Nonindustrial Private Forests of Southeast Michigan: Examining Trends and Adapting Engagement to Sustain Forest Amenities

by

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A thesis submitted
in partial fulfillment of the requirements
for the degree of
Master of Science
(Natural Resources and Environment)
at the University of Michigan
December 2014

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Abstract

Privately owned forests in Michigan provide resources for economic, ecological and social benefits. They are currently undergoing substantial changes: parcelization, fragmentation, spread of invasive and edge species, generational turnover, and changes in landowner interest in forest management. Understanding engagement and management of private forests is essential to maintaining forests amenities that provide billions of dollars for both public and private entities. Available forest management incentives focus mostly on increasing timber on large parcels of land. They are less attentive to nonpecuniary rewards that may help support land use ideals among Southeastern Michigan's nonindustrial private forest landowners who have smaller than traditional forest acreages. Our research findings suggest that universities and public agencies can incorporate multiple approaches for enhancing the interest of forest owners in their land. Forest product industries may also be able to take advantage of nonpecuniary interests in forests among smaller acreage owners by incorporating the multiple-use demands of this ownership group. Michigan's forests have already undergone one major shift during the 20th century as social preferences and interests in forests have moved from logging to conservation. The early 21st century may consolidate this shift while providing economic, social, and ecological benefits if government agencies and universities alter their approach to engagement with nonindustrial private forest owners.

Keywords

Nonindustrial private forests, NIPFs, Southeastern Michigan, management, trends, education, engagement, amenities, natural resources, survey, phone interviews, timber, public sector, university

Personal Background

Mark Alan Yoders graduated from The Ohio State University in Columbus, Ohio with a Bachelor of Science Degree in Natural Resources, specialized in forestry. After his undergrad, Mark served two years in rural Peace Corps Guatemala as an ecotourism facilitator focused on ensuring sustainable natural resource management as a source of alternative income. Following Peace Corps, Mark became a consulting forester and an ISA Certified Arborist. Mark then attended the University of Michigan in Ann Arbor, Michigan for a Master of Science in Natural Resources focused in environmental planning and informatics. Currently, Mark is employed as a geospatial analyst specializing in biophysical modeling.

Acknowledgements

Special thanks to:

- USDA McIntire – Stennis Grant
- University of Michigan Rackham Graduate Student Research Grant
- University of Michigan School of Natural Resources Master's Thesis Funding
- NIPF Owners of Southeastern Michigan

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Introduction

This study focuses on engagement of nonindustrial private forest owners (NIPF) with their forests, engagement of public agencies and researchers with smaller than traditional NIPF acreages and engagement of timber industries with trends in NIPF owners' management objectives. This three-front approach has potential to offer holistic methodology to help reverse NIPF landowner passivity in Southeastern Michigan by identifying and acting on trends in management, interests, desires and outcomes. A primary motivation for this research comes from a USDA Forest Service comparative study that shows NIPF research in the United States has often focused on large parcel landowners and large-scale forest management (Linstad 2002). As a result, regional variations in NIPF ownership have been difficult for researchers and policymakers to discern and act upon (Linstad 2002).

In Michigan, NIPFs have been recognized by both federal and state agencies interested in encouraging forest management while supporting timber economies and is demonstrated through policy incentives offered to NIPF landowners. However, studies on NIPF owner incentive utilization, education, behavior, and forest quality have occurred mostly in the more heavily forested areas of Northern Michigan (Kupiers et al. 2013, Schubert and Mayer 2012, Drzyzga and Brown 2002). They have also attended more to NIPF owners who are already actively managing their forestland (Potter-Witter 2005). Those that have looked at the Southern Lower Peninsula examined agricultural landowners who own forest parcels (Erickson et al. 2002) and agricultural forest owners have existing pecuniary incentives influencing their land management choices. Public agencies follow the same suit; the Michigan Department of Natural Resources designates smaller forest landowners as a low to medium priority when promoting active management of forest lands for the maintenance of ecosystem services (Michigan Forest Resource Assessment and Strategy 2010).

Our study of Southeastern Michigan forest owners has a contrasting focus in comparison to much existing research on Michigan forest owners: it focuses on Southeastern Michigan, forest owners with relatively small parcel size, and landowners who tend to manage their parcels without many active interventions. As such, our study offers perspectives on forest ownership in Michigan that can be used to increase interaction between agencies, universities, small NIPF owners, and the forest product industry. Additionally, the findings of this study may be of relevance in other contexts where NIPF owners buy smaller than traditional NIPF parcels and maintain urban-based incomes.

NIPF owners in Southeastern Michigan manage forests located in a mix of suburban and rural landscapes. These forests are characterized by parcelization and fragmentation, nonnative and edge species invasion, diversity in owner demographics, as well as varied levels of forest management. The geographic influences of nearness to the state capital, two nationally renowned universities, a declining automobile industry, and the predominance of cultivated croplands also mark the context within which NIPF owners make management decisions.

To assess the perceptions, objectives, and behaviors of NIPFs owners and their impacts on forests in southeastern Michigan, our study used a two-pronged approach. We used a mail-in survey to gather information from NIPF owners in Washtenaw, Jackson, Ingham and Lenawee Counties of southeastern Michigan (see Map 1). And we also used phone interviews and on-site forest composition and structure measurements for two self-identified active management and two self-identified passive management NIPF sites to gain additional insight.

The objective of this research is to investigate the trends and perspectives of NIPF owners in Southeastern Michigan in an effort to focus on strategies through which engagement of owners with

their forest can be increased. Such improvements in owner engagement can improve the care and utilization of forests. In particular, our study emphasizes three aspects of NIPF management by owners of smaller parcels: establish an understanding of NIPF owners, emphasize a need in research to understand decision-making by NIPF tracts smaller than 50 acres, and devise appropriate engagement efforts for outreach and technical support. We focused in particular on six influential characteristics of NIPF owners: landowner income, landowner age, years of forest ownership, forest parcelization, forest fragmentation, and landowner interest and education.

Study Background

Southern Lower Peninsula - *Lower Priority*

In Michigan, forestland has returned to half of the pre-settlement era estimate, representing 86 billion board feet of sawtimber, and has seen a net forestland increase of one to three percent annually since 1993 (Michigan's Forests 2012). Most of this increase has occurred in the hands of NIPF owners, as two-thirds of all forestland in the state is maintained by this group (Leatherberry 1998). With such vast holdings, NIPFs hold a critical level of involvement in many forest decisions and outcomes. Current forest estimates for the Southern Lower Peninsula emphasize a regional need for action and research. On a percentage basis the greatest increase of private owners who plan future harvests have 50 acres or less of forestland and these individual owners make up two-thirds of management assistance requests (Leatherberry 1998). The Southern Lower Peninsula contains 17% of the total forestland in the state, but contributed 60% of the total increase of forested land for the state between 2004 and 2009. During the same period, the Southern Lower Peninsula constituted the greatest increase in growing stock removals (62%), higher than all other regions of the state (Michigan's Forests 2009). Also during the same period the Southern Lower Peninsula witnessed the greatest increase in tree mortality, augmented by the emerald ash borer and beech bark disease (Michigan's Forests 2009). These transformations in forest structure and composition witnessed over the past 20 years demonstrate the need for more than low and medium engagement priority for NIPFs in the Southern Lower Peninsula.

Forest Amenities

Forested landscapes provide social, ecological and economic benefits for rural and suburban settings, but historically research and education programs have focused on timber economies of scale in rural areas (Hyberg and Holthausen 1989, Christensen et al. 1996), leaving less emphasis on social and ecological amenities desired by newer classes of suburban NIPF owners. The shift in NIPF landowner objectives from strictly production-based income toward perpetual economic and noneconomic returns (National Report on Sustainable Forest 2010) has been followed by researchers and foresters who have documented the change from traditional farm and forest-based owners maximizing farm conversion and wood fiber production (Stoddard 1942) to landowners focusing on both pecuniary and nonpecuniary objectives (Olson 1979, Leatherberry 1998) to NIPF ownership classes increasing in number, owning smaller forested parcels, and having urban-based incomes (Decoster 1998, Mehmood 2001).

During the course of these changes in NIPF ownership, natural resource related public agencies, consultants and academic institutions have quantified social and ecological forest benefits and found forests are assets, not liabilities. Studies show forest cover increases water quality in polluted areas

when compared to catchments outside of forests and forests provide a reduction in erosion and run-off (Heal 2000, CIFOR 2002, Shah and Maitra 2005, Bonan 2008). Other studies demonstrate that forests conserve and promote biodiversity, resiliency, as well as store carbon (Heal 2000, CIFOR 2002, Shah and Maitra 2005, Bonan 2008). Reduction in wastewater infrastructure, mitigation of heat island effects, and removal of pollution particulates from the air also have been found in a myriad of public benefits studies (McPherson et al. 2005, McPherson et al. 2006, Nowak et al. 2006, Benefits of Trees 2011). And private returns have been readily realized by increases in property value and energy savings (Anderson and Cordell 1988, Wachter 2005, Donovan and Butry 2010, Benefits of Trees 2011).

Research by environmental psychology and public health officials have also documented the influence of natural areas on society. Mental health benefits, based on nature being existentially linked to humans, result in restorative mental and physical effects (Kaplan 1995, Frumkin 2001). Other research has provided evidence of benefits such as shorten recovery time after surgery (Ulrich 1984), increased productivity and attention (Taylor and Kuo 2008), and overall boosts in mental health and effectiveness (Kuo 2001, Maller 2005). And with these ties to mental and physical benefits to humans, it is no surprise that the value of owning forests is partly tied to these intrinsic benefits (Finley et al. 1981, Kurtz 1981, Erickson 2002, Hull 2005).

In traditional forestry, the immediate thought of forest value is tied to economic yield. But new trends in forest management welcomed by today's suburban forest owners supplant high, one-time harvests with dynamic and integrated planning to maximize nonpecuniary benefits while incorporating some harvests to maintain pecuniary benefits. In these terms dynamic planning encompasses options like unplanned harvests that could occur from the three-fold increase in insect mortality from 2003 to 2010 in the United States (National Report on Sustainable Forests 2010). Integrated planning incorporates ecosystem services[1], the capture non-timber products, an existing billion-dollar industry (NTFP 2014), and timber harvesting.

Thus forested and natural areas provide a variety of benefits and proper evaluation of benefits are not to be understated to NIPF owners. This requires investigating ecological and economic values of ecosystem services to identify appropriate concessions between people and the environment (Faber 2002), incorporating natural capital into the decision-making of institutions, individuals and corporations (Daily et al. 2009), and developing GIS technologies to link and aggregate forest ecosystem utility into monetary values (Troy and Wilson 2007).

