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Landowner and Manager Awareness and Perceptions of Pine Health Issues and Southern Pine Management Activities in the Southeastern United States

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We assessed awareness and perceptions of forest landowners and managers in the southeastern United States regarding their stand health especially under the context of the southern pine decline (SPD) phenomenon. E-mail and paper surveys were sent to 4,670 forest landowners and managers in Florida, Georgia, and South Carolina with an overall response rate of 28%. About half (51%) of respondents reported having healthy and symptom-free pine stands, and only 11% reported elevated levels of dying pine or pine mortality within the last year. Few (<30%) respondents were aware of SPD. Insects, disease, and drought were perceived as the most important threats to pine health. Respondents usually used material from state agencies, professional speakers, or research publications for information regarding pine stand management. Data indicate a favorable outlook for pine health in the southeastern United States, as landowners were engaged and willing to use recognized management prescriptions.

Keywords: forest health, *Heterobasidion*, landowners, management, *Pinus* spp., southern pine decline

Forests in the United States provide 17% of the world's industrial roundwood (the majority of which comes from the southern region [Howard and Westby 2013]), ecosystem services such as clean water and air, and countless recreational benefits (Wear and Greis 2013, Wear et al. 2016). Planted and natural southern pine, including loblolly (*Pinus taeda* L.), longleaf (*Pinus palustris* Mill.), slash (*Pinus elliottii* Engelm.), and shortleaf (*Pinus echinata* Mill.), are the dominant species on 34% of southern forestland, with 87% of this land under private ownership (Wear and Greis 2013). Much of this pine-dominated forest is in plantations heavily managed for timber and pulpwood production. Many local and regional economies depend greatly on these pine plantations for socioeconomic stability (Wear and Greis 2013).

Southern pine management includes silvicultural techniques such as weed control, fertilization, thinning, and prescribed fire (Fox et al. 2007, Jokela et al. 2010). Proper use of these management techniques and strategies can improve tree growth and help buffer and prevent losses from abiotic and biotic factors, including drought, overcrowding, and insect and fungal pests (Fox et al. 2007, Nowak et al. 2008, 2015, Jokela et al. 2010). Common insect and disease issues in southern pine forests include engraver beetles (e.g., *Ips avulsus* [Eichhoff], *Ips calligraphus* [Germar], *Ips grandicollis* [Eich-

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hoff]), black turpentine beetle (*Dendroctonus terebrans* [Olivier]), southern pine beetle (*Dendroctonus frontalis* Zimmermann) (Clarke 2001, Nowak et al. 2008, Schowalter 2012), and heterobasidion (or annosum) root rot (i.e., *Heterobasidion irregulare* Otrosina and Garbelotto) (Otrosina and Cobb 1989, Garbelotto and Gonthier 2013).

Forest health, in particular, protecting forests from damage by native and exotic species, is generally considered an important topic, especially in regions where forestry or forest industries comprise a significant portion of the local economy. In South Africa, the impact of forest pests on plantation forestry was considered to be very important (Hurley et al. 2012), and in Canada ~95% of respondents considered local infestations of either gypsy moth (*Lymantria dispar* L.) or jack pine budworm (*Choristoneura pinus* Freeman) to be a problem (MacDonald et al. 1998). Residents in western Alberta, Canada, considered the mountain pine beetle (*Dendroctonus ponderosae* Hopkins) a moderate or great concern influencing several ecosystem (e.g., increased risk of fire and falling trees) and social (e.g., loss of scenic quality and loss of the forest as an economic source) risks (McFarlane et al. 2012). Across the United States, most private forest landowners consider insects and diseases a major forest threat (Abrams et al. 2005, Butler et al. 2007, Weigel and Metz 2011, Hamilton et al. 2012), and a survey of 30 Native American tribes in 16 states considered forest health an important topic (Mater 2005). These studies indicate the close connection many people feel with forests and the fact that that forest health is an important topic in many communities. However, these sentiments may not be shared by nonresidents, as tourists in Bavarian Forest National Park (Germany) showed a neutral attitude toward and favored little to no intervention during a European spruce bark beetle (*Ips typographus* L.) outbreak (Müller and Job 2009).

An increase in landowner education regarding forest health and invasive species has recently occurred in extension forestry programs nationwide (Sagor et al. 2014). Concurrently, a greater amount of forestland in the United States is being owned or managed by private landowners (Butler and Leatherberry 2004, Butler 2008). Although nationwide assessments of landowner or manager attitudes regarding forest health can be difficult due to the diverse forest types and associated diversity of threats these forests face, there is a general perception that forest health is declining (Boag et al. 2015). In the southeastern United States, assessments of landowner knowledge, awareness, and attitudes concerning forest health issues tend to be dominated by those related to the most important pest of pines, the southern pine beetle (e.g., Mayfield et al. 2006, Molnar et al. 2007, Rossi et al. 2010). As such, there is a paucity of data on the awareness of and perceptions regarding other facets of forest health in the forest landowner community.

