

Results of a Survey of Minnesota Foresters Regarding Knowledge of and Treatment Practices for Dwarf Mistletoe in Black Spruce Stands in Northern Minnesota

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Executive Summary

Eastern spruce dwarf mistletoe (*Arceuthobium pusillum*) (ESDM) is a native, damaging pest of black spruce (*Picea mariana*) in Minnesota. Dwarf mistletoes are parasitic seed plants. In black spruce, ESDM causes reduction in tree regeneration success, large branch distortions, and high mortality rates of infested overstory trees that lead to the formation of stand mortality centers. Treatments for ESDM involve removal of infested material, which is typically done utilizing a clearcut system to mimic stand-replacing fires. The current management approach on all state-administered lands in Minnesota is to remove all standing live black spruce greater than 5-feet tall when ESDM is present (“5-foot rule”) followed by removal of residual materials (Minnesota DNR, 2019a). This rule has been in place for more than 30 years in black spruce stands in Minnesota, but there has been little work to assess the effectiveness of this management approach or monitoring of implementation success.

This research is part of an interdisciplinary study to increase detection and management options for ESDM. This piece of the research focused on assessing timber sale foresters’ knowledge and perceptions of effectiveness of current ESDM management practices in black spruce. Five research questions were examined: 1) Can foresters identify ESDM? 2) Do foresters understand the need to eradicate ESDM where timber production is the objective? 3) Are the eradication treatments designed by a forester implemented as designed? 4) Are there impediments to implementing management treatments? and 5) Are the treatments effective?

Timber sale administrators who work in three northern Minnesota counties (Itasca, Koochiching, and St. Louis) which collectively produce the majority of the black spruce volume harvested by county land departments received an on-line survey. Results of the survey indicate respondents have on average 11 years of experience setting up black spruce sales. The majority of respondents have been involved with a black spruce timber sale with dwarf mistletoe at some point in their career, while 70% of respondents had timber sale activity in the past year within a black spruce stand containing dwarf mistletoe.

Respondents generally believe they are knowledgeable about dwarf mistletoe, can correctly identify it in the field, and that their timber sale appraisal and stand assessment methods are effective at detecting the presence of DM in black spruce timber stands. However, higher percentages of respondents were very confident in their ability to either correctly identify DM in the field or in their timber sale appraisal methods than were very confident in their stand assessment methods detecting DM. The presence of witches’ brooms is the indicator used by almost all respondents to identify the presence of DM. Overall, while respondents generally feel able to identify DM, open-ended survey responses suggest there are outreach, education and training needs among foresters who prescribe DM treatments particularly related to documenting treatment options and effectiveness.

The majority of respondents are at least somewhat concerned about the ecological health impacts of dwarf mistletoe to black spruce, and believe that dwarf mistletoe has had at least moderate impacts to black spruce timber production in the state. In spite of these concerns, attitudes were also expressed that because it is a native pest in black spruce that has been around a long time and is ubiquitous on the landscape, it is just a part of the forest ecosystem and unlikely to be eradicated.

Most respondents report that they/their organizations prescribe the 5-foot cutting rule be implemented (i.e., black spruce stems which are 5 feet and taller must be severed or run over as a condition of the timber sale). The conventional equipment configuration with a feller-buncher or chainsaw and one or more skidders was reported by 63% of respondents as being more effective at implementing treatments than cut-to-length harvesting equipment. A variety of impediments to implementing dwarf mistletoe management treatments, both for foresters and loggers, were identified in our study, including financial, administrative, informational, policy-related, and ground conditions. A loggers' loss of production due to additional time required to implement treatment(s) and poor black spruce ground conditions due to weather (e.g., winters have been too warm for the ground to freeze) were the top two barriers which respondents perceived most affect loggers' ability to effectively implement treatments. For foresters, insufficient time or financial resources to adequately address treatment/management was the top barrier limiting their ability to effectively eradicate dwarf mistletoe. Inadequate financial resources limit the extent to which post-sale treatments (e.g., felling, shearing residuals) can be applied.

Another identified impediment is conflicting management objectives and perspectives between foresters and ecologists or wildlife biologists regarding the impacts/value of dwarf mistletoe and associated treatment of it. Minnesota's forest management guidelines within a clearcut area recommend retaining residual live (leave) trees and snags (dead trees) to provide for wildlife requiring perches, tree cavities and bark-foraging sites (Minnesota Forest Resources Council, 2013). Given that black spruce is commonly clearcut, retaining leave trees for wildlife purposes is counter to the 5-foot rule and may result in residual pockets of ESDM-infected trees.