Influences on NIPF Management

While public forest managers are tasked to balance and maintain financial, ecological and social benefits, the decisions NIPF landowners make in managing forests are rarely balanced. Influential elements such as landowner interest, education, income and age, and forest age, acreage, composition and structure create opportunities and barriers for NIPF owners to make forest management decisions.

[1] For this paper, ecosystem services are defined via Michigan Forest Resource Assessment and Strategy 2010: "the improvement of air quality by the sequestration of carbon and filtering air bound particulates; the improvement of water quality by curtailing sedimentation of water bodies, by providing shade to control temperature fluctuations, by providing stabilization of banks, by slowing the flow of rainfall to curtail erosion, and by sequestering some water-bound pollution; by providing habitat for common, threatened and endangered plant species; by holding and enhancing soil quality; by providing genetic resources for future forest generations; and by providing wildlife habitat for game and non-game wildlife species."

Revision of NIPF landowner financial, ecological and social facets that consider biophysical conditions and social perspectives can therefore prove an integral role in increasing overall NIPF utility.

Income and Age

NIPF owners in Michigan have higher household incomes than Michigan's overall population (Leatherberry 1998) and NIPF owners in general tend to have income sources outside the forest (Decoster 1998, Mehmood 2001). Higher income brackets, commonly associated with urban-based incomes, allow NIPF owners to postpone economic provisioning and consume nonpecuniary amenities until harvest is necessary (Hyberg 1989). When harvest is necessary, higher incomes also increase the probability of reforestation practices (Hyberg 1989). Contrastingly, some NIPFs view their forests as stored capital where timber is utilized based on low income conditions and forest products, such as firewood and building materials, are routinely collected for sale and use (Leatherberry 1998). In many individual instances the view of income from the forest for NIPF owners is related to the age of the owner and number of years the land has been under possession. As of 1998, one quarter of Michigan's privately owned forest was owned by retired individuals who obtained their property after 1980 (Leatherberry 1998) and in the Southern Lower Peninsula NIPF owners were found mostly to be full-time employees or retirees (Mueller 2011). Leatherberry's (1998) estimate of property purchases in the 1980s would put tenure around 20-30 years at the state level, which aligns with the 30 year ownership tenure in the Southern Lower Peninsula calculated by Mueller (2011). If a substantial percentage for NIPF owners are retired and have owned property for 30 years, a generational turnover of forestland and owner most likely will occur in the near future.

Parcelization and Fragmentation

Population growth, homeownership incentives, increased wealth, property and estate taxes (Linstad 2002), uncertainty in markets (Mehmood 2001), and regulation (Decoster 1998) have helped spur parcelization and forest fragmentation[2]. Parcelization and fragmentation not only affects purchasing and selling of forested parcels, but also creates shifts in the ecological ability and economic viability of the forest environment. With previous work showing a positive relationship between forest size and forest management (Ma et al. 2012), Michigan exhibiting a decrease in the average acreage of NIPF holdings (Leatherberry 1998) and having an increase in fragmented forests (Michigan's Forests 2009), forest parcelization and fragmentation play an influential role in individual forest property decisions that affect forest health and resource availability.

Hard forest boundaries and species fragmentation create ecological impacts that have the potential to exacerbate the negative effects of forest edge. Forest edge adversely affects the forest ecosystem as they create additional entry ways for invasive and edge flora and fauna to establish themselves (Harper et al. 2005, Gibson et al. 2013) at the detriment of native species (Rolstad 1991, Robinson et al. 1995, Gibson et al. 2013). Not only does this reduction in native flora and fauna reduce the ability of the forest to be utilized for timber and non-timber products as well as nonpecuniary goods, an influx of invasive species can turn a forest into a thicket that suppresses native regrowth and landowner accessibility, further reducing the ability of landowner options. When the forest structure

[2] Parcelization encompasses the legal changing of a parcel from owner to a diverse set of owners and forest. Fragmentation represents physical alteration of the landscape resulting in the breaking of contiguous forest cover.

reaches a new ecological equilibrium containing mostly edge and invasive species, difficulty in implementing an active management approach increases along with landowner apathy as unruly edge and exotic species dominate.

One method to combat fragmentation came in the 1990s, ecosystem-based management of multiple, adjacent or nearby, private and public properties. Also referred to as cross-boundary management, ecosystem-based management views forests outside of property boundaries (Campbell and Kittredge 1996). This management approach works off of the aggregation of forests on the basis of watershed delineations that incorporate water, nutrient and pollutant cycling, and more generally, the "interaction of physical, chemical and biological processes" (Hornbeck and Swank 1992). Pilot projects have seen traction when NIPFs are engaged through incentive programs and educational opportunities that have university supported natural resource trainings, GIS tools that analyze and display findings, and local and community level leadership (Campbell and Kittredge 1996). Inherent issues exist with ecosystem-based management and have been voiced, noting problems of implementation and sustainability. These issues are nicely summarized by Rickenbach et al. 1998, but in brief the questions surrounding ecosystem-based management are issues of devising minimum acreages to participate, addressing landowner turnover, managing diverse secondary objectives and temporal visions, and enforcing rules (Rickenbach et al. 1998). However, as difficult as these may seem, these issues have been experienced and managed by other forest owners across the globe who participate in common property regimes[3], which have the same core principles of managing multiple owners utilizing connected forest parcels (Gibson et al. 2000, Ostrom 1990, Ostrom 1994).

Economically, the trend of smaller NIPF acreages created a concern of "too big to trim and too little to log" (Decoster 1998). The underlying assumption is that it would be difficult for small acre NIPF owners to attract timber companies, especially those with less than 50 acres of forest (Leatherberry 1998). The issue at heart is that timber firms would view smaller-than-traditional sized forest parcels as an undesirable economy of scale where profits margins would be reduced to disagreeable levels. However, studies show that timber industries who are reliant on NIPFs can maintain profits if a shift occurs from the traditional marketing approach of maximum monetary returns to balancing objectives by including ecosystem services and aesthetic beauty in their approach to harvesting (Rickenbach and Steele 2006). While some timber companies have adapted to newer trends of smaller harvests coupled with desired objectives of NIPF landowners, it would be reckless to say that the economic viability of smaller tracts is not in a more precarious state than the traditional large tracts. It is obvious that smaller forest parcels are affected more by the overall stocking of merchantable tree species and also that damage of repeated, unfettered harvests can reduce the overall ability for a forest to regenerate.

Interest and Education

Since the interest landowners have in forest management is intimately tied to the time invested in learning about it, interest and education are more closely knotted than the previously mentioned influences on NIPF owner behavior. Thus to be effectively disseminated, information must be of interest to NIPF owners as well as available through common and accessible venues. Informal and formal

[3] Common property regimes should not be confused with open access property regimes that were the focus of Garrett Hardin's "Tragedy of the Commons" in 1968. For a proper discussion on this often confused language please review: Schlager, Edella, and Elinor Ostrom. "Property-rights regimes and natural resources: a conceptual analysis." Land economics. 249-262. 1992.

methods form the most effective means of educating, especially when the two types of education are viewed as 'interacting modes of emphasis rather than as discrete entities' (Belle 1982).

Logistically, informal education is a lifelong process of accumulating knowledge, skills and insights through exposure to daily experiences. This knowledge is gained through non-traditional means (Malcom et al. 2003) and is generally of internal interest to a person. Formal education is defined through institutionalized, chronological, graded and hierarchically structured systems (Coombs et al. 1974) with individualized learning (Malcom et al. 2003) that is imparted onto a person through extrinsic motivation systems. Where formalized education has a clear cut process of entering, progressing through, and exiting the system, informal education form from circumstances within populations that cannot be reached due to complex financial, administrative, and political establishments (Belle 1982). NIPF owners clearly exist in complex financial, administrative and political establishments and studies show that informal methods of information dissemination prove fruitful when performed through grassroots efforts where there is little governmental interference in management (Meadows et al. 2013, Ferranto et al. 2013).

Traditional methods of forest education are formal in nature and include authoritarian type settings, such as centralized workshops, scheduled appointments with public foresters, and non-interactive media. Informal education differs by allowing self-paced interest to emerge through areas where interest exists or is burgeoning. Informal education, such as peer-to-peer conversations, presents a less rigid and more personal, familiar, available and reciprocal experience. Peer-to-peer conversation studies in Michigan's Western Upper Peninsula reveal that "roughly half of forest owners were influenced by other members of their NIPF communities" (Schubert and Mayer 2012), suggesting that this is an influential venue in disseminating forest information created by agencies and universities.

Methods

Survey Participants

To identify NIPF landowners in Southeastern Michigan with more than 10 acres of forest, the bare minimum size required for economically viable timber harvest, a combination of source data was used. Data from Michigan's Center for Geographic Information and USGS National Land Cover Database (NLCD) were used to delineate political and ecological boundaries. Using ArcGIS and ERDAS Imagine software, a forest cover mask was created by extracting and recoding forest data from the NLCD. The forest mask was then overlaid on Public Land Survey System (PLSS) information in ArcGIS to provide a grid of forest cover and a numbered template using PLSS Section numbers. Next, Random.org was used to generate a sequence of random numbers to be matched with the PLSS Section number. The PLSS Section was then found on the online parcel information viewer and the ArcGIS map document. Visual analytics of the online parcel viewer (Table 1), forest mask and PLSS data were performed to identify parcels with more than 10 acres of forest for a single property owner. Under this method, two hundred fifty potential survey participants were identified for each county of the study area, for a total of 1,000 potential survey respondents. The survey returned 115 responses that were distributed with relative evenness across the study area (Figure 1 and Map 2).

Survey

Mailed July of 2013, the NIPF landowner survey focused on forest management, education, and collaboration and included parcel information and demographic questions. The survey forest management questions revolving around use of passive and active management, desired forest objectives, timber harvest, and land-use change over the last 15 years. Specifically, active management was defined as the development and implementation of a plan for wildlife, water management, or plant species. (E.g. cyclic planting, thinning or harvest; invasive species removal; accredited forester/natural resource manager consultation; sustainable tourism development.). Passive management was defined as infrequent or no interaction with forestland. (E.g. one time timber harvest; trail maintenance only; hunting access only.) Forest education survey questions asked about the utilization of formal and informal forest education sources with inquiries about which educational services they have used during the last 10 years. Educational categories included informal venues such as peer-to-peer conversations as well as formal education venues such as electronic and paper media and consultations with public and private natural resource specialists. Questions about collaboration pertained to the landowner's willingness to participate in ecosystem-based/cross-boundary management that was posed as a voluntary option that retained individual property rights, but included written agreements on management strategies. A final question was added to the end of the survey to find respondents willing to be interviewed by phone and willing to have forest composition and structure measurements taken on their property.