Reports of dying or dead southern pines have existed since the 1950s (Brown and McDowell 1968). Stands were characterized by thinning and yellowing crowns, reduced growth, root deterioration, and production of "stress cones" (Brown and McDowell 1968). After a 5-year study to determine causal factors, the health issues had largely disappeared (Roth and Peacher 1971). Overall, stands had low mortality rates, with only pockets of health issues, which were blamed on insects, pathogens, or planting loblolly pine on sites more suited to longleaf pine (Roth and Peacher 1971). This phenomenon has been recently reported as being an important issue in Alabama and Georgia (Eckhardt et al. 2007, 2010) and has been called "southern pine decline" (SPD) (Figure 1). This syndrome reportedly affects loblolly pine stands of varying ages, although more recent research suggests that other southern pine species may be susceptible (Matusick and Eckhardt 2010a, 2010b, Matusick et al. 2010). South or southwest aspects and steep slopes have been suggested as contributing factors to SPD (Eckhardt and Menard 2008), as have root-feeding insects and the fungi they carry (Eckhardt et al. 2007). Recently developed risk maps suggest widespread SPD risk and occurrence across the pine-dominated southeastern United States (Meyerpeter 2012). However, scientists debate the extent and etiology of SPD (see Eckhardt et al. 2010, Ryu et al. 2013, and Coyle et al. 2015). Coyle et al. (2015) showed no relationship between slope or aspect and reduced pine growth across the southeastern United States. Zeng et al. (2014) suggested a positive association with forest thinning and abundance of this insect-fungal complex, yet forest thinning is a widely practiced and standard silvicultural treatment for southern pine forests, and no definitive link has been shown between thinning and SPD.

Some landowners and managers are uncertain as to whether their land has SPD, if their land is at risk for SPD, or if they should alter their management practices as a result of SPD (C. Bates and M. McClure, Georgia Forestry Commission, C. Beckham, South Carolina Forestry Commission, J. Eickwort, Florida Forest Service, pers. comm., Apr. 23–24, 2015). Our objectives, using a statistically valid survey, were the following: to assess the awareness and perceptions of forest landowners and managers of pine health issues and, specifically, SPD; to determine what, if any, management operations landowners and managers would be willing to allow on their land to address pine health issues or SPD; and to assess the best way to communicate with and disseminate forest

Management and Policy Implications

Forests are an integral part of the regional ecology and economy of the southeastern United States. As such, understanding forest landowner awareness and perceptions about potential forest health issues is a crucial step toward effective land management and policy development. Three important conclusions impacting management and policy can be drawn from our work. First, the importance of the recent southern pine decline issue appears to have been inflated, as the majority of respondents were unaware of the phenomenon. In fact, most forest stands owned or managed by respondents were in good health. Second, forest landowners and managers obtained and responded to information in many different ways and forms. Thus, extension and outreach programs that employ multiple methods of communication would be useful to inform landowners and managers regarding southern pine health and management strategies. In addition, policies that encourage multifaceted extension and outreach programs would likely benefit the most landowners. Finally, forest management should continue to focus on traditional, recommended management techniques such as thinning, prescribed burning, and competition control. Landowners and managers who responded to our survey generally engage in federal and state cost-share programs to support forest management, and policies that enhance and encourage these programs would probably have a beneficial impact on forestry in the southeastern United States.

Figure 1. Pine trees in the southeastern US may be initially stressed by drought or poor growing conditions. After these initial (or primary) stressors have weakened the tree, secondary factors such as insects and fungi may further weaken the tree, resulting in unhealthy-looking trees, poor growth, or even death. Root-feeding insects may colonize stressed trees, and in doing so may bring root-inhabiting fungi with them. This series of events has been called southern pine decline, and while it can occur locally, there is no evidence that it is a region-wide phenomena. Here, a large root is excavated to look for evidence of insect colonization and to collect a sample to determine if fungi are present.

Table 1. Response rate to a survey regarding pine health issues from respondents in Florida, Georgia, and South Carolina, USA.

	State		
	Florida[a]	Georgia[b]	South Carolina[c]
No. of respondents contacted by mail	277	2,294	639
Mailing responses	153	406	396
Mailing response rate (%)	55.2	17.7	62.0
Usable email addresses	72	1,314	
E-mail responses	19	313	
E-mail response rate (%)	26.4	23.8	
Total potential respondents	296	3,608	693
Overall response rate (%)	58.1	19.9	62.0

[a] Florida residents that were contacted by e-mail but did not respond ($n = 53$) also received an initial and follow-up survey in the mail.
[b] Georgia residents contacted by mail only received an initial survey (i.e., no follow-up survey); those contacted by e-mail did not receive a follow-up letter in the mail.
[c] E-mail addresses were not available for South Carolina residents.

health information to forest landowners and managers.

Methods

Initial Survey Design

We found no previous surveys in the research literature regarding landowner and manager awareness and perceptions pertaining to SPD. Hence, we reviewed the literature to identify and examine surveys evaluating landowner and manager awareness and perceptions related to broader issues in tree and forest health. Several such surveys were available in three areas relevant to pine health issues: forest pests (e.g., Billings 2000, Mayfield et al. 2006, Molnar et al. 2007, Hurley et al. 2012, Watson et al. 2013), climate change (e.g., Carlton et al. 2014, Lenart and Jones 2014), and stand management (e.g., Poudyal et al. 2014, Ruseva et al. 2014, Song et al. 2014, Starr and McConnell 2014). Having reviewed these surveys, we created questions and scales to evaluate landowner awareness and perceptions of issues surrounding southern pine health and the SPD syndrome. The initial survey comprised three sections: general health of owned or managed pine stands, knowledge of SPD, and demographics. These sections contained 11, 14, and 11 questions, respectively. Scales for these questions were categorical, ordinal, or write-in answer (see Supplemental Material S1[S]).

Pilot Test

A survey was initially constructed by professionals from several fields including forestry, entomology, pathology, and social science. A pilot test was conducted in paper and online formats (SurveyMonkey). Twelve forest health experts served as respondents. After comments and beta-testing (i.e., a full test run before surveys were administered to respondents), some modifications were made to the survey questions to improve clarity and better address our research questions. All questions and correspondence with the survey population was approved by the University of Georgia Institution Review Board, which oversees research involving human subjects.