Foresters expressed some uncertainty about the effectiveness of individual dwarf mistletoe treatments, as well as the overall statewide effort to control it. While most respondents feel that the 5-ft rule (using either severing or trampling treatments) is at least somewhat effective, there is a fair amount of uncertainty surrounding treatment effectiveness. One likely reason for this uncertainty is because post-harvest checks are conducted to evaluate whether the stand has regenerated, not to gauge the effectiveness of the DM treatments. Once regeneration in a harvested black spruce stand has been confirmed, the stand is unlikely to be visited for decades. Given the long rotation period of black spruce, a forester or logger may only visit the same black spruce stand once in their career. Thus, foresters typically don't know whether dwarf mistletoe was effectively eradicated post-harvest.

This study has highlighted information gaps that could be addressed through education, research and monitoring on dwarf mistletoe in black spruce to better understand the economic and ecological importance of the disease as well as our understanding of the effectiveness of dwarf mistletoe treatments. To confirm whether foresters' assessed level of identification skills are accurate, field-based training might focus on an identification component to ensure that foresters and loggers are correctly identifying dwarf mistletoe across different stages of infection and that individuals performing stand assessments in black spruce stands are looking for and recording the presence of it.

Introduction

Lodgepole pine dwarf mistletoe in jack pine

Jack pine (*Pinus banksiana*) fills an important ecological niche in the Great Lakes Region, dominating on nutrient-poor sandy soils with frequent fire disturbances. It is an intolerant, relatively short-lived tree species with a commercial rotation age generally between 40 to 70 years when mature trees are 8 to 12 inches in diameter at breast height (Benzie, 1977). Logging practices in the late 19th and early 20th century and changes in fire regimes resulted in shifting forest composition and significant reductions in the coverage of jack pine as compared to its pre-European coverage (Radeloff et al., 1999). Jack pine is predicted to fare moderately well under climate change due to its ability to tolerate and even thrive on droughty, sandy soil (Prasad et al., 2014). In Minnesota, there are approximately 216,600 acres of the jack pine cover type (Hillard et al. 2020). In 2018, approximately 64,350 cords of jack pine were harvested, representing around nine percent of the softwood used in sawmill and specialty mills.

The lodgepole pine dwarf mistletoe (LPDM) (*Arceuthobium americanum*) occurs on lodgepole pine in the western United States and Canada and has spread eastward from Alberta on jack pine. It has spread through Saskatchewan and Manitoba, and as far east as northern Ontario. The lodgepole pine dwarf mistletoe (also known as the American dwarf mistletoe) is one of the significant invasive species identified by the Minnesota Invasive Terrestrial Plants and Pests Center (Venette, 2020) that pose a threat to Minnesota's ecosystems. A current threat to the jack pine system in Minnesota is the potential expansion of LPDM from the Canadian Province of Manitoba.

Dwarf mistletoes are parasitic seed plants that depend on their host for support, water, and nutrients. Female LPDM plants develop one-seeded berries which are forcibly discharged from the infected plant at a speed up to 60 miles/hour (Hinds and Hawksworth, 1965; Fertig, 2020). A sticky coating allows the discharged seeds to adhere to surfaces on which they land long enough for the seed to germinate and send its root-like stems into a new host. Seeds are usually dispersed a few feet, but can be discharged as far as 55 feet (Hawksworth and Dooling, 1984). This forcible discharge allows LPDM to spread throughout the stand and to adjoining stands.

In lodgepole pine, dwarf mistletoe is considered a minor pest, reducing commercial value but rarely causing mortality. However, in the jack pine forest type, this parasite causes rapid tree mortality and reduces timber growth and yields (70% volume reduction in infected stands) (Baker et al. 1992). If LPDM is present in regenerating jack pine stands, they will not reach maturity. In addition, LPDM frequently establishes outlying infestations at distances up to 100 miles from the nearest infestation. This capacity for long-distance establishment is believed attributed to multiple neo-tropical bird species migrating during peak mistletoe seed dispersal, whose migration paths pass through Minnesota (Punter and Gilbert, 1989). LPDM has been detected in Manitoba approximately 100 miles from the Minnesota border. This invasive dwarf mistletoe poses a serious threat of becoming established in Minnesota's jack pine forest type.