Field Site and Phone Interviewees

After marking willingness to participate in the mail-in survey, four NIPF landowners were randomly selected for forest composition and structure mensuration and follow-up phone interviews. Before arriving on site, Bing aerial imagery within ArcGIS was used to interpret and digitize strata by land use and land cover. After identification of representative forest cover was completed via aerial imagery in ArcGIS, a point was dropped inside the strata and GPS coordinates were extracted (Example: Map 3). On average, one field plot was identified for every 2-3 acres of forest. To increase representativeness, if species composition and structure differed on site than was present in the aerial imagery, additional on-site plots were determined and their location recorded using a handheld GPS unit.

After arriving on site, a field tour and history of the property was provided by three of the participants with the fourth only giving a lengthy verbal description of property characteristics and history. After introductions and a property briefing, coordinates of each plot point were entered into a handheld GPS unit that served the basis of locating ground plots for forest composition and structure measurement. At plot locations a 10-meter radius was set from plot center and woody species larger than 10 centimeters were recorded. After performing a tree inventory in the 10-meter radius plot, a three-meter radius plot was set and all woody species between 2.5 and 10 centimeters were documented. Species composition and distribution by site can be seen in Figure 2 and Figure 3. Finally, quantitative and qualitative plot attribute information was collected based on site characteristics and items that would aid understanding of forest succession. Information collected on site attributes included data such as farm equipment remnants, distance to adjacent properties and their land use and land cover, nearby hydrological features, and site type (mesic, upland, lowland, etc.)

Forest health assessments were made through the lens of appropriate species composition based on underlying abiotic features. Lowlands were expected to predominantly contain hardwoods species

with the common names of red and silver maple, cottonwood, and swamp white oak. Mesic midlands were expected to contain beech, sugar maple, basswood, red oak, white ash, shagbark and bitternut hickory, black walnut and tulip poplar. The upland forests were presumed to consist mainly of black cherry, shagbark hickory, red, black and white oak with beech and red maple. For a full list of woody species encountered and their corresponding Latin name view Table 2.

The next day after collecting field data, the field site participants were phone interviewed. The phone interviews averaged one hour in length and were guided by a open-ended questions on the history of NIPF owner property, desired management objectives, financial reasons that influence forest decision-making, feelings toward cross-boundary/ecosystem-based management, views toward the investment of forest ownership and decisions and rational for purchasing or not purchasing more forestland. The goal of collecting phone interview data was to create a descriptive dimension that is not readily interpretable through surveys.

Statistical Analysis

Statistical analyses were used to confirm and deny linkages between desired management objectives and actual management approach and desired management objectives and willingness to participate in ecosystem-based/cross-boundary management. Full statistical results can be found in Table 3 and Table 4. The main statistical test used to perform this analysis was logistic regression. This type of regression analysis is used to examine significance of relationships between categorical data versus a binary response. Linear regression cannot deal with dependent variables that are dichotomous or categorical and logistic regressions are better than discriminant analysis because there are only two possible outcomes from the dependent variables tested (Burns and Burns 2009). Analysis was executed using the open-source statistical package R. Where applicable statistical assumptions (Table 5) were tested and met.

Results

Influences on NIPF Management within Study Area

Income and Age

Survey data show a varied annual household income across the NIPF ownership base (Figure 4), and with most property used for purposes other than timber and agricultural production (Figure 5), data suggest income from outside the forest. Specifically, the four county subset median household income was $90,001 -$95,000, higher than the $40,000 – $59,999 estimate provided by Mueller (2011) for the whole Southern Lower Peninsula. All phone interviewees relied on income outside of the forest, but the two actively managing interviewees used timber as supplemental income and the passively managing interviewees had little concern when it came to revenue from the forest. When phone interviewees were asked about the possibility of purchasing more forestland, two passive management phone interviewees shared interest in purchasing more forestland if money was available, especially if land for sale was adjacent to existing ownership, while the two actively managing interviewees declined citing concerns about debt and taxes.

In terms of age and years the property has been owned, study survey participants are in the range of 56-75 years old (Figure 6) and have had the property on average for 25 years, consistent with Leatherberry's (1998) finding that the majority of forest owners are retirees and near Mueller's (2011) tenure estimate of 30 years. The phone interview and field site sample of NIPF owners also fell into the age and ownership range demonstrated by study survey data. Three interviewees, two active and one passive, speaking about engagement with their forestland, explicitly mentioned age as a negative influence and see advancing age as prohibitory to spending time managing the forest. These same individuals stated an increase in time planning for forest and property transfer to family members, land trusts and realty markets.

Parcelization and Fragmentation

The study survey shows that half of all NIPFs own between 10 and 30 acres of forest, with about 15 percent holding 76 to 100 acres (Figure 7). The study survey shows 73.8% of NIPFs respondents having 50 acres or less of forestland in the four county study area while Mueller's (2011) estimate for the entire Southern Lower Peninsula fell at 86.9%. In terms of land use change, 90% of NIPF respondents reported change under their possession, and the most frequently indicated change was from farmland to forest. Forty three percent of NIPF properties stated that other land uses associated with the forest were agricultural or agriculture and homestead according to the study survey. The active and passive management field sites followed the same pattern holding 10-20 acre forests that were converted pasture or agricultural fields or originally agricultural and homesteads containing forest.

Survey results from this study show 37% percent of respondents were open to ecosystem-based/cross-boundary management (Figure 8) when defined in terms of participation with neighbors and nearby forestland properties in a coordinated management regime with the goal of providing higher ecological benefits to the ecosystem. (The survey question was structured to preempt a fear of losing land rights by stating that the landowner would maintain traditional property rights and voluntarily participate.) For ecosystem-based management, the logistic regression suggests that those who have interest in ecosystem services are significantly more interested. With an odds ratio of 4.0, signifying a four to one odd that a person who is interested in ecosystem services will also be interested in cross-boundary management, a target audience for public and university outreach emerges that covers over a third of the study counties' NIPF population. As for phone interviewees, when asked for details on the collaborative management, all backed the idea of ecosystem-based management for increased ecosystem services, but also emphasized the importance of retaining property rights.

Interest and Education

For the study survey, NIPF owners' desired management objectives are aimed toward social, ecological and economic amenities. As indicators of NIPF landowner interests, responses point to stewardship and aesthetics as important objectives (Figure 9). However, raw responses on interests do not indicate which desired objectives lead toward actively managing forests. From the logistic regression, the odds of actively managing forest increase by a factor of 3.9 with ecosystems services and 2.6 with timber harvest as desired management objectives. Simply put, when the desired management objective is ecosystem services there is almost four to one odds that the NIPF owner will actively manage their forest, with timber harvest the probability has 2.6 to 1 odds. To contrast, marking

stewardship or aesthetics as desired management objectives have no significant odds on increasing active engagement by NIPF owners. Additional insight came from phone interviewees. One interviewee mentioned interest in learning more about forest composition and structure after volunteering at a nature preserve and learning about an invasive shrub, which was later identified to be spreading rapidly across the NIPF owner's property. Two interviewees reference a continual desire to learn more about their forested landscape after witnessing the diversity and evolution of plants and animals around their properties. All four interviewees mention individual interest in understanding natural processes and services of the ecosystem at large.

As for education, results show that 50% of NIPF landowners have interest in forest education and that they gain information primarily through peer-to-peer conversations and electronic and paper media. After informal conversations and media, private consulting foresters and the Soil Conservation Service Office are most often consulted for information and advice. For the phone interview respondents, education was also obtained through a combination of formal and informal learning experiences. In terms of formalized, unidirectional education, documentaries and nature television programming as well as field guides and ecology books were the main modes of gathering information on forests. Informally, three interviewees rely on experiential learning in the forest and gathering information via conversations with peers. Two interviewees also stated farm upbringings as events that spur interest in learning about forest processes and resources.

Passive/Active Management and Timber

Forest management survey data from the study reveals that 65% respondents passively manage their forest. Thirty-five percent of survey respondents report actively engaging their forests, which most often includes timber removal to restructure forest composition and age and/or generate income. Information collected from phone interviews on the passively managing NIPF owners was not comparable as field data showed the two passively managed sites too dissimilar in structure and composition for direct comparison. One passive property is a lowland swamp invaded by Russian olive and the other is an upland forest dominated by black cherry. They do however share the same primary objective of land conservation. The two actively managing field sites are more similar and had removed timber under consultation of an accredited forester. Though both forests are similar in age and are rural upland and mesic hardwood sites, large canopy gaps in the now hickory, black cherry, cottonwood and maple forest causes one landowner to lose access to his forest from invasive multiflora rose, greenbrier and black raspberry thickets, which also crowded out the majority of tree seedlings. The other actively managed NIPF experiences a well-spaced maturing cherry, oak and hickory forest with an ash, hickory and oak seedling layer and a handful of 3 meter diameter patches of multiflora rose and black raspberry near the utility right of way. These differing results appear to come from two differences in procedure between the actively managed properties. On one property the consulted forester was on site while logging activities took place while the forester was not present on the other. Additionally, the more satisfied NIPF landowner was proactive in getting written agreements for people, processes, and tree species pre-harvest whereas the other had no legally binding documents to ensure his objectives were met.

Overall, timber harvest is not foreign to NIPFs in Southeastern Michigan. Survey data show that 42% of Southeastern NIPF owners have harvested timber, compared to Leatherberry's (1998) statewide estimate of 48% and Mueller's (2011) estimate of 37.7% for the entire Southern Lower Peninsula. For the two interviewed owners that harvest timber, financial revenue was a primary driver and amenity

received. Each had harvested timber multiple times before and each has future plans for the extraction of more sawtimber. The other two participants have goals in the conservation spectrum, but would consider harvest if it is in the best interest of their forest.

Discussion

Insights on NIPF ownership details such as acreage size, income levels, and harvest history aid in evaluating aspects of NIPF owner behavior, but universities, public agencies, and timber companies can provide better information, support, and stronger engagement to promote the best practices of land management. Changes in this direction may strengthen the ability of NIPF owners to manage their forest parcels more effectively and to document changes that occur.

For the Southeastern Lower Peninsula the need for a new level of engagement is coupled with increases in forest cover and changes in forest composition and structure not seen in other parts of the state. With decreases in average forest acreage per owner and increases in the NIPF population, traditional research and support is not effective in the Southeastern Lower Peninsula. Additionally, the 70 year trend in NIPF acreage, ownership, and urban-based incomes reinforce nonpecuniary rewards as important objectives to NIPF owners who now have fewer incentives to harvest and are less reliant on forest related revenue. These trends make it important to identify different outreach strategies. Such a transformation would be a worthy successor to the forest conservation movement led by Michigan universities and public agencies in the 1900s in response to 60 years of unprecedented forest harvesting.

With NIPF acreage, ownership and parcelization unlikely to change, voluntary ecosystem-based management remains as the primary solution to maintain and increase the utilization of economic, social and ecological forest benefits. A response to these emerging trends, public agencies and universities could add additional educational efforts and incentives to these NIPF landowners to expand forest resource utilization more broadly. To provide the cohesion, ecosystem-based management schemes could be promoted and monitored by local forestry cooperatives.

Institutionally, ecosystem-based management could provide a venue toward more inclusive incentives while supporting forestry cooperatives. Forestry cooperatives could set up enrollment, planning, monitoring, assessment and revision of local NIPFs by incorporating key aspects of longer lasting CPRs. Ostrom's (1990) research shows that successful CPRs have small group size, clearly defined property boundaries, agreement between appropriation and provision of rules, participation in modifying operational rules by the individuals affected, election of accountable monitors to auditors, graduated sanctions for violators, conflict resolution mechanisms, and a high degree of autonomy from external government authorities. If effectively incorporating lessons learned from successful CPRs, a forestry cooperative could leverage collective influence that offers a clearer set of needs and desires to public agencies, universities, and forest product industries.

Because NIPFs exist in complex financial, administrative and political environments universities and public agencies could benefit from broadening their approach to information dissemination. Considering the context of NIPFs, informal methods of information dissemination would be influential and cost effective if coupled with traditional formal approaches to forest education. Yehudit and Revital (2000) and Gerber et al. (2001) find the combination of formal and informal education as effective, attractive, and long-enduring for young and old constituencies, thus creating an approach to streamline

information and apply it to groups of NIPF owners to augment forest interest and engagement. If this information can provide relevant content to local cooperative representatives, it ultimately becomes a source of informal information presented in forest cooperative meetings and peer-to-peer conversations. Through these scenarios NIPF owners receive opportunities to understand individual forest attributes, view their forest as a part of the larger ecosystem, and discuss with NIPF neighbors ways to achieve desired objectives. Furthermore, these formal and informal conversations could be a self-reinforcing mechanism for forestry cooperatives and ecosystem-based management by creating social capital from cohesion on similar desired objectives and interests.

For institutions to disseminate forest education information, NIPF cooperative advocates must be identified and engaged. Building NIPF cooperative leadership teams could be a key task of universities and public agencies since they are of fundamental importance to enforcing cooperative rule sets, spreading forest education, rewarding participants, planning timber harvests, and engaging other owners with less desire to be involved. To aid relevancy, responsibility, and propensity to participate in forestry cooperatives, a focus around ecosystem services and how these services are maintained by timber harvests have the most potential to lead to active NIPF owner engagement. When applied through the lens of ecological services needing maintenance cycles, timber harvest can mimic natural disturbance regimes that historically reset ecological balance. This approach could be especially effective since many passive owners consider harvesting when framed in the best interest of the forest.

To show that well-designed harvests can benefit NIPF forests, agency and university engagement strategies could manage expectations and teach NIPF cooperative leaders and owners protocol for transparent, integrated and dynamic planning. This type of education can dissuade NIPF owners who believe that mimicking disturbance regimes through timber harvest is only of detriment to forests and deter thoughts that harvests are tied to special interests. Examples include quarterly timber pricing documents, consultation with third party foresters, proactive legal agreements, literature and images on different stages of forest succession, and reports on damage by invasive species. This information can empower NIPF cooperatives and owners by allowing recognition and understanding of what their forest should look like immediately after harvest, where their forest is heading in the future, and appreciate the path of forest succession.

Public agencies and universities also could provide tools to document forest conditions. Providing online mapping tools can allow local forestry cooperatives or individual NIPF owners to take intermediary action and plan for future scenarios by documenting and tracking changes in forest structure and composition. Mapping changes in forest composition and structure will allow forest cooperative leaders to better devise plans for harvesting multiple properties and evaluating the appropriateness of timber bids. With the emergence of online mapping allowing user input, universities and public agencies can build portals to enter and track information acquired by cooperative leaders and consulting foresters. Eventually, temporal data on forest data and NIPF owners' management preferences, practices and demographics will accumulate and longer-term research can be done. Such a partnership will allow institutions to research the usefulness of their engagement strategies, make changes as necessary, provide up-to-date information on the spread of undesired species, green tonnage harvested, and track reputable timber companies that are working to incorporate new land use ideals.

GIS and remotely sensed data also present an easy way to build contact databases of potential cooperative leaders. Public GIS departments have information on landowner names, addresses, parcel acreage, as well as databases on involvement in forest programs and local nature conservation

organizations; all of which can be aggregated and sorted to identify owners that have a high propensity to become forest cooperative leaders. These databases layered on top of land cover data can help institutions discover regions with a willingness to collaborate in ecosystem-based management and locate forest parcels that are large enough to reliably contribute.

Another area that could be the focus of agencies and universities is developing a forest management incentive for smaller-than-traditional NIPF acreages. The current structure of forest management incentives excludes many landowners in the Southeastern Lower Peninsula. Particularly, current incentive programs do not align with existing preferences or the characteristics of their parcels, such as residencies on the property. The Commercial Forestry Program (CFP) requires public access for fishing, hunting and trapping for enrolled forests, a minimum forest size of 40 acres, and zoning not of agriculture, pasture, residence, or developed recreational purposes. These stipulations result in ineligibility for the majority of NIPF owners in Southeastern Michigan. The usefulness of CFP for the Southeastern Michigan is revealed when viewing CFP enrollment for the four county study area: one enrollee with less than 50 acres of forest. The next most common incentive program for NIPFs is the Qualified Forest Property Program. Though containing a reasonable mandate of 20 acres or more of forest to participate, it unfortunately mandates that no buildings or structures may exist on the property, effectively nullifying the possibility of enrollment by a large percentage of NIPF owners in Southeastern Michigan.

For the study area, property tax relief could be made available to encourage and reward participation in local forestry cooperatives. Other incentives could be made available, such as grants or vouchers, to subvert the cost of reforestation and mowing cycles necessary to maintain desired species' competitive advantage. One such approach to maintain desired species is through forestry cooperative agreements with road right-of-way mowers, many of whom are neighborhood farmers contracted by county transportation departments. These farmers could enter NIPF properties and perform yearly brush removal or, considering many farmers are certified herbicide applicators, perform cut and spray techniques that are cost effective and safe ways to reduce the spread of undesired and invasive species.

To balance harvest with NIPF owners' desired objectives a version of uneven-aged stand development could be useful. Clear-felling at five acre minimum harvests could be used as a method to mimic wind-throw that is common of straight-line winds, or if just performing a thinning cut, harvests could mimic a high heat, ground-level burn. The smaller clear-felling size allows most NIPF landowners to retain some of the older growth on the property while reducing the cost of post-harvest treatments for the landowner. Additionally, this would reduce the overall impact of a timber harvest on an individual property.

Undoubtedly, agencies and universities would need to help set guidelines for the timber industry to help integrate new approaches that do not alienate NIPF owner objectives. But for timber harvesters, the formation of forestry cooperatives could largely be positive. When done in coordination with forestry cooperatives, harvests could be scheduled to occur with adjacent NIPF owners to reduce fragmentation, maintain reliable ecosystem services, and nullify concerns of low profitability. Ultimately, this approach would combat Leatherberry's (1998) and Decoster's (1998) assertion that many tracts of fewer than 50 acres are economically unattractive to log unless they are close to other areas that are to be harvested. And this should be of interest to the forest product industry considering they would want to take advantage of the 11.8% increase in timberland from 2004 – 2009 for the Southern Lower Peninsula, noted by Michigan's Forests (2009).

Adapting a version of this approach can provide accurate estimates for continuing harvests and make available real-time tracking of native, invasive and edge species. The approach also provides an opportunity for NIPF owners to witness and learn from species evolution that will occur naturally during each stage of forest succession and appreciate the forest in all life stages. Traditional technical and legal information provided by universities and public agencies can strengthen understanding between NIPF owners and timber harvesters to maintain aesthetic values, ecosystem services, and timber extraction. Reinforcement of timber harvests mimicking natural disturbance regimes and appreciating integrated and dynamic planning provides pecuniary and nonpecuniary forest objectives that the NIPF population desires.

Conclusions

In conclusion, this study offers tailored insights and suggestions for a new approach towards greater engagement between NIPF owners, public agencies, universities, and the forest product industry in Southeastern Michigan. The study also suggests how to respond to the detrimental effects of forest parcelization without alienating NIPF's interests in forest ownership. In light of NIPF characteristics in Southeastern Michigan, public agencies in the region can profitably focus on providing educational information on maintenance of forests and stages of forest succession, devising incentives for NIPF owners to engage in ecosystem-based/cross-boundary management, and adapting traditional approaches to timber harvesting. Creating greater awareness among foresters and timber companies regarding the benefits of engaging NIPF owners with the nonpecuniary as well as pecuniary benefits of NIPF ownership is also a strategy public agencies can pursue to maintain appropriate levels of timber harvest.

Information on forest care may be most effectively distributed when formal information sources from agencies and universities are supplied to local NIPF cooperative leaders who can then disseminate it to other local NIPF owners via informal peer-to-peer conversations. Such cooperatives can be vehicles for disseminating information about active management, positive timber harvesting experiences, and opportunities to learn about forest compositional and structural succession. Informal dissemination of information created by agencies and universities may also be financially appealing since it reduces direct demands on agency and university resources, while supporting a grassroots style, peer-to-peer engagement within the NIPF community, a learning experience about the benefits of ecosystem-based/cross-boundary management as well as creating a feeling of connectedness among NIPF owners, their forests, and the ecosystem at-large.

Appendix

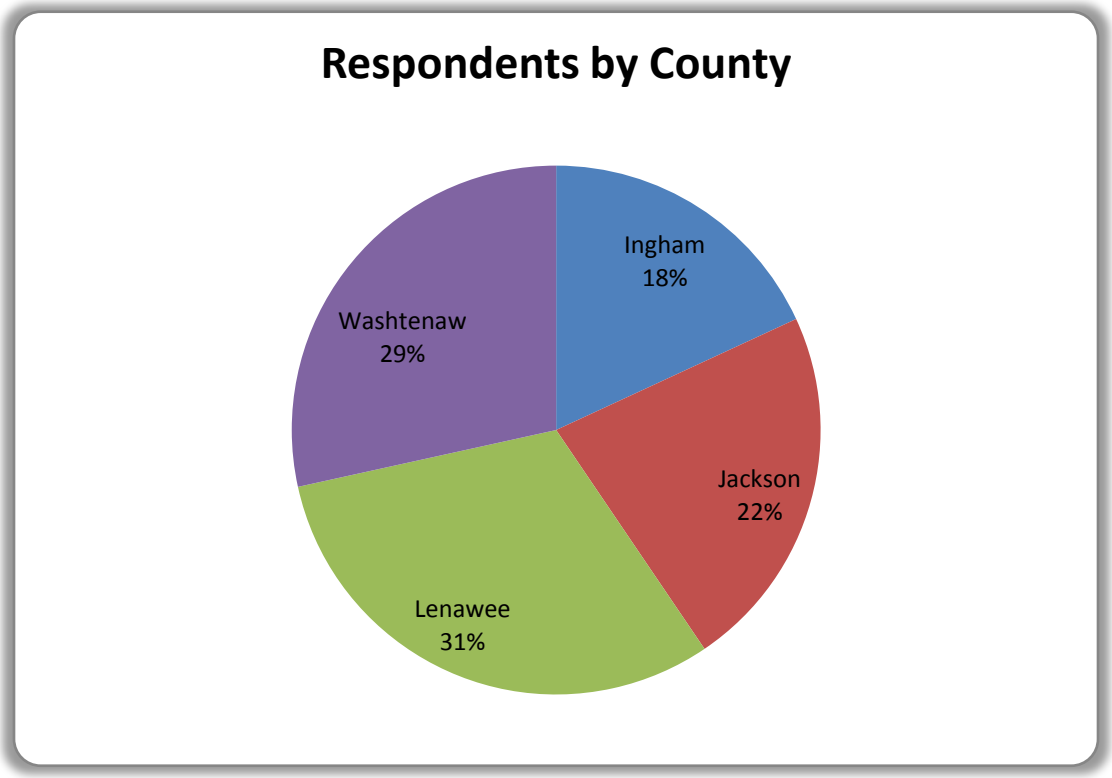


Figure 1: Respondents by County

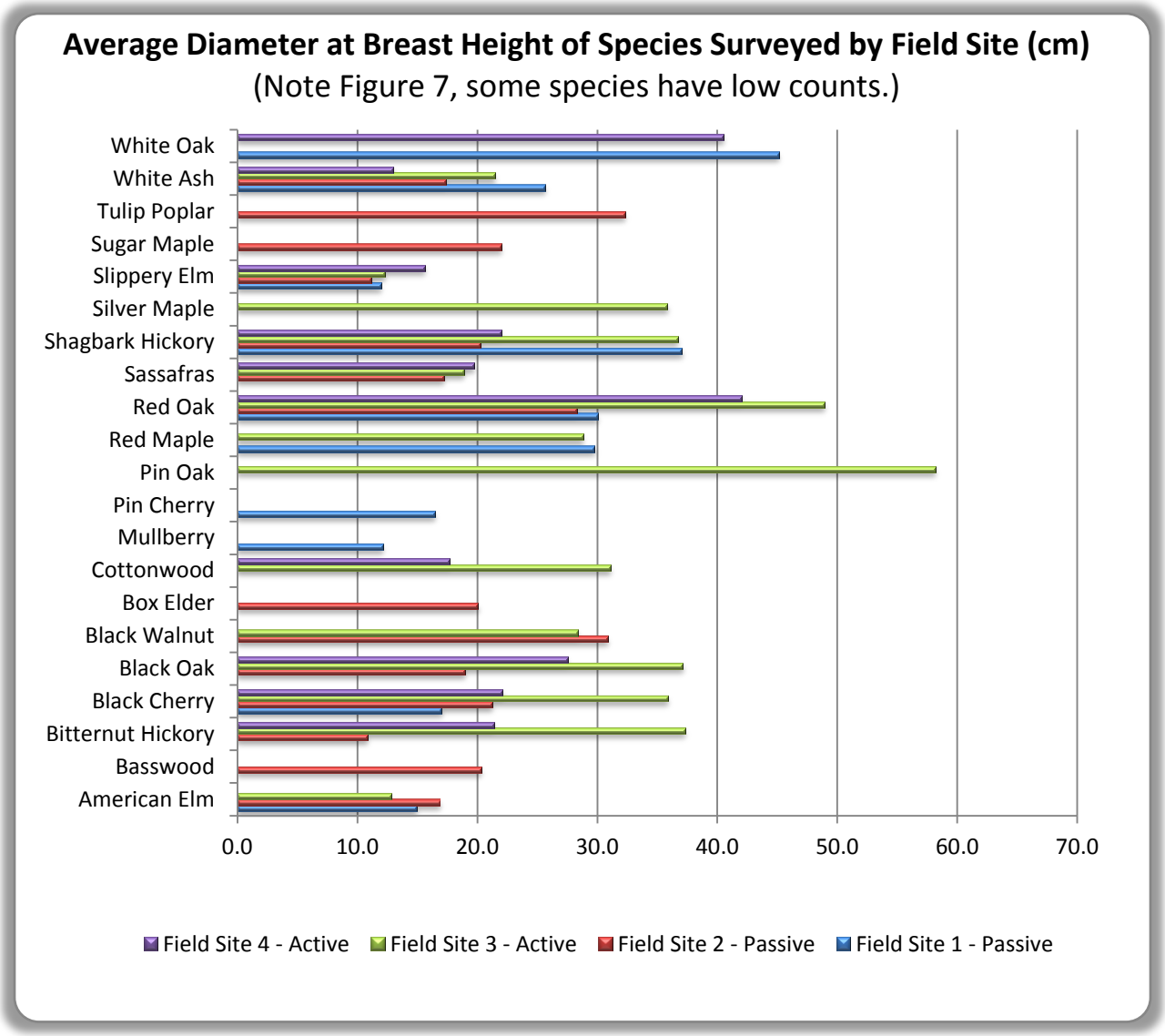


Figure 2: Average Diameter at Breast Height of Species by Field Site (cm)

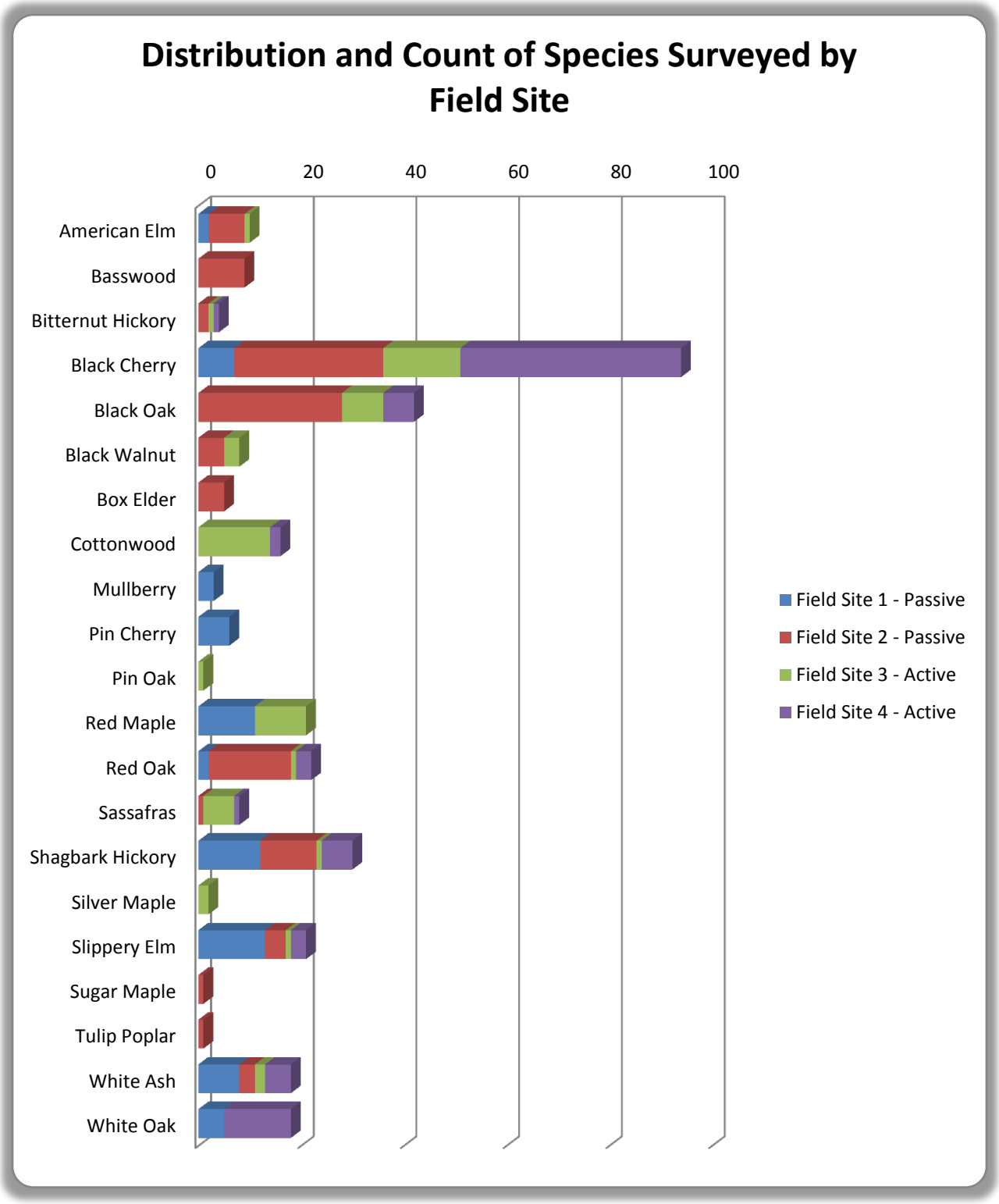


Figure 3: Distribution and Count of Species Surveyed By Field Site

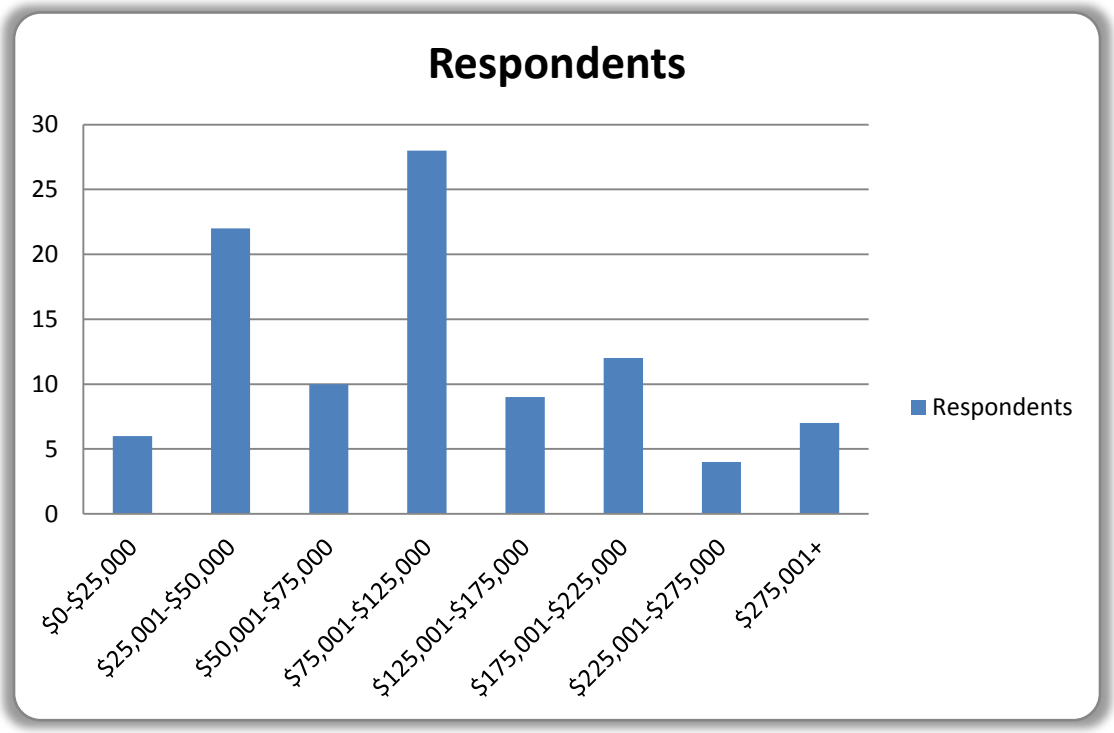


Figure 4: Respondent Annual Household Income

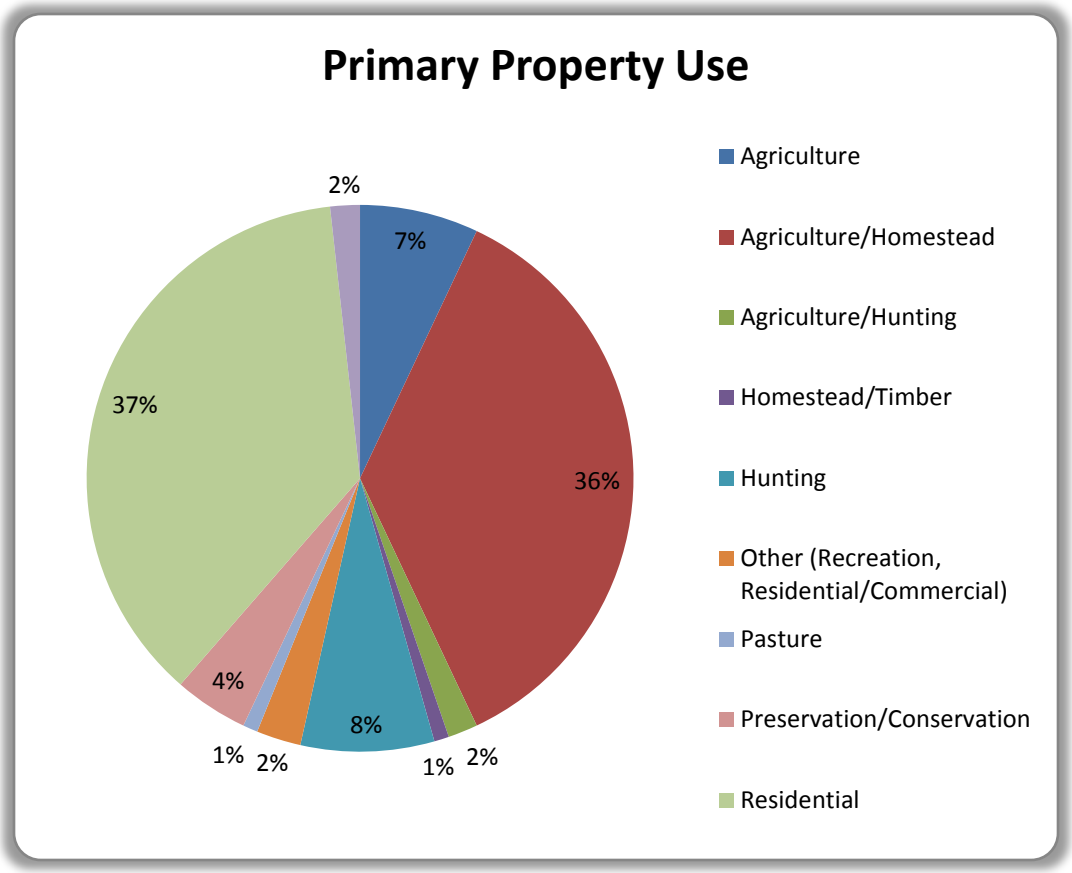


Figure 5: Respondent Primary Property Use (Timber was an option, but not selected.)