Survey Population

Our survey population consisted of forest landowners and managers from three major pine-growing states: Florida, Georgia, and South Carolina. We obtained e-mail (when available) and postal addresses from the Florida Forest Service, Georgia Forestry Commission, and South Carolina Forestry Commission. Participants from Florida and South Carolina had previously participated in the Southern Pine Beetle Prevention Program (SPBPP) (Nowak et al. 2008), which provides cost-share for land management techniques designed to maintain and improve the health of forests. Participants from Georgia were those who had previously dealt with Georgia Forestry Commission personnel on various forest health issues. These people owned or managed parcels of any size and any forest type, although it is estimated that ~99% of these people owned or managed pine land (C. Bates, Georgia Forestry Commission, pers. comm., Sept. 16, 2015).

[S] Supplementary data are available with this article at http://dx.doi.org/10.5849/jof.15-093.

Participants with e-mail addresses from Florida and Georgia (Table 1) received an e-mail invitation to complete an online survey in October 2014, followed by a reminder e-mail 2 weeks later. Participants from Florida without e-mail addresses or who did not respond via e-mail, and participants from South Carolina were mailed a cover letter, survey, and return envelope in October 2014. Nonrespondents from Florida and South Carolina were sent a reminder cover letter, another survey, and return envelope in January 2015. Logistical and fiscal considerations prevented us from contacting every potential Georgia respondent. From a database of >11,000 Georgia landowner and manager addresses (those without e-mail addresses), a cover letter, survey, and return envelope were mailed to 1,000 potential respondents in October 2014 and 1,400 potential respondents in January 2015. Respondents were selected by alphabetizing the total potential respondent list, dividing this list into 11 groups of 1,000 plus extras, and sequentially assigning each group a number beginning with one. The first group (group 1) was contacted in October 2014; the second group (group 2) and the first 400 participants of the third group (group 3) were contacted in January 2015.

Analyses

Data were analyzed separately among states using SAS version 9.4 (SAS Institute, Inc., Cary, NC) for all analyses; $\alpha = 0.05$ was used to denote significance. Within each state we also examined the influence of acreage owned/managed and landowner or manager education level. We created three acreage groups composed of respondents who owned small (≤50), medium (51–1,000), or large (>1,000) acreages. We also created two education level groups, respondents who completed education up to but not completing a 4-year bachelor's degree and those who had at least a bachelor's degree or more (e.g., MS, PhD, JD, DVM, or MD), and examined them separately.

Binomial variables (i.e., questions with a yes or no answer) were analyzed using Wald's χ^2 test (PROC FREQ), assuming a 50% response rate to each answer. The effect of categorical (i.e., questions with answers on a 1–5 scale) or continuous (e.g., respondent age) responses on binomial variables was modeled using logistic regression (PROC LOGISTIC). Impacts of categorical or continuous variables on categorical variables (e.g., influence of acreage ownership group on level of respondent concern) were modeled using analysis of variance (PROC GLM with ESTIMATE statement). Responses of "don't know" or "prefer not to answer" were not included in analyses.

Table 2. Demographic characteristics of respondents from a survey regarding pine health issues in Florida, Georgia, and South Carolina, USA.

Variable	State		
	Florida	Georgia	South Carolina
Gender			
Male	78.5	80.0	77.0
Female	11.6	15.3	13.4
Did not report	9.9	4.7	9.6
Age			
≤29 years	0.0	0.7	0.3
30–49 years	5.8	12.0	11.4
50–69 years	51.7	54.4	45.7
≥70 years	36.6	25.7	36.1
Did not report	5.8	7.2	6.6
Mean (years)	66.3	62.2	64.9
Range (years)	31–90	23–92	21–92
Ethnicity			
White or Caucasian	90.7	90.8	89.9
Black or African American	0.0	1.7	1.0
American Indian or Alaska Native	0.0	0.3	0.0
Hispanic or Latin	0.0	0.3	0.3
Other	1.2	1.0	0.5
Did not report	8.1	6.0	8.3
Education level			
Less than high school	0.6	0.1	0.5
High school or GED	8.7	8.3	8.3
Some college	9.9	13.5	10.1
2-year college degree	8.7	9.3	6.1
4-year college degree	35.5	36.2	38.1
Master's or doctorate degree	20.3	20.2	16.9
Professional degree (JD, MD)	9.9	8.2	13.1
Did not answer	6.4	4.2	6.8

All answers are percent of total responses unless otherwise noted.

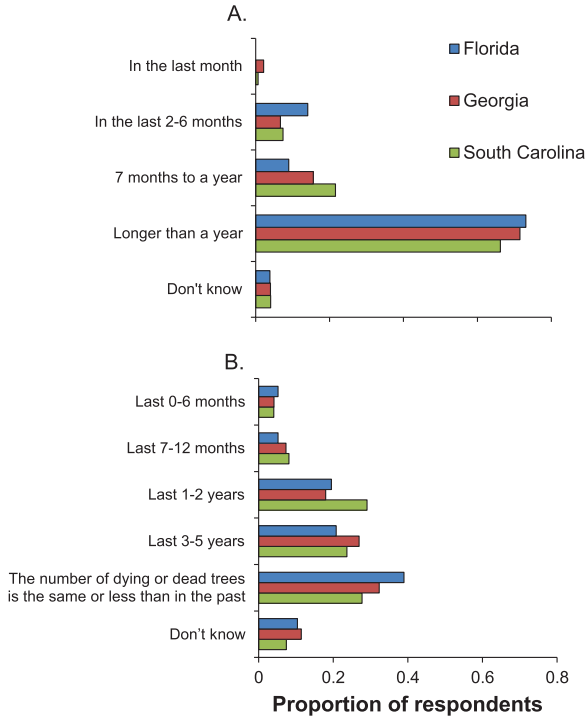

Figure 2. Amount of time since respondents first noticed dying or dead pine trees on their property (A) and last saw an increase in the number of dying or dead pine trees on their property (B).

Results and Discussion

We received 1,287 usable responses (a 28% overall response rate). Respondents were responsible for management decisions on 3,820,042 acres of forestland. Overall response rates varied among states, and there was a particularly low response rate from Georgia mailings (Table 1). E-mail response rates were similar between Florida and Georgia. Mailing response rates were similar between Florida and South Carolina, which were both much higher than that for Georgia. As respondents in Florida and South Carolina were targeted from groups whohad participated in the SPBPP, these respondents definitely owned or managed pine stands. Georgia participants, however, were drawn from a general pool of forest landowners, whose land probably, but not definitively, contained pine. This less-targeted approach, combined with the lack of follow-up communication to Georgia respondents (i.e., nonrespondents from Georgia were not sent a reminder letter after the initial mailing), probably contributed to the much lower response rates (Edwards et al. 2002).

Response rates from Florida and South Carolina compared favorably with those from other published studies and, in particular, with the National Woodland Owner Survey (NWOS) (Butler 2008). This nationwide survey is the official census of forest landowners in the United States and is widely regarded as an authority regarding the understanding of forest landowner thoughts and attitudes toward their land. Response rates for Florida and South Carolina respondents from the NWOS were 48 and 44%, respectively (Butler 2008), which are lower than those in our study (Table 1). Response rates from Georgia landowners in our survey were much lower than those for NWOS participants, where 50% responded (Butler 2008). Although it is possible that the Georgia respondents were less engaged than the Florida or South Carolina respondents with respect to their forest's health, we do not believe this to be the case since every potential respondent from Georgia had been in contact with the Georgia Forestry Commission regarding some forestry-related issue. In fact, since these respondents had all been in contact with their state Forestry Commission, one could argue that these landowners and managers were more interested in forestry issues than other landowners or managers who did not make the effort to contact professional personnel. This contact suggests that these people are as engaged and involved as those in other states and lends credence to follow-up communication as an important factor impacting response rates. Further, even with a low response rate in Georgia, respondents' answers to questions and demographic characteristics (explained in more detail below) were relatively consistent among states, suggesting that we received a representative subsample of the forest landowner and manager population as a whole.

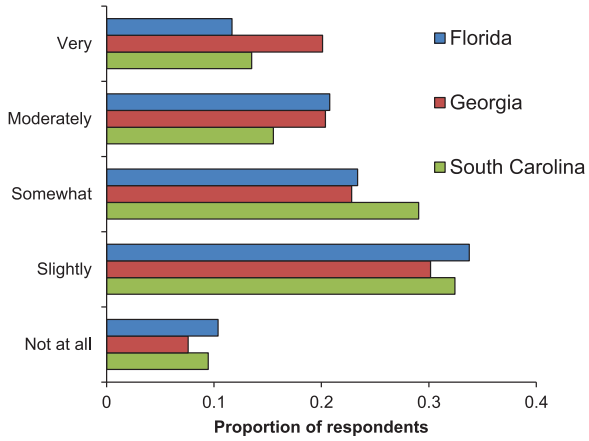

Figure 3. Level of concern regarding the amount of dying or dead pine trees observed on respondents' properties.

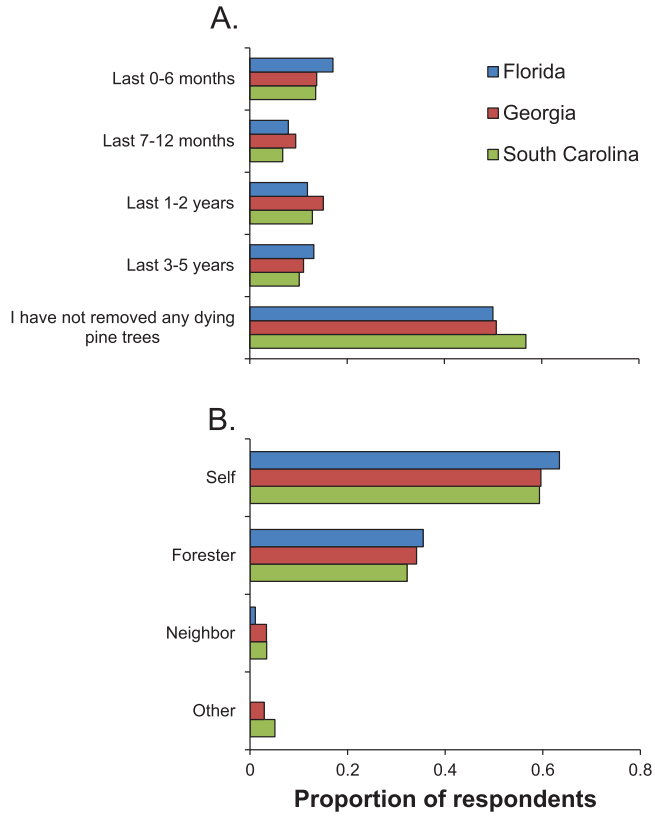

Figure 4. Amount of time since respondent last removed dying or dead pine trees from their property (A) and source used by landowner to diagnose pine health problems on their land (B).

Respondent demographic characteristics were relatively consistent among states. Most respondents were Caucasian males, with a mean age from 62 to 66 years old (Table 2). The large age range of respondents we observed is typical in this region (Measells et al. 2005, Watson et al. 2013). More than 64% of respondents from each state possessed at least a 4-year college de-

gree, with ~30% possessing an advanced degree (Table 2).

Respondent Awareness of Pine Health

Most respondents were aware of the overall health of their pine stands, as very few respondents (between 3.8 and 5.3% per state) indicated that they were unaware of whether their land had dying or dead trees. The amount of respondents that observed dying or dead pine trees was similar in Florida (47.5%; χ^2 [1 *df*, number of respondents $n = 162$] = 0.395; $P = 0.530$) and Georgia (53.9%; χ^2 [1 *df*, $n = 692$] = 4.214; $P = 0.040$) but slightly lower in South Carolina (40.0%; χ^2 [1 *df*, $n = 355$] = 0.049; $P = 0.826$). Many factors impact southern pine health, and researchers and policymakers have developed several successful strategies for southern pine management. For instance, the positive impacts of the SPBPP have been widespread throughout the region (Nowak et al. 2008), as more than 1.2 million acres of pine forest have received preventative silvicultural treatments. In fact, the SPBBP's efficacy was recently demonstrated on a landscape scale (Nowak et al. 2015), suggesting that proper regionwide silviculture of pine stands may help mitigate potential pest problems, especially those related to bark beetles. Because respondents from Florida and South Carolina had taken part in the SPBPP, it is possible that their land was, in general, healthier than that of Georgia residents, who may or may not have participated in this program.

Respondents who owned greater amounts of acreage were more likely to have seen dying or dead pine trees on their land (χ^2 [1 *df*, $n = 1{,}164$] = 4.176; $P = 0.041$). Landowners with larger acreage may have been more aware of dying or dead trees due to more frequent observations. Alternately, smaller parcels of land may be owned by absentee landowners who cannot closely monitor their stands, or smaller parcels may simply be easier to manage (and therefore keep healthy) than larger ones. Landowners who own smaller parcels often have multiple use goals, including timber production, hunting, and various recreational activities (Gan and Kolison 1999, Butler and Leatherberry 2004). Because of these various goals, dying or dead trees, particularly scattered across a forest stand, may not be seen as negative, as the resulting forest heterogeneity may provide habitat for wildlife or other noneconomic benefits. In contrast, landowners owning larger parcels are traditionally focused on production

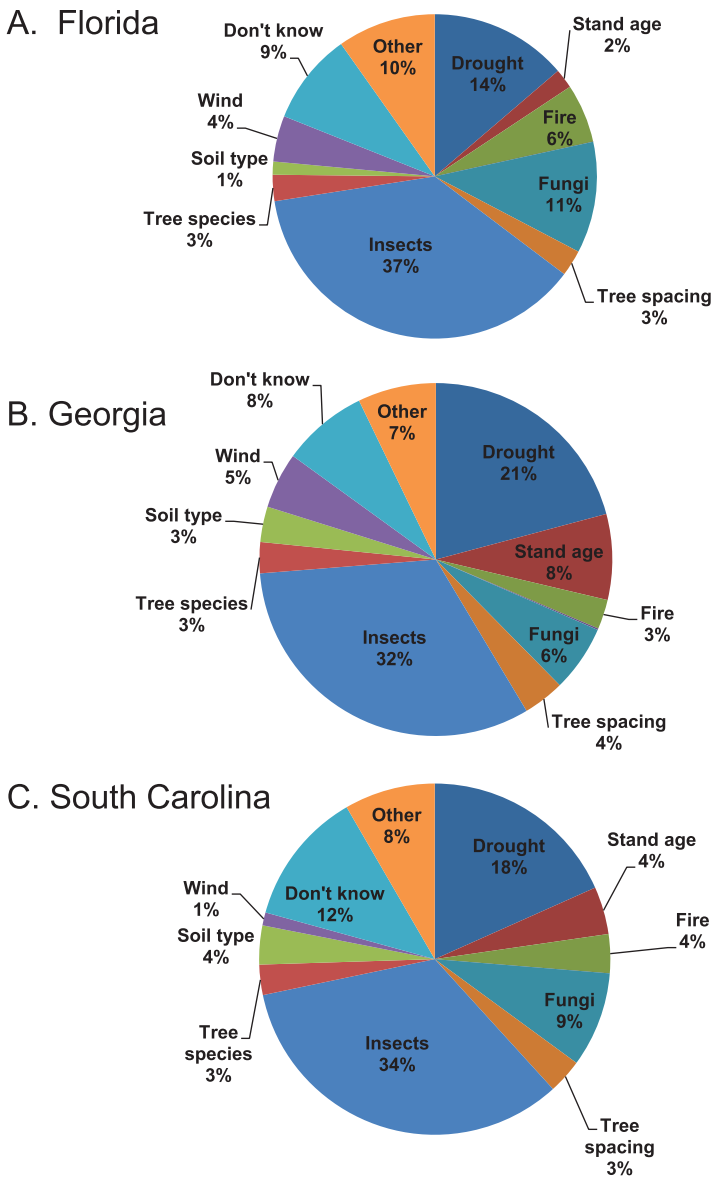

Figure 5. Factors believed to be causal agents of declining health or death of pine stands.

or maximizing economic returns (Butler and Leatherberry 2004).

Most respondents first noticed dying or dead pine trees on their land more than 12 months before taking this survey; only a very small proportion recently noticed dead or dying trees (Figure 2A). Most respondents (Florida, 96%; Georgia, 89%; South Carolina, 93%) reported no or light (<25%) mortality in their pine stands, whereas <1% from any state reported heavy (51–75%) or very heavy (>75%) mortality. Few respondents reported recent (within the last 12 months) increases in dying or dead pine trees (Figure 2B), and those who did most often reported low or no (<25%) levels. No respondents in Florida reported moderate (25–50%), heavy (51–75%), or very heavy (75%) levels of recently dying or dead trees, and only 10% of Georgia and 7% of South Carolina respondents reported these levels of tree health or mortality. The overall low levels of dying and dead pine indicate generally healthy pine stands in this part of the southeastern United States. These results concur with research showing that southern pine growth rates are generally positive across the southeastern United States (Siry and Bailey 2003, Miller et al. 2006, Coyle et al. 2015).

Most respondents had low concern levels (i.e., ranging from "somewhat" to "not at all": 73% in Florida, 63% in Georgia, and 74% in South Carolina) rather than high concern levels (i.e., "moderately" or "very" concerned) about the number of dying or dead trees on their property (Figure 3). The respondent concern level factored into

whether or not action was taken regarding the treatment of dying or dead trees, as most respondents who had seen dying or dead trees on their property had not used any treatments to improve tree health. Further, at least half of the respondents in each state had not removed dead or dying pine trees from their land (Figure 4A), and of those who did, most (81.3%) removed <25% of dead or dying trees. Respondents often independently diagnosed the factors causing their pine health issues or enlisted the assistance of a forester (Figure 4B). Insects, drought, and fungi were most commonly thought to be causal agents for pine tree health issues (Figure 5). Insects and diseases are often the primary cause for concern among forest landowners (Butler 2008, Starr and McConnell 2014), and their threat is considered a strong motivator for positively changing landowner attitudes (Ferranto et al. 2013). However, the concern level regarding forest pests depends on many landowner attributes, including management goals and attitudes (Molnar et al. 2007, Surendra et al. 2009), size of the forest parcel owned (Mayfield et al. 2006), and importance of trees to one's livelihood (Hurley et al. 2012).

The concern level regarding SPD was not related to how long respondents from any state had owned or managed their pine land (all $P < 0.238$), respondent education level (all $P < 0.523$), or respondent age (all $P < 0.264$). However, in South Carolina, respondents who owned or managed smaller acreages had more concern regarding SPD ($F_{4,137} = 2.79$, $P = 0.029$), and this did not occur in Florida or Georgia (both $P < 0.110$). Respondents who own or manage smaller parcels are less likely to harvest (Conway et al. 2003) and may view their land as an aesthetic refuge rather than a fiscal entity. Further, the scope and magnitude of the impacts of any pest on trees in a smaller parcel inherently will be magnified compared with those to a large tract of land. Interestingly, education level did not impact respondent concern level. Several studies have shown that respondents who held a college degree generally comprise more than half of a population (Jacobson 2002, Butler and Leatherberry 2004, Kendra and Hull 2005), and, although while not the case in our study, there is an increase in respondent's knowledge or awareness for ecological issues with advanced education (Creighton et al. 2002, Kirkpatrick et al. 2012, Watson et al. 2013).

Table 3. Awareness and perceptions of pine decline (i.e., SPD) in Florida, Georgia, and South Carolina, USA.

	State		
	Florida	Georgia	South Carolina
Previously heard of pine decline			
Yes (%)	29.7	32.4	25.3
No (%)	70.3	67.6	74.7
χ^2 (1 *df*)	28.5	81.8	96.3
n	172	712	395
P	<0.001	<0.001	<0.001
If yes, have you altered your pine management because of pine decline?			
Yes (%)	39.2	20.3	24.7
No (%)	60.8	79.7	75.3
χ^2 (1 df)	2.4	81.8	24.8
n	51	227	97
P	0.124	<0.001	<0.001
Do you believe you have pine decline on your land?			
Yes (%)	22.0	24.8	27.6
No (%)	38.0	40.7	43.9
Maybe (%)	20.0	23.5	21.4
Don't know (%)	20.0	11.1	7.1
n	50	226	98
What percentage of your land do you believe is affected by pine decline?			
<25%	90.9	67.3	76.0
25–50%	9.1	28.8	24.0
51–75%	0.0	1.9	0.0
>75%	0.0	1.9	0.0
n	11	52	25
How important an issue do you consider pine decline?			
Very important (%)	36.4	45.5	36.0
Important (%)	27.3	21.8	20.0
Moderately important (%)	27.3	25.5	36.0
Slightly important (%)	9.1	5.5	4.0
Not important (%)	0.0	1.8	4.0
n	11	55	25

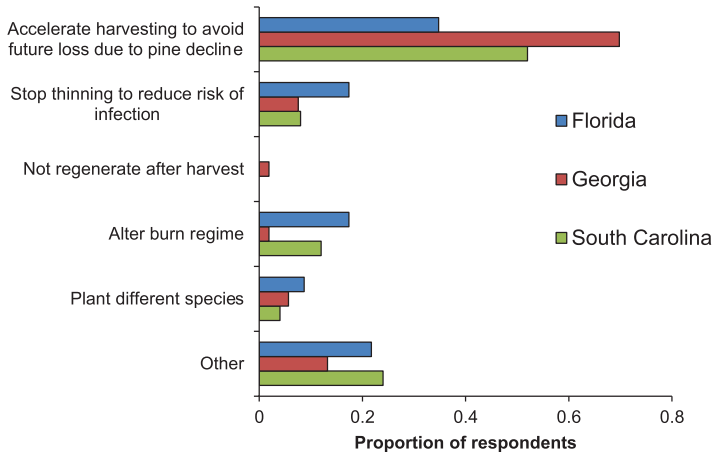

Figure 6. Ways in which landowners altered pine stand management because they believed they had SPD on their land.