Eastern spruce dwarf mistletoe in black spruce

Early detection and eradication techniques need to be refined for LPDM within jack pine in Minnesota to limit potential establishment and reduce loss in this already threatened forest cover type. Since LPDM is currently not present in Minnesota, we focus on Eastern spruce dwarf mistletoe (*Arceuthobium pusillum*) (ESDM) which is the only dwarf mistletoe native to

Minnesota. The ESDM is a damaging pest of black spruce (*Picea mariana*) statewide and can serve as a model system to learn about treatment approaches. Many similarities exist between *A. americanum* in jack pine and *A. pusillum* in black spruce, including reduction in tree regeneration success, high mortality rates of infested overstory trees which create mortality centers, rapid spread, and high reproductive potential (Baker and Knowles, 2004). Black spruce is an important conifer species, both ecologically and economically, in Minnesota and in the northern boreal forests (Burns and Honkala, 1990). In Minnesota, black spruce comprises 1.6 million acres of the 17.4 million forested acres (Miles et al., 2017). It has been estimated that between 35%-59% of black spruce stands in Minnesota may be infected with ESDM (Hanks et al. 2011; Baker et al., 2012).

ESDM produces large branch distortions (witches' brooms) in its host and quickly kills black spruce trees (< 15 years) by diverting nutrients and water (Baker et al., 2006), leading to the formation of a mortality center in stands. Mortality centers result in a significant loss of stand productivity and associated economic value (Baker and French, 1981; Baker et al., 1982). Treatments for ESDM involve removal of infested material, which is typically done utilizing a clearcut system to mimic stand-replacing fires. The current management approach on all state-administered lands in Minnesota is to remove all standing live black spruce greater than 5-feet tall when ESDM is present ("5-foot rule") followed by removal of residual materials (Minnesota DNR, 2019a). This rule has been in place for more than 30 years in black spruce stands in Minnesota, but there has been little work to assess the effectiveness of this management approach to control ESDM; monitor implementation success (i.e., how often and well this treatment is applied); identify information needs, concerns and impediments that may constrain the ability of the logging community and natural resource managers to effectively apply the recommended treatment strategies; and forester perceptions and attitudes about alternative management options.

Many approaches have been attempted to manage dwarf mistletoes, including prescribed burning (Zimmerman et al., 1990), chemical treatments (Livingston et al., 1985, Shamoun et al., 2002), biological control agents (Shamoun et al., 2003), mechanical pruning (Maffei et al., 2016), and silvicultural treatments such as clear-cutting, thinning or sanitation cuts (Conklin, 2000; Muir and Geils, 2002). However, we are unaware of any research that has queried those who prescribe treatments (i.e., foresters and timber sale administrators) and those tasked with carrying them out (loggers) about their perspectives of effectiveness and challenges with implementing treatments. It is here where our research makes a contribution.

This research is part of a larger, interdisciplinary study to increase detection and management options for ESDM which can help inform LPDM detection and treatment efforts as well. This piece of the research focused on assessing timber sale foresters' knowledge and perceptions of effectiveness of current ESDM management practices in black spruce. We examined five research questions: 1) Can foresters identify ESDM? 2) Do foresters understand the need to eradicate ESDM where timber production is the objective? 3) Are the eradication treatments designed by a forester implemented as designed? 4) Are there impediments to implementing management treatments? and 5) Are the treatments effective? Examining these research questions will provide an overview of detection and management of ESDM efforts in the state which will inform detection and management for LPDM.

Methods

Within Minnesota, the majority of black spruce is found in the northern part of the state. Our study area focused on three northern Minnesota counties: Itasca, Koochiching, and St. Louis (Figure 1). Those three counties produced 94% of the black spruce volume harvested by county land departments between 2016 – 2018 (Minnesota DNR 2017, 2018, 2019b). We focused on timber sale foresters who work and operate within these three counties. Foresters set up and administer timber sales, prescribing approaches to eradicate the spread of dwarf mistletoe for loggers to implement. Their knowledge and field experience regarding ESDM are important to understand.

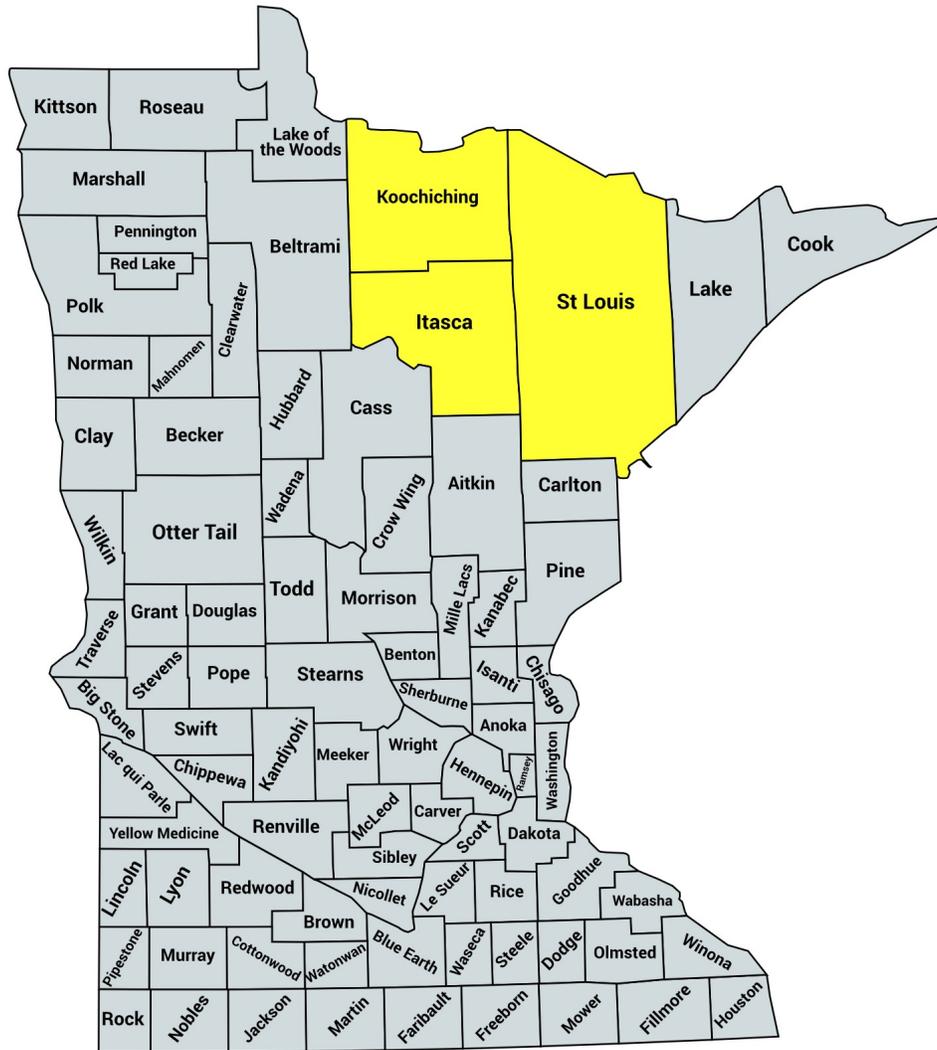


Figure 1. Map of Minnesota with the three study counties highlighted. Created using mapchart.net ©.

An online survey was administered using the platform Qualtrics©, 2019 version. Names, titles, and email addresses of foresters who work in the study area were compiled from current organizational staff directories, Minnesota Government White Pages

(http://mn.gov/white_pages/Lookup), and personal contacts. The list included federal, state, and county level foresters, as well as tribal and those working for private timber industry. In total, 194 forester names and email addresses were represented in the sample (Table 1).

Table 1 Distribution of Foresters by Employer who were Sent and Returned the Survey (n=194)

Employer	Number Sent (%)	Number Returned (%)
Minnesota Department of Natural Resources (DNR)	116 (60%)	61 (56%)
County agencies	44 (23%)	33 (31%)
US Forest Service	25 (13%)	7 (6%)
Industry	5 (3%)	4 (4%)
Tribal	4 (2%)	3 (3%)
Total	194	108

To inform survey design, 10 one-on-one interviews were conducted between October – December 2018 with logging business owners who bought black spruce timber sales in the study area in the past three years. The survey of foresters was developed based upon insights from these interviews, as well as feedback from other study members and Minnesota DNR personnel with expertise in silvicultural treatments for ESDM. Given that ESDM is the only dwarf mistletoe native to Minnesota and the only one which is impacting black spruce, the online survey used the general language of dwarf mistletoe (DM) rather than a specific species name. The questionnaire included 48 questions on the following topics: 1) Familiarity with and ability of respondents to identify DM, 2) Familiarity and experiences with undertaking the recommended DM treatment prescription (e.g., ‘5-foot rule’), 3) Perspectives on the effectiveness of the DM prescription, 4) Impediments that constrain respondent ability to implement management recommendations, 5) Impacts associated with undertaking DM treatment strategies, 6) Information, training and assistance needs relative to DM, and 7) Respondent demographics. See Appendix 3 for a copy of the survey questions. Prior to implementing the survey, the University of Minnesota’s Institutional Review Board reviewed the study protocol and determined it was exempt from further review.

An adapted Dillman’s method (Dillman et al., 2014) was used to increase response rate. Each forester received an email (Appendix 1) message with a personalized link to the survey. Two email reminders each about three weeks apart followed the initial invitation, which also included the survey link, in order to increase responses (Appendix 2). The personalized link ensured only the intended recipients of the survey had access in order to control the sampling frame. The survey was administered between April and June of 2019. Nine emails were undeliverable. After the three survey waves, 108 responses were recorded, for a 58% usable response rate.

Survey responses were automatically coded within a Qualtrics database. Descriptive statistics were completed using the Statistical Package for Social Sciences© (IBM SPSS 25.0, 2016) to determine frequency distribution of individual variables. Many respondents provided responses to open-ended questions which are selectively included in this report to amplify survey results.

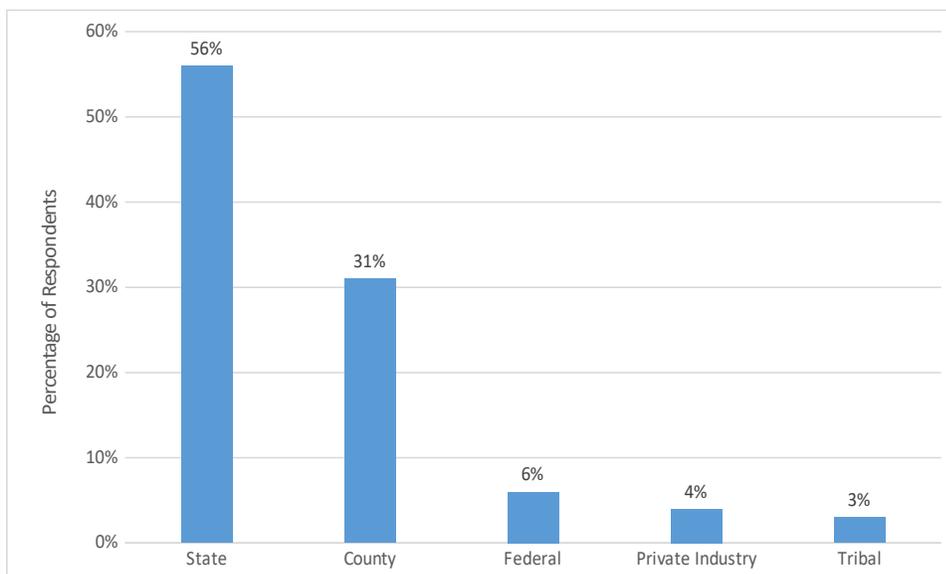
Results

Comparing the rates of returned surveys by organization to the percent sent to foresters in each organization illustrates that county agency foresters were over-represented in the responses, while federal foresters (US Forest Service) were under-represented (Table 1). A non-response bias check was conducted by comparing early survey responders (first 25%) to late survey responders (last 25%) as a proxy to detect differences between respondents and non-respondents based on the assumption that non-responders are similar to late responders (Armstrong and Overton, 1977). Specifically, the responses to questions examined between early and late respondents included: level of DM knowledge, confidence in ability to identify DM, confidence in ability of appraisal methods to detect DM in a stand, confidence in stand assessment method to detect DM in a stand, degree of concern about DM in their work area, degree of concern about DM impacts to ecological health of black spruce, degree of concern about DM impacts to black spruce timber production, number of years working in the forestry field, number of years setting up black spruce sales, and the percent of their timber sales in the past year with DM. Two statistically significant differences were found. