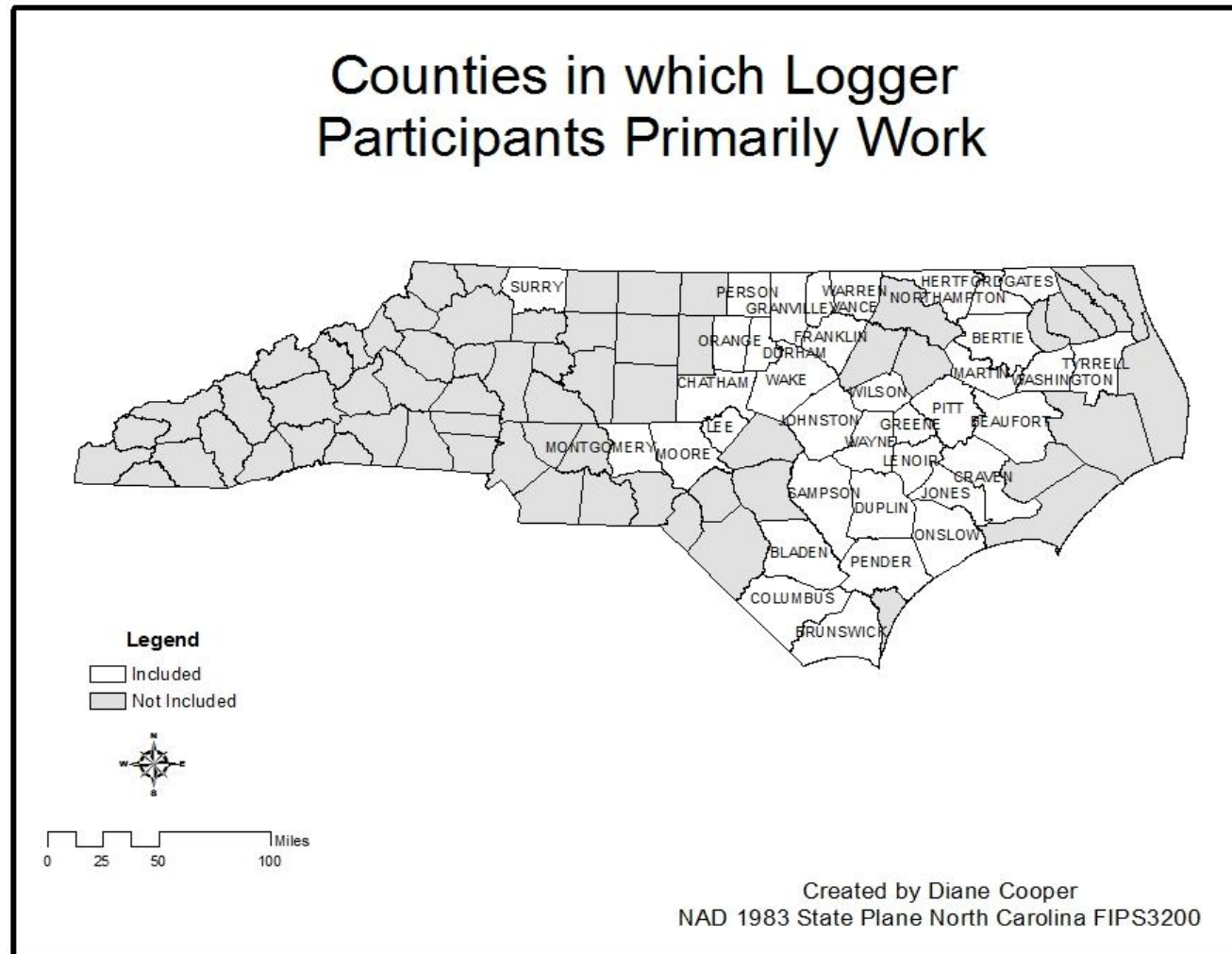


Figure 2: Counties in which North Carolina Logger Interview Respondents Primarily Work

Fifty percent of loggers had at least some college experience which is slightly higher compared to similar studies. For example, Habig (2002) surveyed 162 loggers in Mississippi loggers and found that 56.2 percent cited high school as their highest education, 22.2 percent attended some college, 12.3 received Bachelor's degrees and those that attended graduate school or did not complete high school were less than 3.5 percent. This compares to the 45 percent of loggers who completed high school in this study, 25 percent attended some college or trade school and 20 percent received Bachelor's degrees.

Logger Participation in Biomass Harvesting

As mentioned previously, 13 of the 20 loggers are currently involved in the market for woody biomass, meaning they operate a wood chipper or grinder and sell dirty chips to a facility that utilizes the material for energy production. Logger respondents were asked about the primary buyer of the dirty chips that they harvest. Appendix F provides a list of these power and paper facilities. The delivered price that logger respondents receive for dirty chips is in the range of \$15 to \$30 per ton with an average of \$21 per ton ($n=9$). According to the loggers interviewed, one to three loads (approximately 25 to 75 tons) of woody biomass is typically harvested per acre although this amount varies greatly depending on the nature of the stand before it is cut.

If loggers were not currently participating in the woody biomass market, they were asked to provide reasons for this decision. Loggers explained the high costs of entry into the chipping business and the lack of market opportunities to sell the material. Max (12) was asked if he was hoping to participate in the woody biomass market and he stated, "I would

have to say that demand for the product would have to be there year round and the price would have to be stable and not fluctuate up and down and then if the first two things could happen, I would definitely entertain the idea.” Kevin (15) has not invested in a chipper because of the uncertainty in future markets. He stated, “You chip one week and one week you might be sitting and then you might chip for two to three weeks and then you might be sitting for a month.” Edward (20) owns a chipper but is currently not harvesting woody biomass because the paper mill that he usually delivers to is currently not purchasing woody biomass. He stated, “We're cutting the biomass and putting it on the ground. We have to handle it with the skidders, move it around....and I'm not getting anything for it.” Alex (14) harvests woody biomass but believes the “only problem” of participating in the market is “we don't have enough markets to haul it to.”

An anonymous logger who was not formally interviewed for the study owns his own logging company and previously participated in the biomass market but stopped harvesting dirty chips because, “the price got real cheap, and you've got to make an income off of it and we got to losing money in it.” Hugh (5) discussed the difficulties of harvesting woody biomass, explaining that when fuel prices are high, it is often too expensive to harvest biomass and when fuel prices are low, there is little interest in using the material as a renewable energy source.

However, despite the lack of market opportunities and high costs to entry, many of the loggers who are not currently harvesting expressed that they would probably add a chipping component in the future. For example, Kevin (15) said, “I see the demand coming

up within the next year probably, and the need for purchasing a chipper with the new biomass plants that will be coming on board this year.”

Forest Landowners

Forest landowners interviewed were an average of 63 years of age and respondents owned an average of 1286 acres of North Carolina forestland ($n=20$) across 17 different counties (Figure 3). Forest landowners were predominately male (90 percent). The highest education level of the landowners interviewed is described in Table 6.

Table 5
North Carolina Forest Landowner Interview Respondents’ Highest Level of Education
($n=20$)

Highest Level of Education	<i>N</i>	%
High School	4	20
Some College	1	5
4 year College degree	8	40
Graduate degree	7	35

Forest landowners interviewed were an average of 63 years of age and this is similar to the findings of Megalos (2000) who reported North Carolina NIPF landowners are an average of 62 years old and Miller (2006) who surveyed North Carolina NIPF landowners and reported an average age of 62.6. Landowner respondents owned an average of 1286 acres of North Carolina forestland which was significantly higher than other studies due to four landowner respondents who reported over 2500 acres in forest land. Miller (2006)

found that respondents owned an average of 193.93 acres, much lower than our findings. Respondents in this study were slightly more educated than the findings of Miller (2006) with 75 percent of landowners having completed a bachelor's degree or above compared to 55.6 percent of respondents in Miller's results.

Nineteen of the 20 forest landowners interviewed had a management plan and of the 19 with a management plan, all were currently implementing that plan. Megalos (2000) found that only 16 percent of North Carolina's NIPF landowners had management plans. Thus this sample seems representative of the most active forest landowners, not the general population of landowners as a whole.

Counties in which Landowner Participants Own Forestland

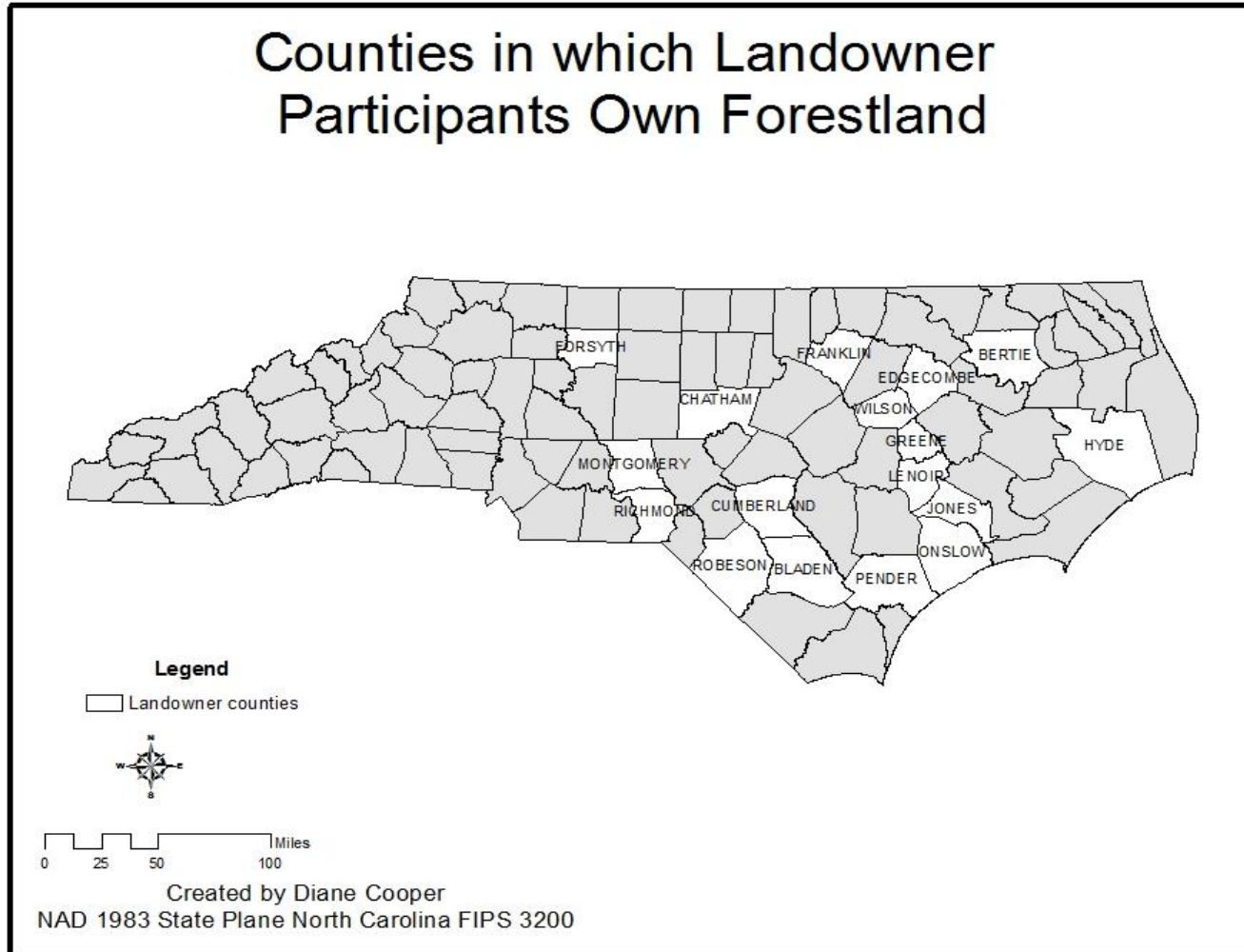


Figure 3: Counties in which North Carolina Landowner Interview Respondents Primarily Work

Forest landowners were asked about their overall objectives for their forestland. The primary objective landowners hold in forest ownership is earning income from timber harvest. Additional dominant objectives included providing wildlife habitat, recreation and having a natural resource to pass down to their children. This differs from previous studies such as Megalos (2000) which reported only one-fourth of North Carolina NIPF landowners' main objective was income from timber production, and Butler and Leatherberry (2004) who found most family forest owners to own forests for aesthetics and nature purposes. However, Newman and colleagues (1996) investigated forest purchasers in Georgia and reported income from timber production to be the main objective of forestland ownership.

In assessing these results, it is important to note that these results may reflect the opinions of the more involved and progressive members of each of these professional groups. The respondents represent the North Carolina Piedmont and Coastal Plain regions which are areas in which forests are typically managed for timber rather than nature or aesthetic purposes. Thus, the results seem to be a reasonable case in representing the southern forestry perspective on additional forest practice regulations.

Thematic Analysis Results

The main theme that emerged from the forest manager, logger and landowner interviews was a general opposition to biomass harvesting guidelines and the reasons given by all groups for this sentiment included the following sub-themes:

- Current best management practices are successful in North Carolina.

- Woody biomass harvesting is only an additional component to harvesting with little or no modification to operations.
- Lack of scientific research supporting claim that harvesting biomass leads to adverse effects on soil, water quality, timber productivity and wildlife habitat.

Additional themes that emerged from forest managers and loggers include:

- Woody biomass has low profit margins which make additional BHGs a threat to the viability of biomass harvesting.
- Biomass harvesting guidelines may prove difficult since accurate estimation of debris is not possible
- BHGs reflect public distrust of the forest industry.

Themes that developed from only the forest manager interviews include:

- BHGs reflect public fear of a desolate site after harvesting operations.

Themes that emerged solely from the logger interview include:

- Financial difficulties of the logging business.

Themes that developed solely from the landowner interviews include:

- A clear definition of woody biomass is needed.
- Landowner interest in woody biomass as an additional forest product.
- Increased government support of the woody biomass market is needed.
- Private property rights should provide landowners freedom in forest management.

Descriptions of the main themes are followed by forest managers', loggers' and landowners' perceived benefits of BHGs and harvesting woody biomass which include:

- Reduced site preparation costs.

- Increased business for consulting foresters.
- Increase in proactive forest management.
- Reduced fire hazard.
- Soil stabilization and erosion control.
- Increase in wildlife habitat.

Finally, recommendations for possible BHGs that were suggested by the forestry stakeholder interviews are presented followed by information regarding the influence of North Carolina forestry organizations.

Success of Best Management Practices

Forest Managers

Most forest manager respondents (19 of 20) believed that BMPS were a success. Many commented on the guidelines being “performance-based standards”, “results driven” and therefore reasonable and effective. Performance oriented guidelines appeal to foresters because there are many different methods that may be used to arrive at the same end result. Numerous foresters cited the North Carolina Division of Forest Resource’s report of 2005 that found statewide implementation of the BMPs to be 82 percent. Brad (13), a Forest Service employee, said, “Results are showing yes, BMPs are working.” Lucas (17) was asked if he believed current BMPs were a success and he responded, “Yes, I do. Our BMPs are results driven. If you have good results, why change what you’re doing?.. If you look at

it, [we are] 97 to 98 percent in compliance of BMPs across the state. To me, that is very successful.” James (18) stated, “I hear reports from the forest service, 95 percent plus adherence to the FPGs and all that. We scrutinize ourselves.”

Although forest managers thought the BMPs were effective when done properly, there were still logging operations that did not follow the recommended procedures. James (18), a procurement manager, stated, “We will have a violation from time to time and will have to go out there and try to [fix] it as quickly as we can. We take it very seriously.” Adam (15), a consulting forester, stated, “BMPs are wonderful but they could be improved by having better enforcement and seeking out the renegades.”

However, when one consulting forester was asked if the BMPs had been successful in North Carolina he stated,

The guidelines are for the most part a disaster and it is a waste of time for everybody. You want the truth? I don't think they are working. The Forest Service does not have the staff or the money to enforce them. And the loggers that are buying directly from landowners know it. They can do anything they want to do. And if the landowner complains or the neighbors complain, the county ranger will go out and look...but nobody says anything, they are not going to walk the back property and look to see what's going on (Jackson 10).

Although Jackson's opinions about the effectiveness of BMPs were in the minority, since most of the foresters believe the current forest guidelines have been implemented on a wide scale, his statements do address the difficulties and high costs of enforcement of forest guidelines which was a concern to many informants.

Loggers

All of the loggers interviewed believed that North Carolina's BMPs have been successful. Anthony (8) stated, "I think that [BMPs] make a big difference. Just about everybody I know practices them pretty good." Loggers expressed that the BMPs in place "work very well" (Hugh, 5) in the protection of water quality and "are necessary to protect the lands and the streams" (Shaun, 11). Connor (12) summarized the positive reaction that all loggers had towards the BMPs saying, "I think they have been successful and I think they have been a great aid to the landowner and the environment." Max (10) gave an explanation of why he thought BMPs were successful saying,

We never cross SMZs and creeks anymore without the crossings. And I don't know of any logger that does that anymore. And almost always, the SMZs are marked for us and we don't have to worry about what to cut or how much buffer to leave because that's already been marked. And with all that being said, I'm sure water quality has improved greatly over the years.

Jason (17) described why the present positive response of those in the forestry community towards the BMPs can be attributed to the mode of establishment, saying:

I think one of the reasons they have been successful is when it started, it was basically as a volunteer implementation program and they figured out real quick the best way to implement these things and the state and everybody else kind of went along with it, working hand in hand with the forestry associations and various groups to come up with plans that would work. It was not forced on everybody—it was kind of volunteered; therefore, they've come up with a solution that has worked.

The majority of the logger participants believed that harvesting woody biomass could negatively impact water quality; however, loggers viewed current BMPs as sufficient protective measure. For example, Blake (4) said, "There will not be any damage [from

harvesting biomass] if you follow the BMPs.” Harrell (7) was asked if the BMPs were enough to protect water quality with an increase in biomass harvesting and he replied, “Yes, the BMPs are enough. The BMPs are fine”, which was a common response from logger participants.

Some loggers were opposed to additional guidelines because they felt as though they already had to contend with an adequate amount of guidelines. For example, Hugh (5) was asked if additional protections were needed with the possible increase of harvesting for woody biomass and he replied, “I think we've got enough! And you aren't going to make me change my mind on that. We've got enough stuff we've got to worry about.” He continued, “I just don't want any more legislation that I've got to contend with. Rules. And I think that there would probably be a consensus across the board on the logging.”

Landowners

Nineteen of the 20 forest landowners interviewed were familiar with North Carolina Best Management Practices (BMPs) and those familiar with the guidelines believed they were successful. When asked if North Carolina's BMPs have been effective, Cory (2) stated,

From my point of view, yes they have, I have tried to be diligent in the way I have applied them. I know they are not mandatory; they are voluntary today but I think they are good practices if you want to make sure you keep your water from being degraded...and keeping your soil intact—I am all for using those.

Roger (19) thought the BMPs had proven to be “beneficial” to landowners. Landowners who were less active in forest management trusted that the guidelines were reasonable. “I

basically leave it up to the man that is handling, to look after it, for me. I assume they are successful, I'm not that involved in it, I really ain't" (Margaret, 17). Landowners generally believed that BMPs were sufficient in protecting water quality. Henry (14) commented, "As long as the sedimentation is kept out of streams with the BMPs, I think we would be fine" and Blaine (12) agreed stating, "We don't have a lot of water quality issues here if BMPs are followed."

Biomass Harvesting: Little to No Modification to Operations

Forest managers

Forest managers believed that woody biomass harvesting is only an additional component to harvesting with little or no changes in logging operations. One forest manager in the private industry sector commented,

We don't have harvesting guidelines for pulpwood, we don't have harvesting guidelines for chip and saw, and we don't have harvesting guidelines for saw timber. And biomass is not new. The forest industry has been harvesting it, using it, burning it, and producing power from it, for decades. So the concept that biomass is something new, which it's not, and that we need separate types of guidelines for it, we don't buy it; we think it's unnecessary (Phillip, 19).

Most respondents felt that BMPs were sufficient in addressing problems that may arise in harvesting operations. One forester worker working in the forest industry sector expressed,

We have already got guidelines for logging. And if it's the same product, biomass, it is being grown the same way as your other products we are typically harvesting. And we have been harvesting biomass for this facility for many years because we have been using hog fuel ever since I can remember and I think as long as you stay within those guidelines, your BMPs, and all the buffer rules and all those things apply, I don't really see the need to develop another set of guidelines, personally" (Beverly, 5).

During a typical harvesting operation, material is felled, and brought to the logging deck to be sorted into the different products for processing. Forest Managers explained that when a biomass harvesting component is introduced to an operation, there is little or no modification to the flow of operations. Felix (20) stated, “It is a very integrated operation and you don’t have to stop and setup much of anything different.” Matthew (14) stated, “I don’t think there are extra guidelines that need to be in place because they are already dragging those limbs and tops to the deck or to a loading area anyway. So I don’t see that harvesting those tops on that deck is going to create any more of a problem.” Ronald (1), a consulting forester commented, “There is nothing, or anything special about biomass harvesting, it is just another market.” Andrew (7) stated “I wouldn’t call them biomass harvesting guidelines because I don’t think that takes into account what we do. When we harvest the site we aren’t harvesting biomass. Biomass comes along, its residue. If we’re lucky, we can get rid of it.”

Loggers

Biomass harvesting is no different than regular clearcut harvesting. You’re going to have the same machinery running on the ground, you will have to observe the same buffer zones and forest practice guidelines– there is no difference–same type of equipment doing the same thing. (Connor, 12)

Connor’s sentiment reflected that of many loggers who believed that harvesting operations did not change when a biomass component was added. “Biomass goes hand in hand with conventional logging and we already have our BMPs and other practices in place

to take care of that and logging compared to biomass harvesting, we're removing wood from the land just the same," said Drew (6). "You have got to keep the sediment out of the water and the SMZs and BMPs are the same way. The crop that you are producing shouldn't have anything to do with it" (Jason, 17). Jack (19) described biomass harvesting saying, "You are pretty much using the same procedure, you are just getting up more material but you still have to follow that same guidelines of putting water bars, seeding, and strawing." Jack (19) said, "I would think the existing guidelines would cover biomass."

Landowners

A majority of landowners believed that biomass harvesting should not be treated separately from a conventional harvest in terms of forest guidelines. Ronald (6) commented, "I don't think biomass harvesting, if they followed the BMPs, is any worse than any other kind of harvesting." Verl (13) stated, there is absolutely nothing to indicate that [biomass] is any different than any other harvest that included a whole tree chipping." Henry (14) also expressed that biomass harvests were not different from current harvest operations saying, "Biomass harvesting is nothing more than a clearcut. We're doing a good job of that now. There shouldn't be any additional harvesting guidelines for biomass."

Lack of Scientific Research Supporting BHGs

Forest Managers

Forest managers believed the proposed BHGs were being established by policy makers without the support of objective scientific research. For example, a forest manager

stated, “There is no document in the literature that I’ve seen that says that nutrients are diminished by biomass harvesting (Felix, 20). Adam (15) reiterated this point: “there is no research of [biomass harvesting] causing depletion to soil.” Beverly (2), a forest manager working in the industry sector commented, “I don’t have enough evidence of what the impacts would be strictly just for harvesting nothing but a biomass stand.” Richard (1), a consulting forester discussed those who were advocating BHGs saying, “If there is any research data to back up those concerns [of biomass harvesting] they haven’t presented them.” Phillip (19), a private sector forest manager stated, “The problem I have with BHGs and all of this debate, is that nobody has shown me that there is a problem. When there is a recognized and definitive problem, not perceptions, not someone’s belief, show us a problem and we will try to figure out if there is a way to fix the problem.” Lucas (17), a forester in the industry sector stated, “If you put in too many restrictions, just based on public opinion, then they aren’t good restrictions. If they are restrictions based on site degradation, wildlife, and other things, then they are.”

Loggers

Loggers believed that the proposed BHGs were being established by policy makers without the support of scientific research. A number of loggers said that additional guidelines were not necessary unless they were provided with information about how BHGs would improve the forest. For example, Shaun (11) was asked about the adoption of BHGs and he responded, “I don’t know what benefits would be...whoever sets those guidelines must have

documentations saying *why* this has got to be done. What is it doing for the land? What are the benefits?”

Logger participants were asked about wildlife habitat and how it was affected from a biomass harvest compared to a conventional harvest. There was no consensus on this topic and many respondents said they were not qualified or did not have enough information to answer the question. However, a few loggers believed that harvesting the woody debris would have a positive effect on wildlife habitat compared to conventional harvest. For example, Jason (17) thought harvesting woody biomass would “help the [wildlife] habitat...when you cut the woods down, its ugly, its bare, I mean, it’s terrible, but the very next day you have green life coming back.” Harrell (7) believed that the wildlife habitat would only be affected temporarily and said, “After you go in and cut it for hogfuel, in a couple of years there is just enough wildlife back in there as there ever was.”

Loggers were asked if harvesting woody biomass has the ability to affect the future growth of timber and a variety of responses were given. Some loggers believed that harvesting biomass would be beneficial to forest productivity. For example, Austin (9) stated, “The trees seem to do better when everything is cleaned up.” Shaun (11) also thought harvesting biomass would improve the land, stating, “I don’t think it will be any different... if its managed right...I don’t think it would hurt the land—in fact it might do it better—getting rid of the underbrush so the next plantation can grow faster better” (Shaun 11).

Gary (19) stated, “We have always removed it, all of it that we could and I don’t see no problem with it growing the trees you know, with it gone. If I had a block of land myself I would harvest the biomass off of it and clean it up before I site prepped, if it was my own

land.” However, a few loggers did voice concern about timber growth rates if CWD was removed from a site. Kevin (15) stated, I think it slows the growth of the trees down because you are not putting nutrients into the soil.” Several loggers thought that removing CWD from the forest floor would not have any effect on the growth rate of trees.

Landowners

“A lot of our regulations come from people that don’t understand,” Elijah (10) said. Stephen (4) agreed saying, “A lot of people make regulations who don’t know anything about forests.” The prevailing opinion of forest landowners was that forest policies are created by political forces or emotions rather than science. One landowner complained, “Research is just not there. North Carolina Woodlands and others are willing to accept, kind of a sustainability standard, but, nobody in my world thinks [BHG]s are necessary other than a necessary political evil” (Verl 13). When Cory (2) was asked if additional guidelines for woody biomass were necessary he responded, “Yeah, I think that would probably need to be something that needs to be addressed. Again, I want them based on good sound research and not just on emotions.” Brandon (9) also believed that scientific research must be done before guidelines are implemented commenting, “I would think there would have to be a lot of research done to determine what level of biomass should be left or should be removed. Right now I am just leaving everything.”

Simon (16) stated, “I don't want to sound critical in saying this, but I think we've got enough government issues and guidelines on some things as it is without implicating some more. You've got to have a lawyer to interpret what all you're supposed to do.”

Thomas (7) voiced concern of regulations stating,

If the [policy maker's] goal is to encourage timber growth, biomass growth, my inclination would be to say that the [biomass] guidelines would be fine. But we also understand that human nature is geared towards power so you start telling some regulators, alright you get to decide what everybody does and the next thing you know they have some off the chart rules and regulations that are sort of ridiculous.

One landowner was asked if his management plan would change if BHGs were adopted in North Carolina and he replied, “Probably not. I would probably just ignore them and go on, knowing that whoever wrote them didn't know what they were doing and didn't understand how to implement them” (Duke, 1).

Forest landowners were asked if they believed that harvesting woody biomass from the site had the ability to affect wildlife habitat. Most landowners indicated that leaving a particular percentage of CWD on the forest floor would not alter wildlife habitat. Evelyn (11) stated, “I think there is no argument on the table for woody biomass gathering to have any negative impacts at all on wildlife.” Another landowner commented,

I have never had any wildlife biologists—you cannot believe how many of them I deal with and how many of them I know and how many of them come to my farm and that know me—I've never had anyone telling me that leaving 15 to 20 percent of the slash off of an operation on the ground out there was beneficial to wildlife (Blaine, 12).

Mark (3) reiterated the lack of wildlife biologist's support for leaving CWD on site stating, “I haven't heard many wildlife biologists talk about biomass being a component of wildlife habitat.”

Forest landowners were also asked about the depletion of soil quality due to woody biomass harvests but most believed it would not be likely. For example, when asked if he

would be concerned that harvesting CWD for energy might affect soil quality, Thomas (7) responded,

No. If I come in once in 30 years and take off everything off the surface of the ground, the ground still has still got all the debris and leaves, et cetera that fell for thirty years. So no, I'm not concerned about that damaging the soil... unless you are going to start digging up stumps, that doesn't feel like a major environmental concern.

Threats of BHGs to Viability of Biomass Harvesting

Forest Managers

Forest managers regarded the woody biomass market as having very low profit margins which makes additional guidelines appear as a threat to the viability of biomass harvesting. Foresters continually declared how they were unable to make a decent profit margin due to the undeveloped markets in North Carolina. High transportation costs paired with high fuel costs in harvesting operations were the reasons given for why it is may not be feasible to add a chipping component to a harvesting operation. There are very high costs of entry in the logging business. Adding a woody biomass component to a harvesting operation requires extra equipment including a fuel chipper and a chip van. The price of fuel chipper is in the range of \$75,000 to \$350,000 depending upon the size and capacity. The principal difficulty in adding a fuel chipping component to a timber harvesting operation is the increase in amount of fuel used during the time it takes to harvest the woody biomass material. Andrew (7), a forester working for a private industry, was asked about operation barriers of harvesting biomass. He responded,

The biggest barrier is [burning more fuel], you are dealing with smaller stems that you usually might leave behind. So if the logger is cutting up a lot more smaller stems, that is a lot more time- mostly on the cutting machine. But also some additional time at the log deck because they have to separate the material... Well, normally the tops would just be put in a bone pile out there somewhere and the skidder would haul it off. And now he's got to keep a separate pile and be able to push it through the chipper. So you know that is just extra time and handling.

Forest managers expressed concern of the introduction of BHGs worsening the already volatile market for biomass. They communicated that if restrictions are placed on a product that currently has such a low market value in comparison to other forest products, biomass harvesting will become unattractive and not economically possible. One forest manager working in the industry sector noted,

If there were stricter guidelines, it would add costs to a logging operation because of what they would have to do as they are harvesting or as they are leaving a tract of timber. If there is an impact on costs it would affect our operations because we consider biomass a low cost raw material. And with that low cost material, you need to try to minimize harvesting costs because you know you have a transportation cost there. (Beverly, 5)

Another forester who agreed that guidelines would affect costs stated, "If you make things too restrictive, you have to be careful of that because, as I said before, your value is so low, if you make things too restrictive, the [biomass] industry will never develop because there is not a profit margin to begin with; it is extremely low" (Patrick, 3). Forest managers also believed that BHGs could become over regulatory and discourage loggers from harvesting the material. "If you set [the BHG] at say 30 percent or 40 percent, I mean, if I gotta leave forty percent of it behind, well, it makes it a lot more hard to justify even putting the chipper out there."

If BHGs are adopted in North Carolina, forest managers believe that the guidelines will increase costs for loggers but forest landowners will be the group who will ultimately absorb the extra costs incurred. Brad (13) commented on BHGs stating, “From a cost standpoint operationally, it will be a much higher cost for the logger.” Matthew (14) discussed the present economics of logging stating, “We've lost probably 35 to 40 percent of our loggers, in the last three years anyway, in the state, to the economy. They're all walking a very thin line of staying in business right now....so adding anything on them, that's a burden that they are not going to be in favor right now” (Matthew 14).

One consulting forester stated, “The landowners are the ones ultimately paying everybody. So they will have to pay the loggers basically, to work on making sure there is 15 to 30 percent of biomass left over.” Matthew (14) a consulting forester stated that with the increased costs that will arise from BHGs, “You're infringing on the landowner if you are putting restrictions on the logger; you're actually cutting into the landowner's money.” Wesley (11) believed, “Landowners will get hurt the worst.” Brad (13) agreed with the increased costs of BHGs saying, “You're adding costs to the system which is never good and you're really dis-incentivizing the landowner to do forestry.”

Loggers

Loggers regarded the woody biomass market as having very low profit margins which makes additional guidelines appear as a threat to the viability of biomass harvesting. Loggers expressed that they are currently constrained by such small profit margins and that any extra use of equipment and fuel without compensation would prove difficult. Jack (19) who is

currently participating in the woody biomass market was asked about leaving 15 to 30 percent of CWD on site following a harvest and he responded, “there would probably be a lot of smaller jobs that I would turn down because I couldn’t justify enough volume to remove it.” Austin (9) was asked about retaining and then spreading 15 to 30 percent of CWD across a site. He responded, “Everything we’ve got is so big it would be hard for us to spread it out real neatly. Cause the way we get paid is by the ton, everything we do is by how much wood we haul so, stuff like that, that takes time and you're not getting paid for it in other words. So it would be hard for us to do that, to justify it.” Blake (4) who is also participating in the woody biomass market stated, “If I got to leave 15 to 30 percent, I’m going to retire.” Harrell (7) discussed the high costs of forest guidelines and when he was asked if additional protections were needed with the possible increase of harvesting for woody biomass he said, “No, I think they need to stick with what they got, if they get any stricter you won’t be able to go in the woods.”

Loggers who were currently involved in the market for woody biomass were asked how BHGs would affect their logging business if they were adopted in North Carolina. Some loggers believed that the adoption of BHGs would not impact operations. For example, Jason (17) said, “It would not affect my operations because we would find a way to figure out a solution to work around it so it wouldn’t affect it” Edward (20) agreed saying, “The job would look worse– leaving wood out there– it just looks bad as far as appearances. But it wouldn’t change the way we do things too much. I don’t see it impacting us that much.” Owen (13) stated, “Well for me, it wouldn’t affect me tremendously because as I told you, I log for Weyerhaeuser. If I was an independent logger, buying timber, and depending on

selling that product it would definitely be a hindrance or would hurt me...it would hurt the landowner also.” Anthony (8) was asked how the BHGs would impact his logging business and he replied, “Things are so tight right now that if you cut something or throw it through a tractor, you need to get paid for it in some kind of form, if you can. Logging is just so darn tight right now.” Max (10) stated,

[BHG] could actually drive up operating costs potentially. It could actually make logging more difficult and complicated, having to deal with certain guidelines and how much you have to leave out there. I think it depends on how strict the rules are, it could definitely add to costs of harvesting and just add more headaches in operations. Like we need some more headaches...”

Edward (20) believed that BHGs would be “a cost with no reward” for loggers.

Accurate Estimation of Debris is Not Possible

Forest Managers

Forest managers were asked about the operational practicality in leaving a certain percentage, usually 15 to 30 percent, of CWD on a site following a harvest. Most foresters thought that estimating a percent of woody debris would be highly problematic from an operational standpoint. “I think it would be very difficult to estimate the amount, that’s because you’re looking at stuff that’s pushed half into the ground, so how can you know what’s there?” (Patrick, 3). Forest managers thought an “eyeball” estimation would be the likely method of determining the amount of CWD left, although they were doubtful that the amount could be approximated accurately or that loggers could make the judgment call.

I don’t know how you can measure it. I think that my gut feeling is that effectively you’re going to leave that much there anyway that they are not going to gather up the

stuff that is broken up and left. Whether you have 15 percent or 18 percent left out there I have no clue, you know, how you would enforce that. I'm sure the forest service here would not want to try to enforce that (Matthew, 14).

When asked if loggers would be able to estimate a certain percentage of CWD on site, one consulting forester responded,

No, loggers will not be able to. I can tell you right now, loggers will not be able to do it. A logger will not be able to do it, no matter what percentage you give him, a logger will not be able to do it. They have no experience. Most loggers I know don't even have a prism. You know, a basic little 30 dollar, 20 dollar whatever it is. They want me to bring my glassy thing out and check 'em. And here you are and want them to estimate a percentage of biomass on the ground? It is not going to happen. It is a whole, something else you are going to have to teach them (Jackson, 10).

Foresters expressed that estimating a percentage would not only be challenging but would also increase costs in enforcing the guideline. When one forester was asked about estimating a particular percentage of CWD on site after harvest he responded,

If I have to go out there and audit every site, that is cost, maybe not a big cost, but it is a cost. Whether we do it, or the government does it, or the North Carolina Department of Forestry, compared to, you look out there and 'yep that looks good', that's not a cost. Then when you say, well you've got to leave certain species, diameter, so much in a pile, spread and so much at the deck- that's an added cost. If all that happens, what happens to your market? You're not going to make any financial return doing it so you're probably not going to do it. You can only do so much. People think there are huge amounts of dollars made in biomass but we're talking pocket change compared to the next higher alternative (Lucas, 17).

Many foresters noted that hardwood stands typically have much more debris left on site compared to pine stands, which if previously thinned and mature, may have very little debris left. Requiring standardized rules of specific percentages of CWD to be left on a site may be difficult with the high degree of variability among harvests. The debris left on a site

may depend on characteristics of the stand rather than if there has been a biomass harvest or not. A forest manager, Andrew (7) stated,

The amount of debris that is left over behind a logging job is mostly a function of the kind of stand it was before you cut it. And what kind of underbrush of you know, how the stand had been managed, its management history and the product classes of the products that are in it and the nature of that stand before you ever put a chipper or a cutter in there.

In addition, forest manager participants believed that violations of BHGs would be a challenge to remediate, particularly if debris was removed during a logging operation without leaving 15 to 30 percent on the site. A consulting forester, Wayne (8) spoke about these difficulties saying,

Somebody from the Forest Service may be coming out and says you've got to put more piles of debris out there. That could be a mess, because at that point, once you've harvested the tract, where are you going to get the debris from? Are you going to haul debris out there to the site? It's like when you have a BMP violation, you come in, seed it, straw it, but if you have already removed the biomass from the tract, what do you do?

Loggers

Loggers were asked how a particular percentage of CWD would be estimated if they were to leave this amount on a tract of land. Most loggers thought the process would not only be difficult to complete accurately, but also believed it would be difficult to enforce. Jack (19) was asked how a particular percentage of CWD would be estimated on a logging job and he answered, "That's a good question, I mean, because tract to tract can vary a lot, the type of wood that was on the tract before it was logged. I don't know; it's going to be hard, really hard to come up with a number on that." Jason (17) replied, "How are you going to know what is 20 percent is? Twenty percent of what? How are you going to police it and who is

going to police it?” Hugh (5) agreed saying that BHGs would cause, “A lot more headache in my opinion. I mean, how you going to judge what’s 30 percent? Twenty percent? I think that’s just ridiculous in my opinion.” Edward (20) echoed this idea saying,

There would be no way to police it because, unless blocks of timber were cruised where you knew exactly what was there, it’s hard to judge what 30 percent of a 100 acre block of timber would be as far as chips go. There is no actual way to measure it and then measure what would be left, because all blocks of timber are different... The biggest dilemma, the biggest problem is—bringing someone through a 100 acre tract and saying, ‘look, you need to leave 30 percent of the chips’

BMPs Reflect Public Distrust of Forest Industry

Forest Managers

One additional theme that emerged from the interviews with forest managers was that they believed BHGs reflected public mistrust of forest industry. This idea of “us versus them” describes the polarization between those who work in the woods and those who influence legislation. Forest managers described how they are skeptical of forest guidelines that are politicized and are a result of polemical lobbying by environmental groups

For example, one consulting forester when speaking about forest guidelines stated, “The new buffer rules were put into place without ever talking to foresters” (Patrick, 3). Brad (13) a governmental agency forester stated, “It is unfortunate that a lot of folks don’t want to believe what the foresters say anymore.” Lucas (17), a forest manager in the industry sector stated, “I would say a very high percentage of those people, their opinion of biomass harvesting is not based upon their opinion of biomass harvesting, it is based upon their opinion of logging in general. That’s just my opinion but it can be verified by a lot of surveys

and things that the general public says and does out there.” Similarly, Jonathan (2), a consulting forester, believed that those in the forest industry were not trusted in the public sphere. He stated,

Today I was talking to a poor younger lumberjack, about 40 years old, he has four kids, he is a phenomenon to me, but he struggles. He should not have to struggle. The soil is left in very good condition, he never skins up the trees... but no one, except for me, sees the virtue of a guy like him, and these are the types of guys that would benefit from those things, if we took some effort to make sure the most deserving people benefitted from this. And this is on a land trust property, a land conservation easement. I’m talking about really good, well stewarded places. All these good things happening, but the Earth Liberation Front will never know about it. I am pissed off at the Earth Liberation Front. We have a freaking paradise out here in a lot of places and no one wants to recognize it because, oh those people are cutting trees they must be bad people.

As stated above, the reason many foresters gave for the lack of collaboration between environmental policy makers and foresters is because individuals working in the forest industry are seen as the “bad people.” Another forester acknowledged the hostility between environmental groups and forestry professional as he stated, “That is often the problem with environmentalists, they don’t often see the whole picture, they think as soon as you cut a tree, that’s a bad thing” (Peter, 4). Phillip (19) reiterated this notion saying, “Contrary to what some in the environmental community believe, the mission of a forester is not to cut the last tree.” Forest managers also held the belief that forest guidelines are often established by policy makers without communicating with or considering the perspectives of those working in the forest industry. Phillip (19) states,

It is really easy for somebody in an office to talk about, well, run that equipment over there, that’s no big deal. Well, yeah it is. They have virtually zero understanding of what takes place on a timber harvest, how it works, what are the economics of it,

what are the mechanics of it, they don't know how the industry works, they think they do but they have never been in the field, they have never practiced forestry.

Loggers

A few loggers mentioned the public's negative view of forestry. Kevin (15) stated, "[BMPs] have definitely made a difference and I hope it makes a difference in what the public thinks about loggers." Gary (18) stated, "The formulation of biomass harvesting guidelines must take the public's [negative] view of forestry into consideration." Shaun (11) briefly explained the disconnect between 'environmentalists' and people in the woods since loggers were often criticized for cutting down trees while loggers realize that trees "will die anyway" and the timber should be utilized beforehand.

BMPs Reflect Public Fear of a Desolate Site

Forest Managers

The polarization between the public and those in the forest industry is illustrated by one particular vivid image of a desolate site, conjured by "outsiders" to the forest industry. "When people think of biomass harvesting, they think there is a big vacuum cleaner that sucks out everything and leaves something like this concrete floor. And they're wrong, that's not what it is." (Felix, 20). Another consulting forester mentioned, "Some of the environmental groups are concerned about wildlife and taking all the material off. They are envisioning it being like the pool table with nothing left. Even if you do a whole tree chipping operation, you got a lot of material left on the site that is good for, you know, the salamanders" (Ronald, 1). Andrew (7) stated,

People seem to think that we are going to dash out there and we're going to just sweep across the landscape, you know. And we're going to take everything that lives or breathes in the woods, even the squirrels, and chip them up! And it's just not going to happen because I mean, the market would really have to make somersaults. It's just not feasible.

The mental image of a site after a biomass harvest or a clearcut that resembles a “concrete floor” or a “pool table” illustrates the disconnect between the perceptions of the two groups. A biomass harvest may evoke this bleak image to the general public or environmental groups because of the fear of environmental degradation and loss of biodiversity of forestlands. However, these types of harvests are seen as only a temporary result of harvesting operations in the view of forest managers. Brad (13) a forester for a governmental agency stated, “I can see how somebody could visualize how an area that is completely denuded and say, “Oh my god! What is going to happen? Well, the trees are going to come back. They will either sprout back or seed in naturally”.

Difficulties of Logging Business

Loggers

The topic of the current state of the economy and the effect on logging businesses permeated throughout most of the logger participants' interviews. One logger who declined to be interviewed only said, “If something doesn't change, you are going to see loggers go out of business.” Walter (2) stated, “The logger needs some help. That's something you need to put in your write up.” He continued, discussing the difficulties of the business,

I'm 60 years old and I don't plan to stay in logging. It's too hard; it's nothing I would recommend a young man to do because it's too many rules and regulations right now. The logger don't get paid like he should...I have been in logging 14 years and I have

not made a cent in the last two years. It's just getting harder and harder, fuel is high and everything you buy is high...and the logging rates for what you can get for wood is not going up.

Spencer (1) expressed the need for the government to provide loggers with financial and legislative support:

I think the government needs to get more involved and put it on the level like the farmers...it could work with the logging association as well. They need to sit down and establish some rules through the legislature concerning forestry that will help these guys out—me and everybody else that is dealing with this machinery and associated with forestry...I think we really need help. The older guys need help, the younger guys coming into the business need help. They need some plan set up to help the younger people get into that field. The way the prices are now, it scares the guys away from the field.

Max (10) explained how loggers are often controlled by paper companies, leaving them dependent on small profit margins. He stated,

Those big paper companies try to hold logging rates down for most of the county because that's more money for them, so they are trying to get it done just as cheap as they can and we don't really have any negotiating power. The loggers don't have any.

Most loggers interviewed owned or worked for small, family owned logging businesses. Clayton (3) stated, "My grandpa sawmilled and my daddy logged too. I'm a third generation, soon to be four. We don't know anything else. And we're a dying breed."

Definition of Biomass

Landowners

Forest landowners were asked about the use and necessity of protections targeted towards woody biomass harvesting and many responded with concern of conflicting

definitions of woody biomass in current political discussions. “I’m not hearing anything that the BMPs need to be changed to address biomass concerns. Things I’m hearing is that we need a definition of what biomass is,” remarked Blaine (12). Duke (1) stated, “I am all for biomass and developing the appropriate definition of it but I am not so sure there should be a limiting definition of what biomass is.” Evelyn (11) described how she was not in favor of the definition of woody biomass including whole trees for chipping. Verl (13) also expressed how not having a clear definition of biomass was a limitation saying,

Everyone is scared to death about what they are going to do on our definitions here. I talked to a fellow yesterday and he was wondering ‘why don’t we develop the [biomass] market?’ And it’s simple, who would make the economic investment, not even knowing if standing trees qualifies in the market. Everything is held hostage right now by definitional issues and debate over standards (Verl, 13).

Interest in Woody Biomass as an Additional Forest Product

Landowners

Forest landowners were asked about their experience with the woody biomass market and selling wood chips for energy. Only two of the twenty interview respondents indicated they had previously had woody debris removed from their property to be used for energy purposes. Landowners who had not previously participated in the woody biomass market communicated interest in the expansion of the market in hopes that previously unmerchantable material could be utilized and provide additional income. In addition, landowners discussed the benefit of a cleaner site following a woody biomass harvest, which subsequently reduces fire hazards and improves forest health. A female landowner, who owns 110 acres of loblolly pine, was asked about familiarity with woody biomass markets

and she responded, “This is all new to me, I’ve never heard of it before. What we have cut, all of it was left. But it would be good to get it out of the way...it has got to help with diseases and forest fires I would think, if it was harvested and used” (Margaret, 17).

The primary reason given for not participating in the woody biomass market was the lack of market opportunities. Ken (8) stated, “I’ve got lots of other biomass out there but I don’t know anything about opportunities to harvest any of it.” Elijah (10) was asked why he had not participated in the woody biomass market he responded, “There is just not anybody around locally doing it... I just did a pre-commercial thinning and I had a tremendous amount of waste laying on the ground, but if it could be harvested it sure would be nice.”

Landowners who were aware of the woody biomass market developments and recent legislation were also eager to participate and be given opportunity to utilize previously unmerchantable woody debris. For example, Evelyn (11) stated, “[Woody debris] is just lying there, and that creates a fire hazard. I am keeping my fingers crossed....because it scares me to have the litter on the forest floor so I want there to be a good [biomass] market and I’m going to be a strong proponent.” She continued, “Gathering woody biomass would enhance the land.” Ronald (6) agreed with the benefits of gathering woody biomass stating that not only would an additional market be a financial advantage to landowners but, “this alternative market is going to make our forests healthier.”

Government Support of Woody Biomass Market

Landowners

The majority of landowners agreed that the government should provide financial support for the biomass market and the positive externalities that landowners are providing to the public. “Biomass won’t work on its own. We need subsidies” (Duke, 1). “[The government] ought to help us have more markets so we can sell our stuff” (William, 15). Evelyn (11) stated, “For the successful gathering of woody biomass, you’re going to have to have tax incentives for loggers, lumber companies and for some landowners.” Another landowner expressed his negative attitudes towards the lack of current government support saying,

I’m really tired of doing all these freebies for somebody else to look good. I would like somebody to give me some more money. Everybody wants us [landowners] to do good for everybody else. Clean water, clean this, endangered species and all of that, but we want some money for what we give and the governor is sitting on her fanny up there not pushing anything, out of ignorance or, cause I realize the state’s busted, we don’t have any money. But, that’s the situation. So all of this stuff you’re asking about the rules and regulations, start asking somebody why we don’t get the amount of money that Georgia gets for pulpwood (William, 15).

Landowners are interested in federal woody biomass opportunities however, there was not discussion of prior success. For example, when the federal Biomass Crop Assistance Program (BCAP) was introduced, Ronald (6) tried to participate to earn extra income. However, he expressed his disappointment with the program saying,

When [BCAP] got so confusing about how it was going to play out I withdrew my request and when the county administrator for the Farm Service Agency called me and I said ‘it’s not clear what’s going on here and I don’t recommend that our county be involved in it until we have clarity and landowners know specifically what they are signing up for.’

Private Property Rights

Landowners

Many forest landowners were reluctant to accept any additional guidelines for a variety of reasons including the belief that forest guidelines are “unconstitutional” or are unnecessary since the private landowner should have the freedom in the responsibility over his or her own forest without an increase in environmental protections. Ronald (6) summarizes the view of several landowners,

I don't like the federal government or the state government who tells a private landowner 'well you can't use your land for that.' I don't like the idea that they tell us we can't clean out a ditch or make a ditch when people are building homes on the waterfront and the ocean, and everybody is on water in the country and yet they worry about us cleaning out a ditch. To me, it's ridiculous, and it's unfair. To me its unconstitutional as well that they are trying to tell us- who pay our taxes and manage the land and who care about it more than they do- how we should be taking care of it.

Stephen (4) remarked, “We need general guidelines that are not strict. BMPs cover many already. The amount of [debris] you take off a man's land should be up to him.” Henry (14) also expressed negative views towards the possibility of additional forest guidelines stating,

As far as the state creating regulations telling the landowner what he or she can and cannot do with a harvest on their property, its damn communism. It needs to be based on the landowner's objectives, not what some kind of state regulation says we ought to be doing. Cause we own the dirt! The government doesn't. And as long as we've got a good management plan, as long as we are applying the current and we're in compliance with the current BMPs and FPGs, then there is not an issue.

Roger (19) voiced his annoyance with government regulation saying, “The last thing I need is someone with a manual to tell me what I can or cannot do on my land” and Duke (1)

captured the overall attitudes of forest landowners toward forest regulations in his comment; “I don’t think I need someone to tell me and my forester how to harvest the trees.”

Benefits of Biomass Harvesting Guidelines

Loggers

Three of the twenty loggers interviewed were not opposed to the adoption of BHGs and instead welcomed these guidelines, contrary to the beliefs of their counterparts. Although these respondents were in the minority, they did express their belief that removing more material from a site as woody biomass could be problematic and that BHGs could improve the quality of the soil, increase tree productivity and reduce erosion. Spencer (1) explained “I wouldn’t be against [BHGs] because I think everything brought to the forestry field is for a good reason and a good cause. That’s what we need, more guidance, guiding us the right way.”

Landowners

Two of the twenty forest landowner interviewees were in support of additional forest guidelines focused on biomass harvesting. One landowner, Evelyn (11) commented,

[North Carolina] is first in forestry for a reason and I think we need to be proactive about this. And to be proactive you need to have guidelines and standards. I would be very much for them because i think it would be haphazardly done and inefficiently done without guidelines.

Reduced Site Preparation Costs

Forest Managers

Forest manager respondents agreed that the utilization of biomass can decrease the costs of site preparation for the landowner, which includes planting and bedding to enhance regeneration. Phillip (19) stated, “[Harvesting of woody biomass] provides a cleaner site that is likely to require minimal site prep activity and less investment from a landowner for reforestation.” Andrew (7) stated, “The added benefit we get is by getting our site cleaned up better than it otherwise would” which decreases costs of future planting.

BHGs Providing Increased Business for Consulting Foresters

Forest Managers

“The more rules that are in place for any forestry, the more confused the landowner will be, the more likely they will be to hire me,” Jackson (10), a consulting forester, stated. A few consulting foresters noted that if biomass harvesting guidelines are adopted in North Carolina, their business is likely to benefit since more people will seek the services of a registered forester to clarify and monitor the new guidelines. However, despite the possible personal advantage of increased guidelines, these foresters still opposed potential BHGs.

Proactive Forest Management

Forest Managers

Many forest manager respondents thought that better markets for wood products encouraged landowners to be more proactive in forest management. Forest managers placed a great deal of emphasis on forestry decisions and practices being reliant on ‘the market.’ Adam (15) stated, “What causes good forestry practices? The market. We’re not dummies and we know there has to be good markets. The better markets we have, the better we will practice good forestry.” Michael (12) stated, if the logging cost made it uneconomical to harvest that landowner’s tract, then that closes a market opportunity for that landowner, so tracts don’t get harvested and forest management practices don’t get implemented. Similarly, Phillip (19) stated,

If markets are good and landowners have a reasonable expectation that markets would be good in the future, it’s an important incentive for them to keep that land in forest, to reforest the land, to make intentional decisions on how to manage and improve the land.

He continued, “If we ever lose markets, if we ever lose the economic value of timber, we will have very bad forest practices and we will lose forest land and our forest will be in a lot worse condition (Phillip, 19).

Reduced Fire Hazard

In the past, prescribed burning was performed after a harvest. However, with the increase of liability and urbanization, less burning has been done so there is more debris left on harvesting sites, which can act as a fire hazard, particularly if left in large piles.

Removing this debris for energy production can reduce a possible fire and smoke hazard.

Forest managers and forest landowner respondents mentioned the reduction in fire hazard as a benefit to the harvest of woody biomass.

Soil Stabilization and Erosion Control

Forest Managers

When asked about the effects of woody biomass harvesting Matthew (14) replied,

What I would wonder about is the loss of nutrients out of the decay of those tops going back into the soils...It's proven in pine straw raking—if you rake pine straw repeatedly, you reduce the growth of the remaining stand. You reduce the fertility of the site...You are taking away the nutrients that would have gone back into the ground.

Patricia (9) stated, “I think [the effect of biomass removal] would happen over time, a consistent removal of biomass in a particular area, over time, sure enough could affect nutrient properties of soil.” Forest managers did express some concern of biomass harvesting affecting soil quality; however, as mentioned previously, most demanded that sound research document the effects before operations are to be modified.

Loggers

Max (10), a logger, was asked about the recommendation of leaving 15 to 30 percent of CWD on site following a harvest, and he responded, “It seems like a fairly reasonable amount to be left, at least there is something being left to stabilize the soil and help the tree growing process. I don't think taking everything off the tract is a good idea.” Max (10) continued saying,

A lot of the time we are using all of that debris to stabilize the ground, to stop the runoff, so if all that debris was getting chipped up and hauled off, then it could create an issue to where the guidelines may have to be changed, it really would— if we started to grind all that stuff up, I wouldn't have that any longer to utilize.

Walter (2) stated, “If you leave it 30 percent and require a few piles here and there, I think that would help, help a lot.”

Landowners

Several landowners expressed concern of soil damage and depletion of nutrients from harvesting woody biomass. “If you continue to take the trees off of there and don't leave some of the mass there to regenerate the soil, you're going to deplete the soil” (Brandon 9). “We don't pay much attention to the soils that take hundreds of years to develop that we can destroy with a single logging operation...I think there needs to be more attention to our soils by BMPs but I would not like to see another set of guidelines imposed on ones that are already there” (Duke 1). Cory (2) stated, “You can't continue taking [woody debris] away and not adding something back to it. He continued saying,

Whenever I have had a harvest, I always encouraged my logger to make sure that [debris] was scattered about... I like to see that stuff scattered back on those sites so I don't get an erosion problem. [The debris] will rot and turn back to organic matter. I think that is an excellent guideline.

Increase in Wildlife Habitat

Loggers

Kevin (15) explained his experience in Virginia with retaining a designated amount of CWD for the restoration of wildlife habitat during logging operations,

Virginia has wildlife programs and I have cut two tracts up there where I had to take a pile of tops, one grapple full of tops per acre, and spread it out across the whole tract for wildlife. The state pays the landowner for so many years for these wildlife habitats. It don't really cost me a whole lot, it is simple to do it, and the landowner pays for it, so I thought that was a good idea.

Landowners

Landowners were asked how they felt about leave 15 to 20 percent of CWD on their site following a harvest. Ken (8) who owned forest land for recreation purposes, did not mind complying with the designated percentage guideline. He stated, "It would probably take a little bit of land out of production but to me it would be desirable from a wildlife standpoint."

Recommendations for BHGs

Forest Managers

When asked for suggestions for biomass harvesting guidelines, most forest managers took this time to explain why guidelines specifically for biomass harvesting were not necessary. However, there were several recommendations for forestry guidelines to increase focus on soil quality in addition to water quality.

Instead of requiring a percentage left on site, I think it should be more related to soil impacts. In other words, like the FPGs...they don't really tell you how to do it, but the end result is to prevent water pollution and sediment and the streams. So I would think it would make sense for the BHGs to move towards preventing soil impacts. So if the logger has tracked equipment, maybe he can harvest all of the woody debris. If he doesn't, he has to leave 50 percent of the woody debris, if it is in a wet site (Patrick, 3).

Jackson (10), a consulting forester, recommended leaving a percentage of the ground surface covered with woody debris rather than a percentage of debris left on the ground.

Brad (13) suggested, “The BHG itself should be clear enough that it could be easily interpreted and easily measured, easily monitored.” Richard (1) a consulting forester believed that a five year look back strategy would be the best way to determine if biomass harvesting was doing any damage on wildlife and soil before placing restrictions on the operations. He stated, “I think [a five year look back] would be much better than making the regulations onerous on the landowners and the buyers and everybody else.”

Loggers

Those who thought leaving 15 to 30 percent of CWD was reasonable believed that it should be done on problem areas. For example, Jack (19) was asked about retaining 15 to 30 percent of CWD on site and he responded, “It would be possible but only necessary in what we call the main skid trails.” Clayton (3) stated, “I would think if there was a slope, you would try to leave [debris] there. If it was more of a flat place, it may not take as much.”

A small number of loggers suggested that guidelines be tailored to the region. For example, Jason (17) suggested that guidelines should be different for the coast where the productivity of timber growth is higher than areas such as the Piedmont. He stated, “It just depends on what part of North Carolina you’re talking about. One law won’t fit across the whole state.” Kevin (15) was asked if North Carolina’s BMPs should be adapted to address biomass harvesting and he responded, “I think in certain counties, maybe not in Neuse River or the Roanoke River area, but when you get in the western part of the state, I think the guidelines do need to change. Because we don’t have a problem with erosion in this area like you do in Halifax and Warren County.”

Jason (17), a logger, also offered advice for the formulation of guidelines saying,

[Policy makers] need to visit everybody who is in the biomass business now and get some comments from every single one of them before they come out with a set of rules. And they need to be loggers, they need to have had experience logging, they have to be able to show criteria. As long as you don't just give somebody a briefcase and say, here now you're the expert on biomass, and he don't know his damn way from Raleigh to the coast—I'm against that. But if the guy is legitimately trained and knows what he is doing, I am for it.

Landowners

Landowners were asked if they had any recommendations for BHGs and a variety of responses and suggestions were given. Some landowners took this opportunity to insist that additional forest guidelines were unnecessary. For example, Duke (1) commented, "I am not sure you can regulate good forestry." A few landowners discussed enforcement and how without it, guidelines were futile. Thomas (7) stated,

If you don't have enforcement capabilities of guidelines or rules or regulations with teeth in them that are regularly used, somebody will do whatever they feel is in their best interest to do. So if you are going to have guidelines, have the gumption to have monitoring and enforcement, somewhere or another.

A few landowners suggested that for the woody biomass market to expand, woody material must be gathered for energy at the time of harvest rather than later. For example, Evelyn (11) stated, "There does not need to be a delay, they don't need to come in a year later and gather the woody biomass....Come on in right behind, get it done at one time." Elijah (10) stated, "I think it would be much more economical to be there on the spot with the logger doing it or a contractor doing it while the logger is there, as far as going in to the

guideline.”

Forestry Organizations

Both the North Carolina Forestry Association (NCFA) and the North Carolina Association of Professional Loggers (NCAPL) have strong political power in the state and several respondents were confident that guidelines regarding harvesting woody biomass would not be adopted because of these organizations influence in the forestry sector. Jackson (10), a forest manager, stated,

Legislation will never pass in North Carolina. It is not going to. I think if you go back and look at the teeth we are trying to put in the board of registration laws for registered foresters, the forestry association has fought it all the way. Anything that requires a logger to learn about something, or spend more money, the forestry association fights you all the way. They will pad the pockets of whoever they need to pad.

Max, a logger, (10) explained the NCAPL saying,

We have those guys as watchdogs and they are trying to get wood pellet companies into the state. Another thing too, with having that organization watching out for us, we don't see anything too intense as far as rules and regulations being passed. I don't think they would let it happen; they would do something to put a stop to it. So it's nice to have those guys and organizations in our corner as far as rules and regulations.

CHAPTER 4. DISCUSSION

Success of Best Management Practices

Forest managers, loggers and landowners as a majority agreed that best management practices were reasonable and effective and had an overall positive opinion of the guidelines. This attitude is similar to the results of previous studies. Husak and colleagues (2004) found forest landowners, forestry consultants, and timber industry professionals to all have “awareness of the effectiveness” of BMPs as well as overall positive attitudes towards the guidelines. Milauskas and Wang (2006) surveyed West Virginia loggers and 89 percent reported they “always” comply with BMPs. All groups were very confident in the ability of BMPs to protect water quality and most surveys of BMPs effectiveness support this notion (Arthur 1998; Schuler and Briggs 2000; Aust and Blinn 2004).

Biomass Harvesting: Little to No Modification to Operations

All three groups agreed that biomass harvesting should not be treated separately from a conventional harvest in terms of the guidelines applied. During a typical logging operation in the southeast, after the tree is felled, the whole tree is skidded to the log deck where the limbs and tops are removed and the wood is sorted for each market. Adding a woody biomass harvesting component consists of the addition of a chipper and a chip van which are brought to the logging deck. The material which will be used for woody biomass is put through the chipper at the logging deck and the operational process of harvesting trees in the woods is not altered. Therefore, in the Southeastern U.S., harvesting biomass does not

significantly change operations in terms of harvesting material; it only supplies an additional product. However, harvesting operations differ across regions. For example, in the Northeastern U.S., harvesters leave the limbs and tops where the tree is felled, rather than bringing the material to the logging deck. These variations must be considered when adopting guidelines that may have been created for a region with different harvesting methods.

Lack of Scientific Research Supporting BHGs

Forest managers, loggers, and forest landowners shared the belief that if biomass harvesting policy should be adopted, there must be scientific research in support of the guidelines. All three of the groups agreed on the importance of the scientific method to achieve results that supported the creation of biomass harvesting guidelines. The three groups also expressed concern that forest policy may be based on emotions rather than science or by policy makers who were not familiar with the technicalities of harvesting operation. Similar studies found the same general attitudes towards new forest policy.

For example, Holt (2009, 31) found that forest stakeholders in Oregon hoped that the biomass industry was “not politicized and driven by politics” and instead based upon funding and science. Eliason and Blinn (2003) found that natural resource professional were wary of new guidelines and wanted to “understand the reasons” and “understand the end result...the end goal” before new forest guidelines were to be adopted. Dietz and colleagues (1989) found that forest professionals believed the public had little knowledge of forests. Similarly, Dirkswager and colleagues (2011) interviewed landowners and found them to believe that

policy makers who formulated biomass harvesting policies did not understand the economics of harvesting timber.

There is a large body of research that has explored the science behind the dynamics of woody biomass and the detrimental effects that harvesting the material could have on forest ecosystems. Harmon and colleagues (1986) found snags and downed coarse woody debris to be important to forest ecosystems and critical to wildlife habitat. Downed CWD has been shown to benefit a variety of organisms, including invertebrates, vertebrates, fungi and plants (Freedman 1996; Hunter 1999). Downed CWD may also be important for nutrient retention (Harmon et al. 1986). It has been shown to protect erosion by reducing overland flow (Jia-bing et al. 2005). The growth in woody biomass markets may significantly increase the amount of CWD that is harvested (Hess and Zimmerman 2001) and Moorman and colleagues (1999) suggest that the extraction of woody biomass may alter the dynamics of CWD and lead to lower amounts of the material due to shorter harvest rotations. This reduction in downed CWD could have detrimental effects on many several species of wildlife including mice, small snakes, lizards, and salamanders (Harmon et al. 1986; Patrick et al. 2006). The Pennsylvania biomass harvesting guidelines state that, “good biomass practices can enhance and improve forestland; poor practices can damage and devalue it” (PA Department of Conservation and Natural Resources 2008, 30). Similarly, Hess and Zimmerman (2001, 6) found there to be a consensus among experts that the “absence of downed woody debris would be detrimental to biodiversity and ecological processes.” Despite the available science, there is still reluctance among the forestry community to accept additional regulations to protect forest ecosystems in the event of increased biomass harvests. This is

similar to the results of both Botkin (1990) and Peterson (1997) who found that the scientific method often exacerbates, rather than lessens, environmental conflict. The high ambiguity of science supporting the effects of woody biomass harvesting and the high level of conflict between interest groups suggests that it will be difficult to implement BHGs, since there is neither a top-down nor bottom-up pressure and support from the interest groups interviewed here (Matland 1995). Per Matland (1995), the coalition of local level actors will determine the policy implementation depending on their influence and strength. The resistance of loggers, landowners, and foresters to more BHGs will impede their adoption. Environmental interest groups and agencies may support the rules, but it appears they will face fairly pervasive opposition. The new conservative legislature in North Carolina, and much of the South, will also make development of new laws or even new BHG guidelines difficult. On the other hand, a recent court ruling that all woody materials, even whole trees, qualify as biomass, along with the rapid expansion of more wood pellet plants may cause enough pressure that Biomass Harvesting Guidelines will be developed.

Threats of BHGs to Viability of Biomass Harvesting

Woody biomass is currently a low value product and many believed the market was too volatile to introduce further guidelines on the harvesting process. Forest managers and loggers identified the transportation costs of woody biomass as one of the most challenging factors of adding a chipping component to an operation. These findings are in line with those of Aguilar and Garrett (2009) who reported that the costs of harvesting and transporting was identified by professional forest managers as the biggest challenge to harvesting woody

biomass as a renewable energy feedstock. Dirkswager and colleagues (2011) conducted a phone survey with logging business owners in Minnesota and found low product prices, high equipment and fuel costs, the lack of material, and environmental regulations to be primary barriers in the harvesting of biomass. They also reported on several landowners who expressed that by increasing the amount of forest regulations, it will be more difficult to maintain sustainability in timber harvesting. It is not clear which group will bear costs of BHGs. Loggers will spend more time implementing BHGs which will result in increased fuel costs and equipment usage. The price that landowners receive for woody biomass may also be reduced with BHG implementation.

Accurate Estimation of Debris is Not Possible

In this study, forest managers and loggers did not think it would be possible to accurately estimate a particular percentage of CWD left on a site, particularly with the high degree of variability across sites. The ability to monitor and enforce this type of guideline was also of concern to respondents. Several respondents asked how the guideline would be enforced if most of the debris was already harvested from a site or if there was not enough debris before the stand was cut to retain a particular percentage. For example, Connor (12), a logger, stated “If they had a situation where you had to leave a certain percentage you may have a difficult time reaching that percentage, because you may not be able to do it.” These results suggest that guidelines requiring a certain percentage could only be voluntary without having an accurate method of measuring CWD. Forest managers rarely have an inventory of CWD before a harvest, so retaining a specific percentage may be impractical.

There are several methods that may be used to estimate amounts of downed wood (Stahl et al. 2010). Bebber and Thomas (2003) were the first to introduce a standard wedge prism to sample CWD, which is occasionally used to estimate downed wood in the Southeast. A parallel study was completed in North Carolina that involved replicating BHGs by retaining 30 percent of coarse woody debris following a harvest so that comparisons could be made to traditionally harvested areas. Thirty percent of the total acreage was marked and when the designated region was harvested, limbs and tops from those trees were scattered back out across the entire site. One logger (Edward, 20) who was involved in this study stated, “It was probably a little bit easier than I thought it would be...we went through there and guesstimated we left 30 percent.”

BMPs Reflect Public Distrust of Forest Industry

Forest managers and loggers described the public’s distrust of those involved in the logging industry. Respondents believed that forest guidelines were often formulated by policy makers based on the public’s (negative) opinions of logging rather than sound science. A review of the literature suggests the polarization between those in the forest industry and the public is not a new concept. The association of British Columbia Professional Foresters sponsors opinion polls of the public’s perception of foresters each year and found that in 1997, 66 percent of the public believed it was “very important” to have forestry reserved for professional foresters. This percentage decreased each year and in 2002, this number dropped to 40 percent (Market Facts Market Trends 2002). Thomas (2002) as cited in Luckert (2006) wrote of American foresters and stated, “Twenty or so years ago, foresters were among the

most respected and trusted professionals in the United States. Sadly that is no longer so...” Keefer and colleagues surveyed loggers in Pennsylvania and 70 percent felt the “negative public image of the logging industry” was the most significant pressure faced in the logging business (2003, 91). These sentiments of forest managers and loggers illuminate the isolation and lack of effective communication between those working in the forestry industry and the public.

BMPs Reflect Public Fear of a Desolate Site

Forest managers frequently mentioned the public’s fear of having a timber harvest site left as a denuded landscape of stumps. This perception was a reason forest managers cited as why policy makers believed that biomass harvesting needed to be regulated although, according to respondents, this bleak observation was only a temporary scene which is quickly replaced by new growth of the forest. The public’s fear of a desolate site is explored throughout the literature. Egan and colleagues (1997) investigated tree farmer opinions in West Virginia and found that 55 percent believed clearcutting should be banned. Bliss (2000) investigated the public’s perceptions of clearcutting and found that several opinion polls have continually reported the widespread disapproval. Bliss also describes that Americans find clearcutting to be “aesthetically offensive” and the practice leads to conjured images of vast deforestation and degradation.

Logging Business

The economic challenges of operating a logging business during such a poor economy were discussed frequently by loggers throughout the interview process. Recent literature discusses the difficulties of the logging business. For example, Bolding (2010) documented the challenges of logging in West Virginia which include an aging workforce, recent mill closures and volatility of the market. Egan and Taggart (2004) found 69 percent of loggers surveyed in New England did not encourage their children to enter the logging business and only 51 percent of respondents stated that they would still be logging in five years. Loggers are constrained by low prices, lack of markets, and high operation and fuel costs and expressed the desire to capitalize on available business opportunities.

Definition of Biomass

Forest landowners expressed unease of the conflicting definitions of woody biomass in political discussions. A number of landowners believed that definitions of woody biomass should not be restrictive based on the type of material or if the material is located on public or private land. A small number of landowners mentioned that they did not want the woody biomass definitions to include whole-tree chipping. There have been ongoing political debates regarding the formulation of a clear definition of woody biomass. Aguilar and Garrett (2009) surveyed state foresters, state energy biomass contacts, and members of the National Council of Forestry Association Executives to understand perspectives of the definition of biomass and found that respondents believed the definition of biomass “should not differentiate between naturally regenerated forest stands and plantations or private and

public forestlands. There are differing definitions throughout the literature. For example, the state of Maine has three different definitions of biomass to distinguish between ‘biomass’, ‘energy wood’, and ‘energy fiber’ (Maine Forest Service 2008).

Interest in Woody Biomass as an Additional Forest Product

Forest landowner respondents that had not previously participated in the woody biomass market communicated interest to participate in the market in hopes of a cleaner site and a supplement to their income. This interest of landowners to participate was expected as Paula and colleagues (2011) found that 84 percent of family forestland owners were willing to supply wood from their forests for energy purposes.

Government Support of Woody Biomass Market

The majority of landowner respondents were interested in participating in the woody biomass market but several noted that since it is such a low value product, government incentives would be needed to encourage growth of the market. Beach and colleagues (2002) reviewed empirical literature on NIPF ownership and reported 71 percent of the cases reviewed found that cost sharing, technical assistance and/or tax incentives encouraged silvicultural treatments.

Private Property Rights

Forest landowners were very adamant about private property rights and believed they deserved the freedom to manage their forest as they wished, without an increase in

environmental protections. These results are comparable to Williams and others (1996) who found a majority of Arkansas NIPF landowners to believe they should have the ability to use their land as they chose without regulations although the landowners were in supportive of environmental protection. Bliss and colleagues (1994) surveyed southeastern landowners and reported 76 percent felt their property rights should be limited if it was essential for the protection of the environment. In a similar study, Bliss and colleagues (1997) reported rural residents, urban residents and forest landowners believed that private property right were necessary but secondary to environmental protection and there was no significant difference between the groups.

Benefits of Biomass Harvesting Guidelines

The benefits of BHGs as suggested by respondents include reduced site preparation costs, increased forest landowner management and greater business opportunities for forestry consultants. Additional benefits include soil stabilization, erosion control, and increase in wildlife habitat which are some of the main components to sustainably manage the forest as a whole. Husak and others (2004) investigated the perceived benefits of best management practices and found that NIPF landowners placed the highest value on increased stream bank stability and wildfire protection. Forest consultants placed the highest ratings on wildlife, scenic or public enhancements. Schulte and colleagues (2008) conducted interviews with forestry professionals in the U.S. Midwest to learn more about the woody biomass and found that forest managers believed a growing biomass market would encourage landowners to be more proactive in forest management. Munsell and Germain (2007) and Paula and

colleagues (2011) show that profitable woody biomass markets may encourage forest landowners to engage in active forest management.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

The results of 60 semi-structured interviews of forest managers, forest landowners and loggers in North Carolina reflect the forestry stakeholders' reluctance to accept any additional forest guidelines, particularly related to the harvesting of woody biomass, due to the perceived economic and social impact of increased regulation. Previous studies have addressed the perceptions of these three groups related to conventional harvesting operations, the market for woody biomass and the forest industry, yet this study is distinctive in that it explored the opinions of the forest community regarding the possibility of biomass harvesting guidelines, in advance of actual guideline adoption. This study provides insight into the resistance of forest managers, loggers, and landowners to accept additional forest recommendations and describes the barriers that may be faced in policy formulation.