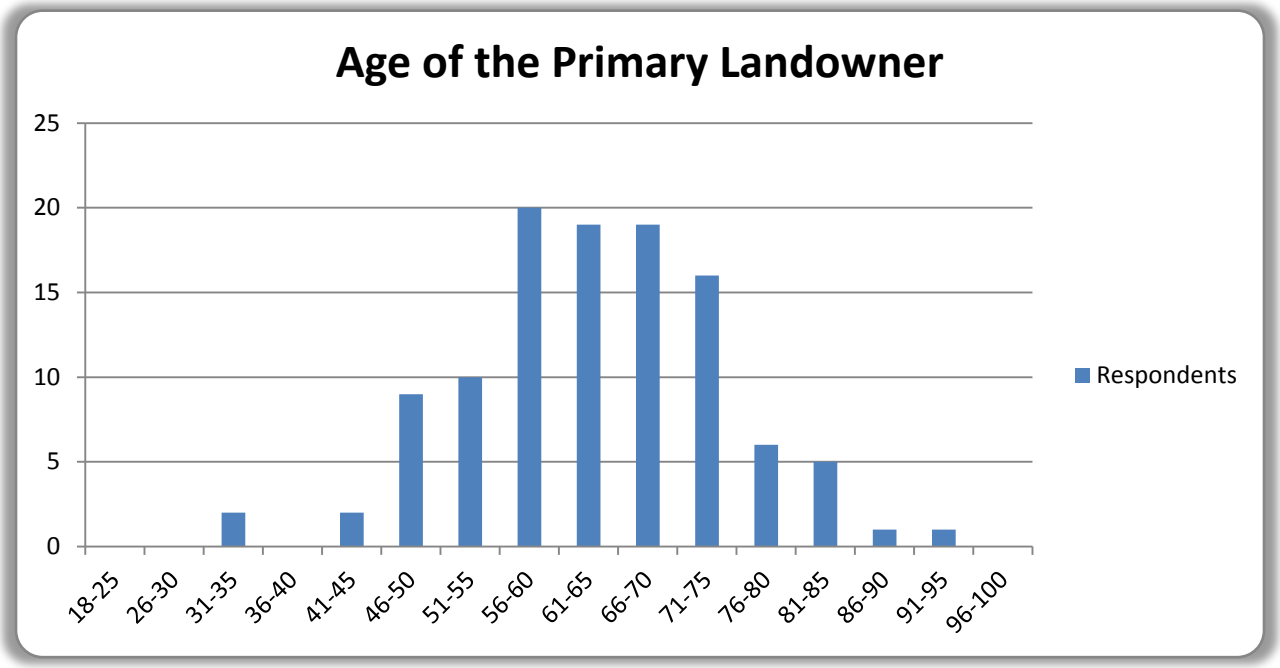


Figure 6: Respondent Age

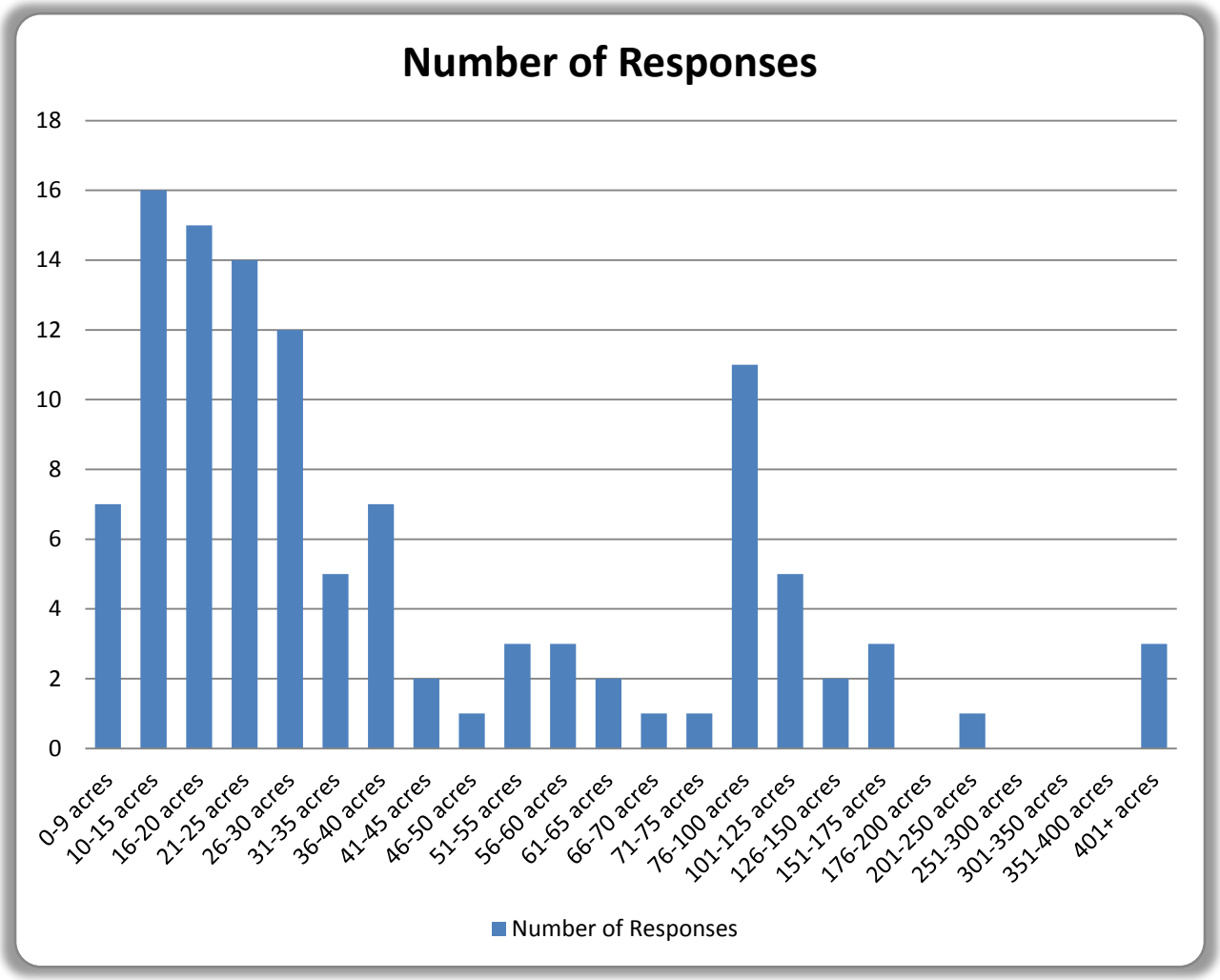


Figure 7: Respondent Forest Acreage Owned

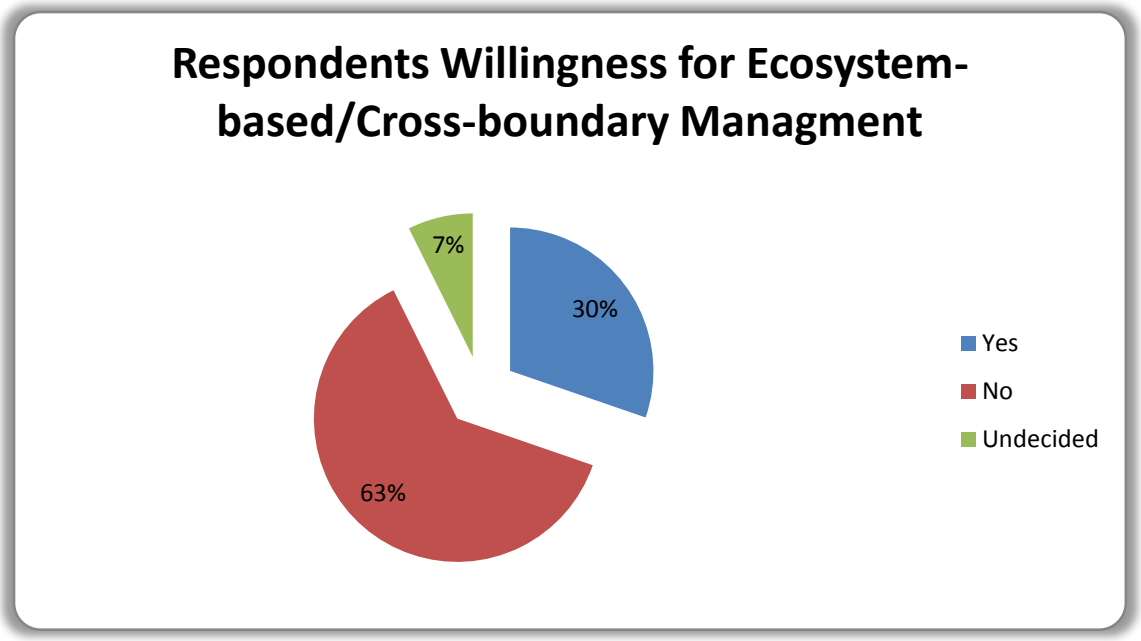


Figure 8: Respondent Willingness for Ecosystem-based/Cross-boundary Management

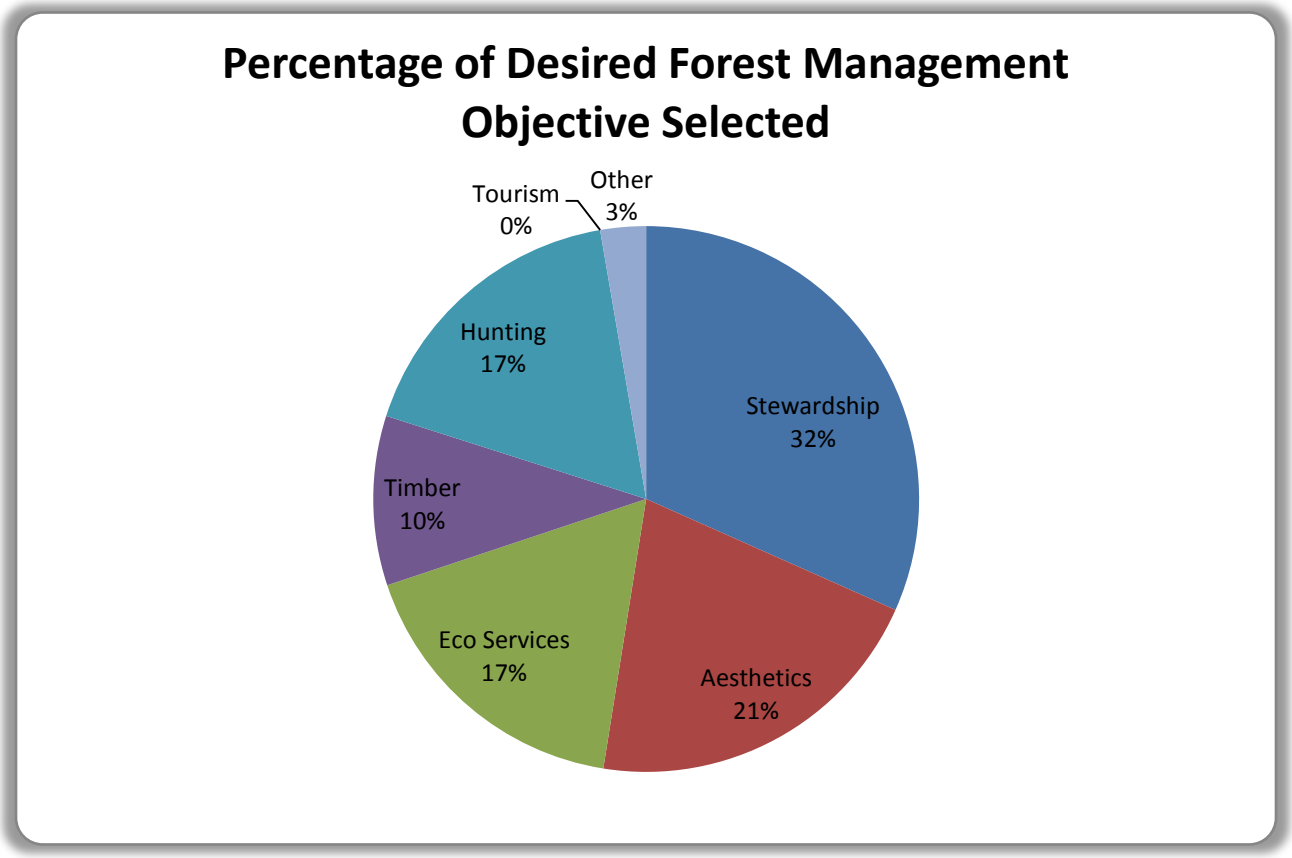
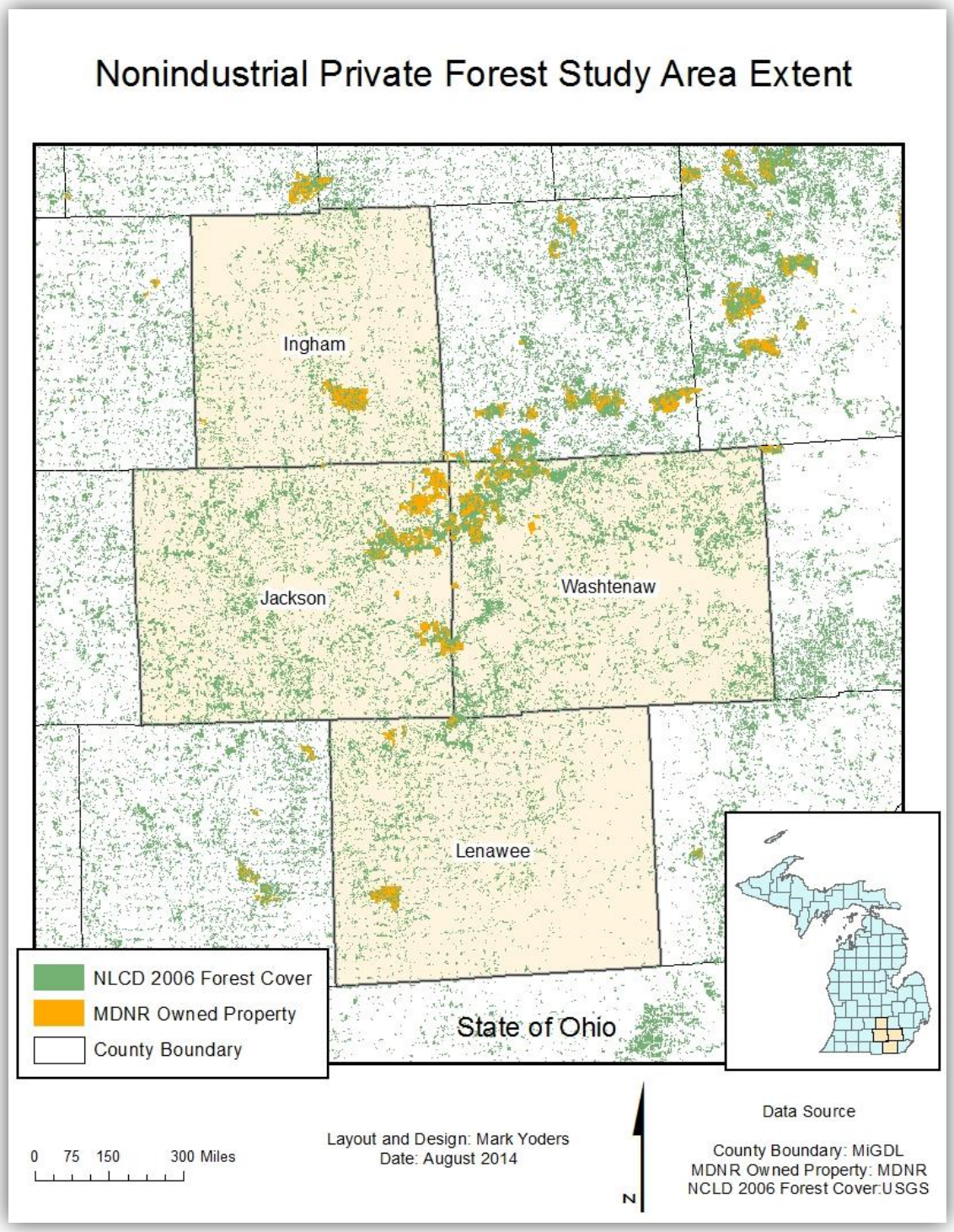
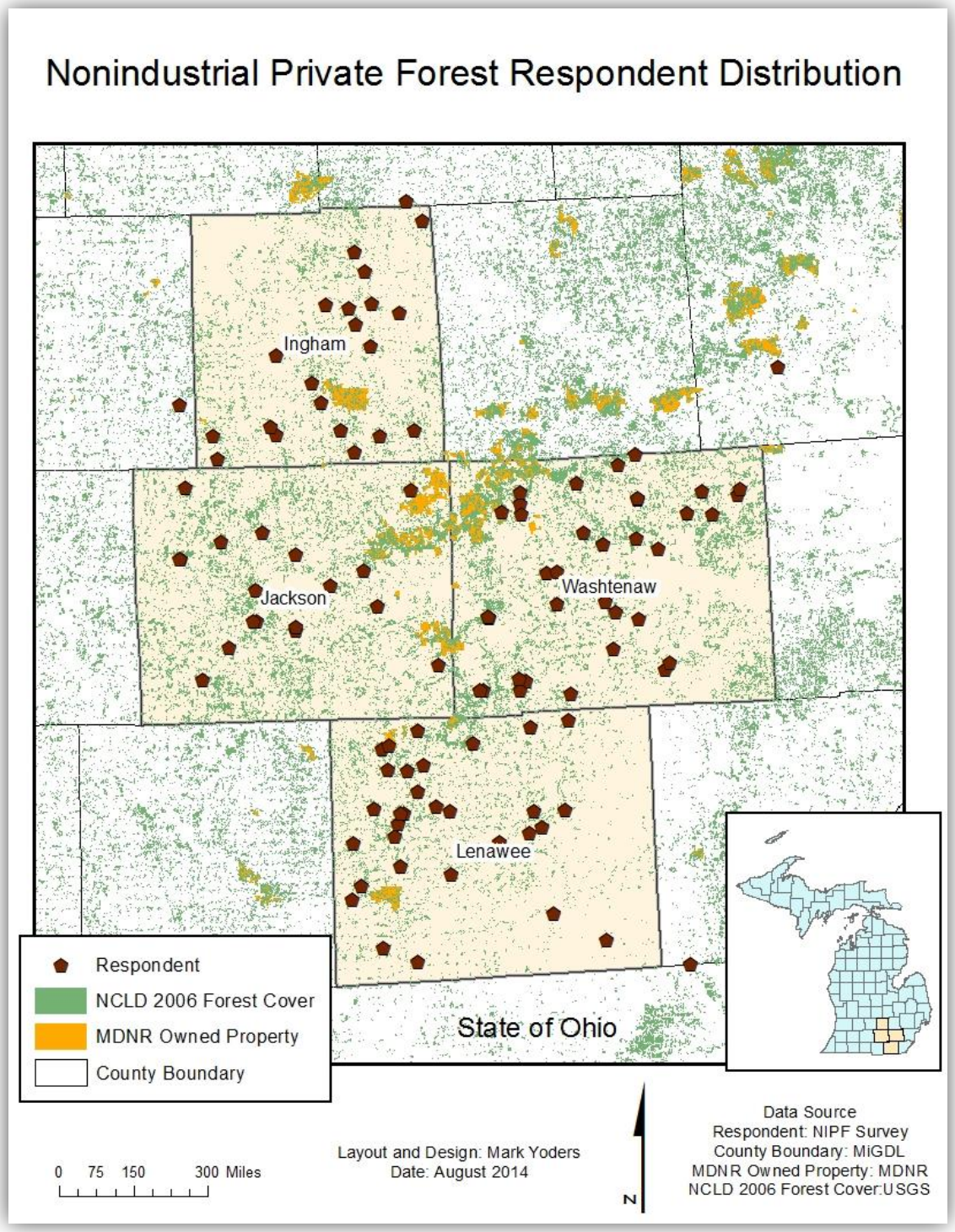


Figure 9: Percentage of Desired Forest Management Objective Selected



Map 1: Study Area



Map 2: Respondent Distribution

Map 3: Aerial image of interviewee parcel overlain with photointerpreted and digitized site characteristics.

Online Parcel Viewer Information	
County	Parcel Viewer URL
Ingham	http://ingham-equalization.rsgis.msu.edu/
Jackson	http://www.co.jackson.mi.us/CountyGIS/Landing/index.html
Lenawee	Parcel Information and NLCD Forest Intersect File Provided by Lenawee County GIS Department
Washtenaw	http://www.ewashtenaw.org/government/departments/gis/MapWashtenaw_Main.htm

Table 1: Online Parcel Viewer Information

Woody Species Surveyed - Common and Scientific Names	
Species Common Name	***Species Scientific Name***
American Elm	*Ulmus americana*
Autumn Olive	*Elaeagnus umbellata*
Basswood	*Tilia americana*
Bitternut Hickory	*Carya cordiformis*
Black Cherry	*Prunus serotina*
Black Oak	*Quercus velutina*
Black Raspberry	*Rubus occidentalis*
Black Walnut	*Juglans nigra*
Box Elder	*Acer negundo*
Cottonwood	*Populus deltoides*
Greenbrier	*Smilax spp.*
Honeysuckle	*Lonicera spp.*
Mulberry	*Morus spp.*
Pin Cherry	*Prunus pensylvanica*
Pin Oak	*Quercus palustris*
Red Maple	*Acer rubrum*
Red Oak	*Quercus rubra*
Russian Olive	*Elaeagnus angustifolia*
Sassafras	*Sassafras albidum*
Shagbark Hickory	*Carya ovata*
Silver Maple	*Acer saccharinum*
Slippery Elm	*Ulmus rubra*
Sugar Maple	*Acer saccharum*
Tulip Poplar	*Liriodendron tulipifera*
White Ash	*Fraxinus americana*
White Oak	*Quercus alba*

Table 2: Woody Species Surveyed Common and Scientific Names

Actual Management vs Desired Management Objectives - Logit with Odds Ratios and Confidence Intervals						
Factors	**Estimate**	**Std. Error**	**p-value**	**Odds Ratio**	**CI 2.5%**	**CI 97.5%**
Stewardship	0.05149	0.53199	0.922	1.0528435	0.3734532	3.070586
Aesthetics	-0.53628	0.47219	0.256	0.5849217	0.2252458	1.453093
Eco Services	1.36154	0.46949	0.004**	3.9021941	1.5895722	10.14678
Timber	0.93805	0.50837	0.065*	2.5549959	0.9496003	7.094778
Hunting	-0.81195	0.49535	0.101*	0.4439898	0.16104	1.139426
Other	0.80297	0.86594	0.354	2.2321499	0.3743625	12.48505

Table 3: Actual Management versus Desired Management Objectives. Significance Codes: **0.05, *0.10; df = 105. Confidence intervals are based on the profiled log-likelihood function. Estimate is the coefficient estimate (log-odds ratio) that shows how likely that factor is to occur, where positive or negative show the direction towards or away from the dependent variable. P-value indicates whether or not the coefficient is different than 0, which in the case of the dependent variable signifies not active (passive) management. Odds ratio is the natural exponential function of coefficient estimate and an easier way to interpret the coefficient estimate where the odds ratio value is the odds of the independent variable occurring for each increment of 1 for the dependent variable.

Willingness to Collaborate vs Desired Management Objectives - Logit with Odds Ratios and Confidence Intervals						
Factors	**Estimate**	**Std. Error**	**p-value**	**Odds Ratio**	**CI 2.5%**	**CI 97.5%**
Stewardship	-0.01655	0.54151	0.976	0.9835908	0.34207555	2.932383
Aesthetics	-0.45540	0.47590	0.339	0.6341918	0.24260653	1.588588
Eco Services	1.37548	0.47439	0.004**	3.9569806	1.59664048	10.398181
Timber	0.09076	0.53097	0.864	1.0950074	0.37449374	3.073712
Hunting	-0.82188	0.49720	0.098*	0.4396056	0.15920337	1.136130
Other	-0.77155	1.14739	0.501	0.4622942	0.02281469	3.244476

Table 4: Willingness to Collaborate in Ecosystem-based/Cross-boundary Management versus Desired Management Objectives. Significance Codes: **0.05, *0.10. df = 105. Confidence intervals are based on the profiled log-likelihood function. Estimate is the coefficient estimate (log-odds ratio) that shows how likely that factor is to occur, where positive or negative show the direction towards or away from the dependent variable. P-value indicates whether or not the coefficient is different than 0, which in the case of the dependent variable signifies not willing to collaborate in Ecosystem-based/cross-boundary management. Odds ratio is the natural exponential function of coefficient estimate and an easier way to interpret the coefficient estimate where the odds ratio value is the odds of the independent variable occurring for each increment of 1 for the dependent variable.

Statistical Assumptions of Logistic Regressions
Does not assume a linear relationship between the dependent and independent variables.
The dependent variable must be a dichotomous.
The independent variables need not be interval, nor normally distributed, nor linearly related, nor of equal variance within each group.
The categories (groups) must be mutually exclusive and exhaustive; a case can only be in one group and every case must be a member of one of the groups.
Larger samples are needed than for linear regression because maximum likelihood coefficients are large sample estimates. A minimum of 50 cases per predictor is recommended.

Table 5: Assumptions of Logistic Regressions (Burns and Burns 2009)

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