Landowner Awareness and Perceptions of the SPD Issue

Although there is considerable evidence that SPD is not a regionwide issue (Coyle et al. 2015) and state forest health professionals in the southeastern United States do not believe SPD is a major problem (Southern Group of State Foresters 2015), questions by landowners as to the importance of SPD still persist. At least two-thirds of respondents in each state had not heard of SPD before taking this survey (Table 3), and the majority of those who knew of SPD first heard of the issue more than 1 year before taking the survey. Respondents who had heard of SPD represented only 11.8% of the total land area accounted for in this survey. These data indicate that SPD is not a well-

known issue, which may explain why SPD is not detectable on a regional basis and is, at best, a conglomeration of abiotic and biotic factors affecting individual stands (Coyle et al. 2015). Only 90 respondents (out of nearly 1,300 usable surveys) altered their stand management because of pine decline (Table 3). Most respondents who altered their pine management tended to do so by accelerating harvesting (Figure 6). This action was most prevalent in Georgia, where nearly twice as many respondents as in Florida accelerated harvesting to avoid future forest loss. Although highly variable, pine stumpage prices have been trending downwards over the last several years, but it is possible that in some areas the economics were beneficial for harvesting. As the profit margin for loggers decreases (Baker et al. 2014), factors such as proximity to a mill and stem size and total volume often dictate whether harvesting will be profitable (Kluender et al. 1997, Wear et al. 2007). As such, the greater number of pulp mills in Georgia and South Carolina than in Florida (Wear et al. 2007) may have increased the respondent's choice to harvest in those states. Our data in Figure 6 also show that respondents from Florida stopping stand thinning at twice the rate of those in Georgia or South Carolina; this probably corresponds with the low number who accelerated harvesting. Respondents in Florida and South Carolina, but not Georgia, were more likely to alter prescribed burning regimes. Prescribed burning is recommended for many southern pine forest types across the region, so the disparity among states in this regard is unexpected.

Respondents most commonly heard about pine decline from other landowners or managers, university and state agencies, or friends and/or family (Table 4). However, when these respondents wanted information pertaining to pine health issues, most went to their state agencies or their local land-grant university (Table 5). Most respondents who had heard of SPD reported low or no mortality, and few believed they had SPD on their land (Table 3). Among states, the percentage of respondents who answered these questions the same was very similar (Table 3). Respondents who believed they had SPD on their land overwhelmingly believed the issue to be at least moderately important (Figure 7). In general, people closest to or most impacted by a real or perceived forest health issue tend to be more involved with and interested in or have stronger convictions regarding the topic (e.g., McFarlane et al. 2006, Chang et al. 2009), and our findings support this.

Table 4. Sources from which respondents have heard of pine decline.

	State		
	Florida	Georgia	South Carolina
	(%)		
Arborist	3.2	5.3	7.2
Friends and/or family	12.6	14.5	13.2
Handouts/brochures from universities or state agencies	23.2	15.0	8.6
Internet (Google, Wikipedia, other search engine, etc.)	8.4	8.4	5.3
Magazine	6.3	6.2	3.9
Newspaper	3.2	5.1	6.6
Nursery personnel	0.0	0.7	0.7
Other landowners or land mangers	16.8	21.4	30.9
Professional speaker/continuing education courses/conferences	4.2	7.0	6.6
Radio	2.1	0.4	0.0
Research publications	7.4	4.0	3.3
Social media	0.0	0.7	0.7
TV	2.1	2.2	2.0
Other	9.8	10.5	9.3

Table 5. Sources of information used by respondents regarding pine health issues and frequency of which respondents use the information.

	State		
	Florida	Georgia	South Carolina
	(%)		
From where do you receive information?			
State forestry agency	32.9	39.1	35.0
Major university	34.2	18.9	17.1
USDA Forest Service	11.0	10.7	5.1
I have not received information	19.2	30.0	39.3
Other	2.7	1.3	3.4
How often do you use this information?			
Always	8.6	6.6	4.7
Very often	5.7	7.9	14.1
Fairly often	22.9	19.9	10.9
Sometimes	34.3	26.5	25.0
Rarely	17.1	20.5	18.8
Never	11.4	18.5	26.6

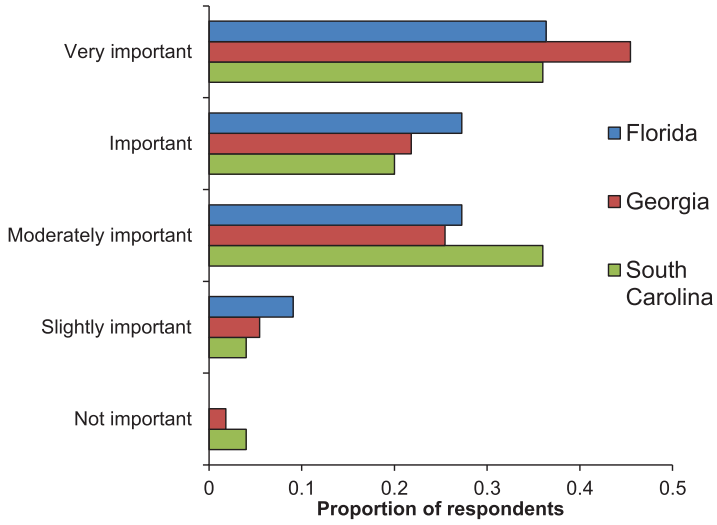

Figure 7. Level of importance given to SPD assigned by people that believe they have SPD on their land.

Respondents from Florida were most likely to have received information regarding pine health issues, whereas the highest

Table 6. Management activities landowners would use and for which they would accept financial assistance.

Management activity	Activities respondents would use			Activities for which respondents would accept assistance		
	Florida	Georgia	South Carolina	Florida	Georgia	South Carolina
	(%)					
Burning to control ground vegetation	24.8	21.9	19.1	20.5	19.5	16.1
Herbicide application to control ground vegetation	14.5	16.2	16.5	14.7	17.2	16.1
Mechanical removal of excess ground vegetation	10.3	12.2	10.3	10.5	15.4	12.9
Pesticide application to control diseases	10.9	9.8	9.4	12.6	14.5	12.6
Pesticide application to control insect pests	12.1	11.7	11.8	12.1	15.1	13.9
Allow my land to be used for providing pine health risk education for other landowners	6.1	7.0	7.4	5.3	2.2	5.0
Thinning to reduce basal area	20.6	15.4	19.1	15.8	11.8	13.7
Not sure	0.6	3.0	4.7	1.1	0.9	1.3
I would not be willing to use management activities	0.0	0.5	0.9	2.1	2.6	3.4
Other	0.0	1.3	0.9	5.3	0.9	5.0

Respondents could choose more than one answer, so percentages are from total number of times an option was chosen.

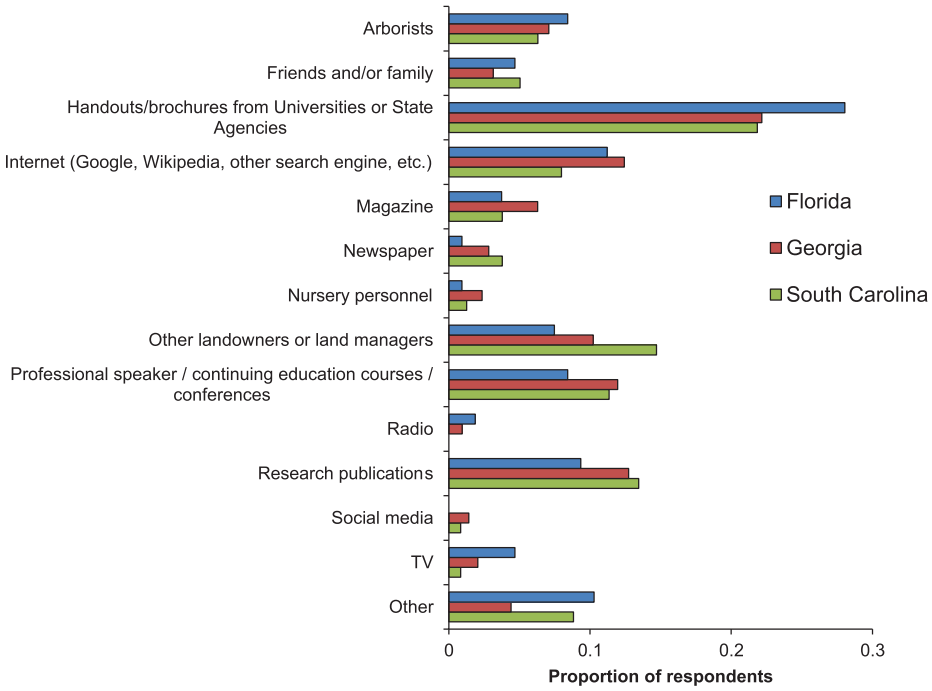

Figure 8. Sources from which people prefer to get information on SPD.

proportion of respondents in South Carolina had not yet received such information (Table 5). Respondents who did receive information used it sparingly (Table 5). These data present an interesting future research direction, namely, why are usage rates for pine health information so low even though southern pine production is a major economic factor in the region? It could be that current methods of information dissemination lack efficiency and that certain demographics would be better reached using specific techniques.

Respondents who had heard of SPD indicated they would also use and accept financial assistance for management activities such as thinning, burning, and weed removal (Table 6). Standard silvicultural activities are known to contribute to reduced pest susceptibility in southern pine forests (e.g., Nowak et al. 2015). Very few respondents were not willing to use management activities, and it would be beneficial for future research to understand why these landowners or managers felt this way.

Most respondents preferred to get forest health information from university or state agencies, research publications, other landowners or managers, or professional speakers (Figure 8). Our results are similar to those of Rossi et al. (2010) who found that printed materials from professional sources were preferred over items presented by newspapers, magazines, radio, and TV. Respondents indicated that they often used the Internet for information and only occasionally used social media. In contrast, few respondents in a survey regarding participation in the SPBPP used Internet resources (Rossi et al. 2010). Forest owners in Tennessee preferred to receive information from either books or relatives and acquaintances, and state and federal entities were least likely to be used as information sources (Steiner Davis et al. 2015). Forest owners in Michigan most often obtained information from written sources (e.g., publications, books, and articles) or field tours, although the Internet was also valued as a useful tool for information dissemination (Kuipers et al. 2013). It is likely, however, that the preferred media may be changing from print to electronic in today's technological environment and as the landowner age inevitably shifts to the younger generation.

Conclusions

Results from this research—based on respondents who owned or managed >3.8 million acres of forestland in three pine-producing states in the southeastern USA—suggest that forests are generally healthy, with low mortality. The issue of SPD appears to have been exaggerated, as research indicates SPD is not a regional issue and is very likely is a combination of abiotic and biotic factors that initially stress trees and increase susceptibility to insects and fungi (Coyle et al. 2015). Still, some landowners believe it is an issue and that southern pine beetle may be present on their land. Thus, increased efforts for education and extension/outreach would be very valuable to provide sound forest health information for SPD and other forest health issues. One

limitation of this study was the somewhat low response rate, which may reflect slightly different respondent pools in each state or different levels of landowner engagement toward forest health and management. Future studies of this nature should use measures or tests to examine nonrespondent bias or follow up by calling nonrespondents on the phone. Respondents obtained information from many different sources, and efforts to refine information dissemination are critical so that forest extension and outreach personnel can more effectively communicate with landowners and managers. Specifically, determining what extension and outreach methods are most effective for different demographics would be very valuable and much needed research. Standard, traditional forest management practices (e.g., thinning, prescribed burning, and competition control) are both recommended and accepted by most respondents, and we believe that proper forest management is integral to reducing stand susceptibility to future pest issues.

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