The response of forest managers, loggers, and landowners regarding the opposition of biomass harvesting guidelines parallels the resistance that the public typically has for additional environmental policies and regulations. However, this study provided unique results in that respondents expressed positive opinions and acceptance of BMPs yet antipathy towards additional forest guidelines. The differences among sectors were not always as anticipated. For example, consulting foresters could potentially profit from additional forest guidelines yet still opposed BHGs. Loggers would likely incur more costs from the implementation of BHGs, at least in the short run, than landowners yet were more positive regarding adoption the guidelines.

According to previous literature, the removal of CWD could have detrimental effects on forest ecosystems, specifically on nutrient retention and wildlife habitat. The concern of the sustainability of woody biomass harvesting has been expressed by the public, ENGOS, and various state forestry departments. Yet most forest manager, logger and landowner respondents in this study believed that there was not sufficient scientific literature or evidence to support this claim. Available science related to the negative effects of woody biomass harvesting is either not well known by the forestry community or not believed. This suggests that the introduction of science has had little practical value to the perceptions of respondents and illustrates the gap that exists between the forestry community's perceptions and the available science.

The findings from this qualitative study point to several recommendations in developing appropriate forest policies and incentives for practicing sustainable forestry on privately owned land. Recommendations for policy makers include the following:

- Consider the divide in public discourse regarding biomass policy to lessen conflict between environmental groups, forest managers, forest landowners and loggers.
- Consider the forestry community's reluctance of adopting additional guidelines.
- Develop guidelines based on sound science and research and adapt responses accordingly—if considered, focus on wildlife and nutrient protection.
- Develop standard protocols for measuring the amount of biomass initially and the amount to be left on site.
- Recognize and consider the positions of both the NCFA and the NCAPL.
- Specify local relevance of woody biomass harvesting guidelines.

- Define the term *woody biomass* clearly in appropriate policy.
- Target concerns of underrepresented audiences such as inactive and younger forest stakeholders.
- Enhance effective community education and an adaptive management approach with involvement of all stakeholders.

Areas of additional research include assessing the perceptions of environmental groups regarding biomass harvesting guidelines. This group was left out of this study due to time and financial constraints, however, the opinions of this group would provide insight into the biomass harvesting guideline debate. Future studies could include a cost analysis to assess the financial impact of biomass harvesting guidelines on logging operations. Since the trajectory of the market for woody biomass in the coming years is unknown, further research could be completed to better understand the upcoming events. This study can aid in making informed policy decisions around BHGs that are not only sustainable, but also integrate the suggestions of the forestry community into guideline formulation. This information can also contribute to North Carolina management decisions regarding sustainable biomass harvesting guidelines and certification standards. The qualitative data and recommendations provided can be used for further education and outreach for the southeastern forest community and for the evaluation of specific solutions for the barriers of harvesting woody biomass.

REFERENCES

- Alden, A. M., C.R. Blinn, P.V. Ellefson, and P.G. Nordin. (1997). Timber harvester perceptions of benefits and costs of applying water quality best management practices in Minnesota. Minnesota Agricultural Experiment Station. Staff Paper: 22, 133.
- Aguilar, F. and H.E.G. Garrett. (2009). Perspectives of woody biomass for energy: survey of state foresters, state energy biomass contacts, and National Council of Forestry Association Executives. *Journal of Forestry*, 107(6): 297-306.
- Arthur, M.A., G.B. Coltharp, and D.L. Brown. 1998. Effects of best management practices on forest streamwater quality in Eastern Kentucky. *Journal of the American Water Resources Association*. 34(3): 481–495
- Aust, W.M. and C.R. Blinn. (2004). Forestry best management practices for timber harvesting and site preparation in the eastern United States: an overview of water quality and productivity research during the past 20 years (1982-2002). *Water, air, and Soil Pollution: Focus* 4:5-36.
- Beach, R.H., S.K. Pattanayak , J. Yang, B.C. Murray, and R.C. Abt. (2002). *Empirical Studies of Non Industrial Private Forest Management: A Review and Synthesis*. RTI International: Working Paper.
- Bebber, D and S. Thomas, (2003). Prism sweeps for coarse woody debris. *Canadian Journal of Forest Research*. 33: 1737-1743.
- Benjamin, J., R.J. Lilieholm, and C. Coup. (2010). Forest biomass harvests: A “special needs” operation? *Northern Journal of Applied Forestry*. 27(2): 45-49.
- Bihun, Y., and S.B. Jones. (1993). Loggers’ leap of faith. *American Forests*. 99(9/10): 46-47, 60.
- Birch, Thomas W. 1996. Private forest-land owners of the southern United States. (1994). USDA Forest Service North Eastern Forest Experiment Station. Resource Bulletin.
- Blinn, C.R. and M.A. Kilgore (2001). Riparian management practices: a summary of state guidelines. *Journal of Forestry*. 101(8): 37-41.
- Bliss, J.C., S.K. Nepal, R.T. Brooks Jr., and M.D. Larson. 1994. Forestry community or grandfalloon? *Journal of Forestry*. 92(9):6-10.

- Bliss, J.C., S.K. Nepal, R.T. Brooks, and M.D. Larsen. (1997). In the mainstream: Environmental attitudes of mid-south forest owners. *Southern Journal of Applied Forestry*. 21(1): 34-43.
- Bolding, M.C., S.M. Barrett, J.F. Munsell, and M.C. Groover. (2010). Characteristics of Virginia's logging businesses in a changing timber market *Forest Products Journal*. 60(1): 86-93.
- Brown, M.J. (2002). *Forest Statistics for North Carolina, 2002*. USDA Forest Service Resource Bulletin SRS-88. Asheville, North Carolina: USDA.
- Brown, M. J., B.D. New, S.N. Oswalt, T.G. Johnson, and V.A. Rudis. (2006). *North Carolina's Forests, 2002*. USDA Forest Service Resource Bulletin SRS-113. Asheville, NC : USDA
- Botkin. D.B. (1990). *Discordant harmonies: a new ecology for the twenty-first century*. New York: Oxford University Press.
- Butler, B.J. and E.C. Leatherberry. (2006). America's Family Forest Owners. *Journal of Forestry*. 102(7): 4-9.
- Corbin, J. and A. Strauss. (2008). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks, California: Sage.
- Cubbage, F.W. (2004). Costs of forestry best management practices in the South: a review. *Water Air & Soil Pollution: Focus*, 4: 131-142.
- Damery, D., M. Kelty D. Benjamin, and R.J. Lillieholm. (2009). Developing a sustainable forest biomass industry: Case of the US Northeast. *Ecology and Environment*. 122: 141-152.
- Decker, D.J., T.L. Brown, N.A. Connelly, J.W. Enck, G.A. Pomerantz, K.G. Purdy, and W.F. Siemer. (1992). Toward a comprehensive paradigm of wildlife management: integrating the human and biological dimensions. in W.R. Mangun (ed.) *American fish and wildlife policy: the human dimension*. Carbondale, Illinois: Southern Illinois University Press. 33-54.
- Dietz, T., P.C. Stern, and R.W. Rycroft. (1989). Definitions of conflict and legitimation of resources: the case of environmental risk. *Sociology Forum* 4: 47-70.
- Dirkswager, A.L., M.A. Kilgore, D.R. Becker, C. Blinn, and Alan Ek. (2011). Logging business practices and perspectives on harvesting forest residues for energy: a Minnesota case study. *North Journal of Applied Forestry*. 28(1): 41- 46.

- DNR New Brunswick. [Department of Natural Resources New Brunswick.] (2008). *Forest Biomass Harvesting*. New Brunswick Department of Natural Resources. Technical Paper. Retrieved on July 11, 2011 from:
<http://www.gnb.ca/0078/Policies/FMB0192008E.pdf>
- Dunk, T. (1994). Talking about trees: Environment and society in forest workers' culture. *Canada Review of Sociology*. 31(1): 14-34.
- Dutcher, D.D., J.C. Finley, A.E. Luloff, and J. Johnson. (2004). Landowner perceptions of protecting and establishing riparian forests: A qualitative analysis. *Society and Natural Resources*. 17: 319-332.
- Egan, A. and D. Taggart. (2004). Who will log? Occupational choice and prestige in New England's north woods. *Journal of Forestry*. 102(1): 20-25.
- Egan, A.F., C.C. Hassler, and S.T. Grushecky. (1997). Logger certification and training: A view from West Virginia's logging community. *Forest Products Journal*. 27(7/8): 46-50.
- EIA [Energy Information Administration]. (2010). *Annual Energy Review 2009*. Retrieved January 24, 2011 from <http://www.eia.doe.gov/aer/pdf/aer.pdf>.
- Eliason, S.K. and C.R. Blinn. (2003). Natural resource professional continuing education needs in Minnesota: focus on forest management guidelines. *Northern Journal of Applied Forestry*. 20(2): 71-78.
- EMC [Environmental Management Commission]. (2010). *Report and Recommendations Concerning Forest Resource Impacts of the Woody Biomass Industry in North Carolina*. Retrieved March 15, 2011 from:
<http://www.ncleg.net/documents/sites/committees/ERC/2009-2010%20ERC%20Documents/March%2018,%202010/Handouts%20and%20Presentations/2010-March%20-%20Woody%20Biomass%20Report.pdf>
- Enrich, A., Greene, and S. Baker. (2009.) *Status of Harvesting & Transportation for Forest Biomass – Preliminary Results of a National Survey of Logging Contractors, Procurement Foresters, Wood Dealers and Forest Managers*. University of Georgia. Center for Forest Business, Warnell School of Forestry & Natural Resources. Technical Paper. Retrieved July 7, 2011 from:
http://frec.vt.edu/cofe/documents/2010/Enrich_COFE_BiomassSurvey.pdf

- EPA [Environmental Protection Agency]. (1994). *What is Nonpoint Source (NPS) Pollution?* Taken from EPA's Polluted brochure EPA-841-F-94-005. Retrieved July 11, 2011 from: <http://www.epa.gov/owow/NPS/qa.html>.
- Evans, A.M. and R.T. Perschel (2009). *An Assessment of Biomass Harvest Guidelines*. Santa Fe, New Mexico. Forest Guild.
- Force, J.E., G.E. Machlis, and L. Zhang. The engines of change in resource-dependent communities. *Forest Science*. Volume 46(3): 410-422.
- Fossey E., C. Harvet, F. McDermott and L. Davidson. (2002). Understanding and evaluating qualitative research. *Australian and New Zealand Journal of Psychiatry*. 36: 717-732.
- Freedman, B., Zelazny, V., Beaudette, D., Fleming, T., Flemming, S., Forbes, G., Gerrow, J.S., Johnson, G., and S. Woodley. (1996). Biodiversity implications of changes in the quantity of dead organic matter in managed forests. *Environmental Reviews*. 4: 238-265.
- Galik, C.S., R.C. Abt, and Y. Wu. (2009). Forest biomass supply in the Southeastern United States: Implications for industrial roundwood and bioenergy production. *Journal of Forestry*. 107(2): 69-77.
- Grado, S.C.; Measells, M.K; Habig, R.B.; Capella, L.M. (2002). Values, attitudes, and perceptions of forest industry constituency groups. Research Bulletin FO 211. Mississippi State, MS: Forest and Wildlife Research Center, Mississippi State University.
- Grado, S. C. (2005). Attitudes and perceptions of Mississippi loggers and environmentalists toward the forest industry. *Bulletin of Science, Technology & Society*. 25(3): 260.
- Greene, W.D., F.W. Cabbage, and J.F. McNeel. (1988). Characteristics of independent loggers in Georgia. *Forest Products Journal*. 38 (7/8): 51-56.
- Gray, D.E. (2004). *Doing Research in the Real World*. London: Sage.
- Habig, R.B. (2002). Attitudes and Perceptions of Loggers and Environmental Groups in Mississippi. Unpublished Master's Thesis. Mississippi State University.
- Habig, R.B., S.C. Grado, L.A. Grace, and L.M. Capella. (2005). Attitudes and perceptions of Mississippi loggers and environmentalists toward the forest industry. *Bulletin of Science Technology Society*. 25(3): 260-270

- Han, Han-Sup, Harry W. Lee, Leonard R. Johnson. (2004). Economic feasibility of an integrated harvesting system for small-diameter trees in southwest Idaho. *Forest Products Journal*. 54(2): 21-27.
- Harmon, M.E., J.F. Frankin, F.J. Swanson, P. Sollins, S.V. Gregory, L.D. Lattin, N.H. Anderson, S.P. Cline, N.G. Aument, J.R. Sedell, G.W. Lienkaemper, K. Cromack, Jr., and K.W. Cumming. (1986). Ecology of coarse woody debris in temperate ecosystems. *Advances in Ecological Research*. 15:133-302.
- Hess, G. and D. Zimmerman. (2001). Woody debris volume on clearcuts with and without satellite chip mills." *Southern Journal of Applied Forestry* 24(4): 173-177.
- Hunter, M.L. (1999). *Maintaining Biodiversity in Forest Ecosystems*. Cambridge: Cambridge University Press.
- Husak, A.L., S.C. Grado, and S.H. Bullard. (2004). Perceived values of benefits from Mississippi's forestry best management practices. *Water, Air, and Soil Pollution: Focus* 4: 171-185
- Ice, G.G. (2004). History of innovative best management practice development and its role in addressing water quality limited waterbodies. *Journal of Environmental Engineering*. 130(6): 684-689.
- Ice, G.G., E. Schilling, and J. Vowell. (2010). Trends for forestry best management practices implementation. *Journal of Forestry*. 108(6): 267-273
- Jackson, C.R., G. Sun, D. Amatya, W.T. Swank, M. Riedel, J. Patric, T. Williams, J.M. Vose, C. Trettin, W.M. Aust, R.S. Beasley, H. Williston, and G.G. Ice. (2004). Fifty years of forest hydrology in the southeast. *A Century of Forest and Wildland Watershed Lessons*. Society of American Foresters: Bethesda, Maryland.
- Jia-bing, W., G. De-xin, H. Shi-jie, Z. Mi, and J. Chang-jie. (2005). Ecological Functions of Coarse Woody Debris in Forest Ecosystem. *Journal of Forestry Research* 16(3): 247-252.
- Keefer, M.J. (2001). Profiling Pennsylvania's logging community. Master's Thesis, Pennsylvania State University.
- Keefer, M.J., J.C. Finley, A.E. Luloff, and M.E. McDill. (2002). Characterizing loggers' forest management decisions. *Journal of Forestry*. 100(6): 8-15.
- Keefer, M.J., J.C. Finley, A.E. Luloff, and M.E. McDill. (2003). Understanding loggers' perceptions. *Journal of Sustainable Forestry*. 17(3): 81-99.

- Kilgore, M.A. and C.R. Blinn. (2004). Policy tools to encourage the application of sustainable timber harvesting practices in the United States and Canada. *Forest Policy and Economics*. 6:111-127.
- Kilgore, M.A., J. L. Greene, M.G. Jacobson, T. J. Straka, and S.E. Daniels. (2007). The Influence of Financial Incentive Programs in Promoting Sustainable Forestry on the Nation's Family Forests. *Journal of Forestry*. 105(4):184-191.
- Kluender, R. A., T. L. Walkingstick, and J. C. Pickett. (1999). The Use of Forestry Incentives by Non-industrial Forest Landowner Groups: Is It Time For A Reassessment of Where We Spend Our Tax Dollars? *Natural Resources Journal*. 39(4): 799- 818.
- Labriole, M.M. and V.A. Luzadis. (2011). New York Society of American Foresters' Perceptions of Climate Change. *Journal of Forestry*. 109: 89-93.
- La Capra Associates. (2006). *Analysis of a renewable portfolio standards for the state of North Carolina*. Technical Report prepared for North Carolina Utilities Commission.
- Lincoln, Y.S. and E.G. Guba. (1985). *Naturalistic Inquiry*. Beverly Hills, California: Sage.
- Londo, Andrew J. (2004). An assessment of Mississippi's nonindustrial private forest landowners' knowledge of forestry BMPs. *Water, air & soil pollution: Focus*. (4): 235-243.
- Luckert, M.K. (2004). Why are enrollments in forestry declining? *Forestry Chronicle*. 80(2):209-214.
- Maine Forest Service, University of Maine and Trust to Conserve Northeast Forestlands. (2008). *Biomass Retention Guidelines for Timber Harvesting in Maine*. Maine Forest Service: Orono, Maine.
- Market Facts. Market Trend. (2002). July 2002 British Columbia-wide public opinion tracking poll: *Public perceptions and attitudes towards RPFs and forest management*. Vancouver, BC. Retrieved July 9, 2011 from: www.abcfp.ca/publications_forms/publications/documents/2002-opinion-poll.pdf.
- Matland, R.E. (1995). Synthesizing the implementation literature: the ambiguity-conflict model of policy implementation. *Journal of Public Administration Research and Theory*. 5(2):145-174.
- Milauskas, S.J. and J. Wang. (2006). West Virginia logger characteristics. *Forest Products Journal*. 56(2): 19-24.

- Miles, M. B., and A. M. Huberman. (eds.) (1994). *An Expanded Sourcebook, Qualitative Data Analysis* (2nd ed.) Thousand Oaks, California: Sage Publications.
- Mills, T.J. and R.N. Clark. (2001). Roles of research scientists in natural resource decision-making. *Forest Ecology and Management*. 153:189-198.
- Measells, M.K., S.C. Grado, H.G. Hughes, M.A. Dunn, J. Idassi, and B.Zielinske. (2005). Nonindustrial private forest landowner characteristics and use of forestry services in four southern states: Results from a 2002–2003 mail survey. *Southern Journal of Applied Forestry*. 29(4):194-199.
- Megalos, M. A. (2000). *North Carolina landowner responsiveness to forestry incentives*. Unpublished PhD. Dissertation. North Carolina State University.
- Megalos, M.A. (2008). *Sustainable Woody Biomass Harvesting: Minimizing Impacts*. Extension Forestry, North Carolina State University. Retrieved March 15, 2011 from: <http://www.ces.ncsu.edu/forestry/biomass/pubs/WB005.pdf>.
- Megalos, M. A. (2009). *Air quality and North Carolina wood energy*. North Carolina Cooperative Extension: Raleigh, North Carolina. Retrieved March 15, 2011 from: <http://www.ces.ncsu.edu/forestry/biomass/pubs/WB010.pdf>
- Mehmood, S., M. Pelkki, and R. Montgomery (2009). The costs of BMP/SFI compliance: Arkansas loggers' perspectives. Proceedings of the 2003 Southern Forest Economics Workers Meeting. New Orleans, Louisiana.
- Miller, K.T. (2006). *Reaching non-industrial private forestland owners with their preferred methods of information delivery*. Unpublished Master's Thesis. North Carolina State University.
- Moorman, C.E., K.R. Russell, G.R. Sabin, and D.C. Guyunn, Jr. (1999). Snag dynamics and cavity occurrence in the South Carolina Piedmont. *Forest Ecology and Management*. 118:37-48
- Munsell, J.F., and R.H. Germain 2007. Woody biomass energy: An opportunity for silviculture on nonindustrial private forestlands in New York. *Journal of Forestry*. 105(8): 398–402.
- National Wildlife Federation. (2010). *Growing a Green Energy Future: A Primer and Vision for Sustainable Biomass Energy*. National Wildlife Federation. Technical Paper.

- NCDENR [North Carolina Department of Environment and Natural Resources]. (2006). *Forest Inventory and Analysis Fact Sheet North Carolina. 2002*. Retrieved March 15, 2011 from: <http://srsfia2.fs.fed.us/states/nc/NCFACT~1.PDF>.
- NCDENR [North Carolina Department of Environment and Natural Resources]. (2008). *North Carolina Division of Forest Resources Annual Report*. Retrieved March 12, 2011 from: <http://www.dfr.state.nc.us/NCDFRAnnualReport.pdf>.
- Newman, D.H., Aronow, M.E., Harris, T.G. Jr., Macheski, G. (1996). *Changes in forest land ownership characteristics in Georgia*. Proceedings: symposium on nonindustrial private forests learning from the past, prospects for the future. University of Minnesota, Minnesota Extension Special Programs: St. Paul: Minnesota. 214-221.
- North Carolina Extension Forestry. (2008). *Economics of Harvesting Woody Biomass in North Carolina*. North Carolina Forest Service. Technical Paper. Retrieved July 6, 2011 from: http://www.ncforestassessment.com/assessment_document.htm
- North Carolina Forest Assessment (2010). Retrieved on July 6, 2011 from: <http://www.ncforestassessment.com/PDF/NC%20Forest%20Assessment%20Part%204%20%20Chapter%204%20Enhancing%20the%20Benefits%20of%20North%20Carolina%27s%20Forests.pdf>
- NCFA [North Carolina Forestry Association]. (2005). *A landowner's guide to forestry in North Carolina*. [pamphlet] Raleigh North Carolina: NCFA.
- NCFA [North Carolina Forestry Association]. (2008). *NCFA Position Statement—Wood for Biomass/ Biofuels*. Retrieved June 20, 2011 from: <http://www.ncforestry.org/WEBPAGES/BIOMASS%20POSITION%20STATEMENT.pdf>.
- North Carolina Forest Service. (2011). *Frequently Asked Questions about Logging in N.C.* Retrieved July 7, 2011 from: http://www.dfr.state.nc.us/Managing_your_forest/logging_faq.htm#license
- North Carolina General Assembly. (2007). *General Statute 62e133.8: Renewable energy and energy efficiency portfolio standard (REPS)*. Retrieved January 24, 2011 from: http://www.ncga.state.nc.us/enactedlegislation/statutes/html/bysection/chapter_62/gs_62-133.8.html.
- PA Department of Conservation and Natural Resources. (2008). *Guidance from Harvesting Woody Biomass for Energy in Pennsylvania*. Retrieved on July 22, 2011 from: http://www.dcnr.state.pa.us/PA_Biomass_guidance_final.pdf

- Patrick, D.A., M.L. Hunter, Jr., and Aram J.K. Calhoun. (2006). Effects of experimental forestry treatments on a Maine amphibian community. *Forest Ecology and Management*. 234:323–332
- Paula, A.L. C. Bailey, R. J. Barlow, and W. Morse. (2011). Landowner willingness to supply timber for biofuel: results of an Alabama survey of family forest landowners. *Southern Journal of Applied Forestry*. 35(2): 93-97.
- Perlack, R.D., L.W Wright, A.F. Tuhollow, R.L. Graham, B.J Stokes, and D.C. Erbach. (2005). *Biomass as feedstock for a bioenergy and bioproducts industry: The technical Feasibility of a billion- ton annual supply*. Oak Ridge, Tennessee: Oak Ridge National Laboratory and U.S. Department of Energy.
- Perlin, J. (1989). *A Forest Journey: The Role of Wood in the Development of Civilization*. New York: Norton.
- Peterson, M.N., T.R. Peterson, M.J. Peterson, R.R. Lopez, and N.J. Silvy. (2002). Cultural conflict and the endangered Florida Key deer. *Journal of Wildlife Management*. 66(4): 947-968.
- Peterson, T.R and C.C. Horton. (1995). Rooted in the soil: How understanding the perspectives of land-owners can enhance the management of environmental disputes. *Quarterly Journal of Speech*. 81: 139-166.
- Peterson, T.R., K. Witte, E. Enkerlin-Hoeflich, L. Espericueta, J.T. Flora, N. Florey, T. Loughran and R. Stuart (1994). Using informant directed interviews to discover risk orientation: How formative evaluations based in interpretive analysis can improve persuasive safety campaigns. *Journal of Applied Communication Research*. 22: 199-215.
- Peterson, T.R. (1997). *Sharing the earth: the rhetoric of sustainable development*. Columbia, South Carolina: University of South Carolina Press.
- Peterson, T.R. and R.R. Franks. Environmental Conflict Communication. (2005). *The Sage Handbook of Conflict Communication*. Thousand Oaks, California: Sage.
- Pierce, R.S., J.W. Hornbeck. W.C. Martin, J.M. Tritton, T.C. Smith, A.C. Federer and H.W. Yawney. (1993). *Whole-tree clearcutting in New England: Manager's guide to impacts on soils, streams, and regeneration*. [Technical report]. Radnor, Pennsylvania: U.S. Forest Service.
- Pinchot Institute and The Heinz Center. (2010). *Forest Sustainability in the Development of Wood Bioenergy in the U.S.*. The Pinchot Institute for conservation and The H. John

- Heinz III Center for Science, Economics and the Environment. Pinchot Institute for Conservation: Washington, DC.
- Plate, R.R., M.C. Monroe, A. Oxarart. (2010). Public perceptions of using woody biomass as a renewable energy source. *Journal of Extension*. 48(3): 3FEA7
- Reeb, J.E. (1996). Logger Training in Kentucky: Results of a post survey. *Northern Journal of Applied Forestry*. 13(3): 109.
- Susaeta, A., J. Alavalapati, P. Lal, J.R. Matta, and E. Mercer. (2010). Assessing public preferences for forest biomass based energy in the southern United States. *Environmental Management*. 45:697-710.
- Schuler, J.L and R.D. Briggs.(2000). Assessing Application and Effectiveness of Forestry Best Management Practices in New York. *Northern Journal of Applied Forestry*. 17(4): 125-134
- Schulte, L., J. Tyndall, R. Hall, and K. Grubh. (2008). *Rapid assessment of woody biomass capabilities in three regions of the U.S. Midwest*. Retrieved January 15, 2011 from: <http://www.nrem.iastate.edu/landscape/Publications/FinalWoodyBiomassReport.pdf>.
- SGSF[Southern Group of State Forester's]. (2009). *Woody Biomass Harvesting Guidelines*. Services, Utilization and Marketing Task force and Water Resources Committee. [Technical Paper].
- Smidt, M.F. and C.R. Blinn. (1994). Evaluation of logger continuing education needs in Minnesota. *Forest Products Journal*. 44(3): 57-62.
- Stahl, Goran, J.H. Grove, M.S. Williams, and M.J. Ducey. (2010). Critical length sampling: a method to estimate the volume of downed coarse woody debris. *European Journal of Forest Resources*. 129:993-1000.
- State of North Carolina Utilities Commission. (2010). *News Release: North Carolina Utilities Commission Adopts Final Rules Implementing Session Law 2007-397 (Session Bill 3)*. Retrieved March 11, 2011 from: <http://www.ncuc.commerce.state.nc.us/>.
- Stidham, M. and V. Simon Brown. (2011). Stakeholder perspectives on converting forest biomass to energy in Oregon, USA. *Biomass and Bioenergy*. 35 (1): 203-213..

- Summit Ridge Investments. (2007). *Eastern hardwood forest region woody biomass energy opportunity*. Retrieved March 15, 2011 from: <http://spfnic.fs.fed.us/werc/finalrpts/06-DG-300.pdf>.
- Thomas, J.W. (2002). Are there lessons for Canadian foresters lurking south of the border? *Forestry Chronicle*. 78(3):382–386.
- Tyndall, J.C., L.A. Schulte, and R.B. Hall. (2010). Expanding the US cornbelt biomass portfolio: forester perceptions of the potential for woody biomass. *Small Scale Forestry*. DOI: 10.1007/s11842-010-9149-4.
- Webb, T.J. and D. Raffaelli. (2008). Conversations in conservation: revealing and dealing with language differences in environmental conflict. *Journal of Applied Ecology*. 45: 1198-1204.
- Williams, R.A., D.E. Voth, and C. Hitt. (1996). *Arkansas' NIPF landowners' opinions and attitudes regarding management and use of forested property*. Symposium on non-industrial private forests: learning for the past, prospects for the future. University of Minnesota. Minnesota Extension Special Programs: St. Paul, Minnesota. 230-237.

APPENDICES

Appendix A

LIST OF ACRONYMS

BCAP	Biomass Crop Assistance Program
BHG	Biomass harvesting guideline
BMP	Best management practice
CWD	Coarse woody debris
ENGO	Environmental non-governmental organization
FPG	Forest practice guideline
NIPF	Non-industrial private forest
REPS	Renewable Energy and Energy Efficiency Portfolio Standard
SMZ	Stream management zones

Appendix B

IRB APPROVAL

North Carolina State University is a land-grant university and a constituent institution of The University of North Carolina

**Office of Research
and Graduate Studies**

NC STATE UNIVERSITY

Sponsored Programs and
Regulatory Compliance
Campus Box 7514
2701 Sullivan Drive
Raleigh, NC 27695-7514

919.515.2444
919.515.7721 (fax)

From: Carol Mickelson, IRB Coordinator
North Carolina State University
Institutional Review Board

Date: April 30, 2010

Project Title: Perceptions of Biomass Harvesting Guidelines and Sustainability of Harvesting Woody Biomass for Renewable Energy

IRB#: 1450-10

Dear Diane Cooper:

The research proposal named above has received administrative review and has been approved as exempt from the policy as outlined in the Code of Federal Regulations (Exemption: 46.101. b.2). Provided that the only participation of the subjects is as described in the proposal narrative, this project is exempt from further review.

NOTE:

1. This committee complies with requirements found in Title 45 part 46 of The Code of Federal Regulations. For NCSU projects, the Assurance Number is: FWA00003429.
2. Any changes to the research must be submitted and approved by the IRB prior to implementation.
3. If any unanticipated problems occur, they must be reported to the IRB office within 5 business days.

Please forward a copy of this letter to your faculty sponsor, if applicable. Thank you.

Sincerely,

Carol Mickelson
NCSU IRB

Appendix C

PRELIMINARY FOREST MANAGER INTERVIEW GUIDE

Background

1. What is your position within the company?
2. What type of equipment do you currently use for harvesting biomass?
3. What material do you harvest for biomass? (tops , limbs, brush, stems, roundwood for chips, other)
4. At what point during the harvest is biomass collected? (For example, during harvesting, after harvesting)
5. About how much biomass do you usually harvest per acre? (tonnage?)
6. What are some concerns or conflicts you have faced while harvesting woody biomass? (For example, harvesting or delivery concerns, physical or technical barriers, problems with equipment)
7. What are some difficulties or challenges of harvesting biomass compared to conventional harvesting methods?

BHGs

Biomass harvesting guidelines are designed to protect water quality, site productivity, and wildlife habitat before and after woody biomass harvests and they include strategies for retention of standing dead trees, down wood, and forest floor litter.

8. What are some guidelines that you currently implement to lessen the environmental impact of biomass harvesting?
9. Current BHGs generally recommend leaving between 20% and 30% of harvestable coarse woody debris (CWD) on site after harvest. Could this practice be implemented on site? Could 20%-30% CWD be estimated accurately? (If yes, which method is best for measuring CWD? What are the potential benefits of this practice?) (If no, what are some concerns or problems with this recommendation?)
10. BHGs may suggest dispersing the biomass material, rather than leaving it in clusters or piles. What is usually done with the debris after harvesting? Is spreading out the biomass material a realistic option in a logging operation? (If yes, is this more difficult than leaving the debris in piles?)(If no, what are some constraints of this practice?)
11. In your view, does biomass harvesting that you conduct affect site productivity in comparison to a conventional harvest? (If yes, does biomass harvesting reduce site productivity? In what way could operations be adapted to increase site productivity?) (If, no, what are some practices of biomass harvesting that could potentially improve site productivity?)
12. In your view, does harvesting biomass impact wildlife habitat in comparison to conventional logging? (What logging operations could be done to improve wildlife habitat?)

13. Do you think biomass harvesting that you perform changes the water quality of the area? (If yes, What operations directly affect water quality? how does biomass harvesting reduce water quality? What are some specific practices that could improve water quality? If no, which specific operations can improve the water quality?)
14. How do you think newly implemented BHGs will affect your work? (Will you object or do you welcome guidelines to follow?)
15. What are some recommendations that you would suggest for BHGs for the mitigation of environmental impacts?
16. Will new BHGs change the management prescriptions you write?
17. What is the probable or actual end market buyer for the biomass produced?

Appendix D

FINAL FOREST MANAGER INTERVIEW GUIDE

Background

1. What are the objectives of your firm?
2. Counties of operation?
3. What type of equipment is currently used for harvesting? (list equipment and number of operators)
4. What are your production materials?

Biomass Harvesting

5. What types of biomass harvests (if any) does your company or your landowners perform?
6. Is there any additional equipment used for harvesting biomass?
7. What is typically done with the downed CWD (limbs and tops) following a harvest? (Historically? Burning?)
8. What are some concerns or conflicts faced while harvesting woody biomass? (Harvesting or delivery concerns, physical or technical barriers, problems with equipment, adequate markets, compared to conventional)
9. About how much biomass is usually harvested per acre? (tons)
10. What is typically the end market buyer for the biomass produced?
11. Do you think our FPGs and use of BMPs has been successful in NC? Should we revise these protections because we now have biomass harvests?
12. About what percent of CWD is typically left after a biomass harvest?
 - i. Spread out? Clusters?

BHGs

13. Current BHGs generally recommend leaving between 15% and 30% of downed CWD on site after harvest.
 - i. Could this practice be implemented on site? (How or why not?)
 - ii. Could 15%-30% CWD be estimated accurately?
 - iii. Problems with this guideline?
14. BHGs may suggest dispersing the 15-30% of the downed CWD:
 - i. Is this doable/ realistic? (How or why not?)
 - ii. If so, how/when would it be done?
 - iii. Problems with this practice?
15. BHGs may recommend leaving 15-30% of debris in clusters/piles
 - i. Is this doable/ realistic?
 - ii. If so, how/when would it be done?
 - iii. Windrows/ linear pattern for planting?
 - iv. Problems with this practice?
16. What do you think about designating a percentage (15-30%) of the site where non-merchantable material is not cut until the very end and then redistributed?

Feasible?

17. If 15-30% of CWD is left on site after harvesting biomass, how does this affect site preparation in comparison to a conventional harvest?
18. In your view, how does harvesting biomass impact each of the following in comparison to conventional logging?
 - a. Soil?
 - b. Wildlife
 - c. Water quality?
19. How do you think newly implemented BHGs would affect your work? (Will they affect the management prescriptions that you write? Will you object or do you welcome guidelines to follow?)
20. What are some recommendations that you would suggest for BHGs for the mitigation of environmental impacts caused from biomass harvesting?

Demographics:

1. Male or Female?
2. What is your age?
3. What is the highest level of education you have completed?

Appendix E

PRELIMINARY LOGGER INTERVIEW GUIDE

1. What is the name of your company?
2. What is your equipment spread?
3. What type of biomass material do you harvest?
4. What is your average production of biomass?
5. What is the storage time for biomass material?
6. What are some conflicts you have faced while harvesting woody biomass? (For example, harvesting or delivery concerns, physical or technical barriers, equipment)
7. What are some difficulties or challenges of harvesting biomass compared to conventional harvesting methods?
8. What are some recommendations that you would suggest for BHGs?
9. If a policy were to require a certain percentage of biomass left on the site, would it be possible to accurately estimate this percentage?
10. What is the best way to measure the amount of biomass on a site?
11. Would a two pass system be effective? For example, leaving tops and limbs for up to six months and recovering after material is dry?
12. Should biomass harvests be compensated on a per-acre or per-hour basis or on the tonnage of biomass removed?
13. What is usually the end market buyer for biomass?

Appendix F

FINAL LOGGER INTERVIEW GUIDE

Background

1. How many employees (or logging crews) within the company?
2. Counties of operation?
3. What types of equipment is currently used for harvesting?

Biomass

4. Do you harvest hog fuel /dirty chips (biomass)? If no, why not? Have you before?
5. Is there any additional equipment used for harvesting biomass?
6. About how much biomass do you usually harvest per acre (tons)?
7. What is the delivery price per ton for biomass?
8. What are some difficulties or conflicts you have faced while harvesting woody biomass?
9. Who usually buys the harvested biomass?
10. Are you familiar with Forest Practice Guidelines (FPGs) and Best Management Practices (BMPs)? Do you think our FPGs and use of BMPs has been successful in NC? Do you think we should increase these protections because we now have biomass harvests?
11. What is usually done with the downed coarse woody debris (CWD- tops, limbs) following a harvest?
 - a. About what percent of CWD (limbs and tops) is typically left after a biomass harvest?
12. Is it typically spread out or scattered?

BHGs

13. Current BHGs generally recommend leaving between 15% and 30% of downed CWD on site after harvest.
 - a. How could 15%-30% CWD be estimated accurately?
14. BHGs may suggest dispersing the 15-30% of CWD following a harvest.
 - a. How would this be done?
 - b. Problems with this job?
15. Some BHGs recommend leaving 15-30% of CWD in piles.
 - a. How would it be done?
 - b. Problems with this job?
 - c. Piles in lines/ debris in windrows?
16. What do you think about designating a percentage (15-30%) of the site where tops, limbs, and cull trees are not cut until the very end and then redistributed across the tract?
17. If 15-30% of CWD are left on site after harvesting biomass, would this affect site prep, and if so, how?
18. How would new BHGs affect your business?

- a. Will you be opposed or welcoming of guidelines to follow?
 - b. Would you perform a job with these restrictions?
 - c. Are changes in the current guidelines (FPGs, BMPs) needed?
19. Are you in favor of a new training program for biomass harvesting educations and estimating CWD following a harvest?
20. Would the buyer of the biofuel help pay with the increase of costs of harvesting for biomass?
21. Do you think harvesting for hogfuel affects the ability to grow timber in the future?
22. How does harvesting biomass impact each of the following compared to conventional logging?
- a. Wildlife?
 - b. Soil?
 - c. Water quality?

Demographics

- 1. Male or Female
- 2. What is your age?
- 3. What is the highest level of education you have completed?

Appendix G

PRELIMINARY LANDOWNER INTERVIEW GUIDE

Background

1. How many acres of woodlands do you own?
2. Do you currently have a management plan for your woodlands?

Current Biomass Production

3. Do you currently harvest for biomass?
4. About how much biomass do you usually harvest per acre? (tonnage?)
5. What material is harvested for biomass? (tops , limbs, brush, stems, roundwood for chips, other)
6. At what point during the harvest is biomass collected? (For example, during harvesting, after harvesting)
7. What are some difficulties or challenges of harvesting biomass compared to conventional harvesting methods?
8. What is the probable or actual end market buyer for the biomass produced?

Biomass Harvesting Guidelines (BHG)

Biomass harvesting guidelines are designed to protect water quality, site productivity, and wildlife habitat before and after woody biomass harvests and they include strategies for retention of standing dead trees, down wood, and forest floor litter.

9. What are some guidelines that are currently implement on your land to lessen the environmental impact of biomass harvesting?
10. Current BHGs generally recommend leaving between 20% and 30% of harvestable coarse woody debris (CWD) on site after harvest. Do you think this practice could be implemented on site? Could 20%-30% CWD be estimated accurately?
(If yes, which method is best for measuring CWD? What are the potential benefits of this practice?) (If no, what are some concerns or problems with this recommendation?)
11. BHGs may suggest dispersing the biomass material, rather than leaving it in clusters or piles. What is usually done with the debris after a harvest? Which method would you prefer?
12. In your view, does biomass harvesting affect site productivity in comparison to a conventional harvest? (If yes, Does biomass harvesting reduce site productivity? In what way could operations be adapted to increase site productivity?) (If no- What

- are some practices of biomass harvesting that could potentially improve site productivity?)
13. In your view, does harvesting biomass impact wildlife habitat in comparison to conventional logging? (What logging operations could be done to improve wildlife habitat?)
 14. Do you think biomass harvesting that is performed changes the water quality of the area? (If yes, What operations directly affect water quality? how does biomass harvesting reduce water quality? What are some specific practices that could improve water quality?) (If no, which specific operations can improve the water quality?)
 15. What are some recommendations that you would suggest for BHGs for the mitigation of environmental impacts?

Appendix H

FINAL LANDOWNER INTERVIEW GUIDE

Background

1. How many acres of woodlands do you own?
2. In which counties are your woodlands located?
3. What are your objectives as a landowner?
4. Do you currently have a management plan for your woodlands?
 - a. If yes, are you implementing the management plan you have?
 - b. If no, why not?

Current Biomass Production

5. Do you currently harvest for biomass/ woodchips for energy?
6. If not, would you like participate in biomass markets? Why or why not?
7. What are some difficulties or challenges of harvesting biomass compared to conventional harvesting methods?
8. What is the probable or actual end market buyer for the biomass produced?

Biomass Harvesting Guidelines (BHG)

9. Are you familiar with Forest Practice Guidelines (FPGs) and Best Management Practices (BMPs)? Do you think our FPGs and use of BMPs has been successful in NC? Should we increase these protections because we now have biomass harvests?
10. Current BHGs generally recommend leaving between 15% and 30% of harvestable coarse woody debris (tops and limbs) on site after harvest. Would you welcome this guideline? Why or why not?
11. BHGs may suggest dispersing the biomass material, or leaving it in clusters or piles. What is usually done with the debris after a harvest? Which method would you prefer?
12. If 15-30% of downed Coarse Woody Debris (CWD) is left on site after harvest, how does this affect site preparation?
13. How does the amount of biomass harvested affect the following?
 - a. Soil?
 - b. Wildlife?
 - c. Water quality?
14. In your view, does harvesting biomass affect site productivity in comparison to a conventional harvest? Why or why not?
15. What are some recommendations that you would suggest for BHGs for the mitigation of environmental impacts?
16. If adopted in NC, will BHGs will affect your management plan? (Do you object or do you welcome new guidelines to follow?)

Demographics:

17. Male or Female?

18. What is your age?

19. What is the highest level of education you have completed?

Appendix I

CONSENT FORM

Confidentiality Agreement
North Carolina State University
INFORMED CONSENT FORM for RESEARCH

**Perceptions of Biomass Harvesting Guidelines and Sustainability
of Harvesting Woody Biomass for Renewable Energy**

Principal Investigator: Diane Cooper

Faculty Sponsor: Fred Cabbage

What are some general things you should know about research studies?

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time. The purpose of this study is to gain a better understanding of biomass harvesting guidelines in the Southeastern United States. You are not guaranteed any personal benefits from being in a study. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?

The purpose of this study is to investigate the operational and economic feasibility of biomass harvesting guidelines. We are particularly interested in the viewpoint of loggers, forest managers, and landowners in the Southeast. The information you all provide will help establish practical biomass harvesting guidelines. It can be incorporated into state Renewable Energy Portfolio Standards and help Southeastern states reach their goals to develop practical and sustainable biomass harvesting guidelines.

What will happen if you take part in the study?

If you agree to participate in this study, you will be asked to answer questions about harvesting woody biomass and biomass harvesting guidelines. The information you provide will remain entirely confidential, and there will be no way in which anyone could identify you or connect your information to you. If you choose not to answer some questions, that will not influence any other information you might provide. You may decide if you feel comfortable if I tape your responses. If you do not wish to have your responses taped, I will take notes. You may see the notes or listen to the tape at any time during the interview. Some of the questions may be very short; for others, you may want to provide much information. Please feel free to bring up any issues about harvesting woody biomass or biomass harvesting guidelines that might not be part of the interview. You may end the interview at any time. I expect the interview to take between 30 minutes to 2 hours as your time permits.

Risks

There are no foreseeable risks associated with participating in this study.

Benefits

You will receive no direct benefit from participation in this study. However, you may receive indirect benefits by knowing that your information contributes to current and future management decisions regarding biomass harvesting guidelines in the Southeast. You will also be contributing to the body of knowledge regarding renewable based energy policy.

Confidentiality

The information in the study records will be kept strictly confidential. Data will be stored securely in locked cabinets in my faculty sponsor’s office. Tape recordings will be erased as soon as transcriptions are completed. I will assign unique number immediately so that your name cannot be linked to the information you provide. No reference will be made in oral or written reports which could link you to the study. You will NOT be asked to write your name on any study materials so that no one can match your identity to the answers that you provide.

Compensation

No compensation is offered for your participation.

What if you have questions about this study?

If you have questions at any time about the study or the procedures, you may contact the researcher, Diane Cooper, at Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27695-8008, 225-803-2110, dmcoope2@ncsu.edu or Fred Cabbage, fred_cabbage@ncsu.edu, 919-515-7789.

What if you have questions about your rights as a research participant?

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus, 919-515-4514

Consent to Participate

“I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may withdraw at any time.”

Subjects Signature: _____ Date: _____

Investigators Signature: _____ Date: _____

Appendix J

FACILITIES CURRENTLY PURCHASING WOODY BIOMASS FROM LOGGER RESPONDENTS

Carolina Pole Inc. -Eutawville, SC,
Coastal Carolina Clean Power- Kenansville, NC
Craven County Wood Energy- New Bern, NC
Domtar, Plymouth- NC
International Paper- Riegelwood, NC
Kapstone Paper and Packaging Corporation- Roanoke Rapids, NC
Pennsylvania Power Company- Hurt, VA
Capital Power- Roxboro, NC
Southport Energy- Southport NC
Uniboard Mill- Moncure, NC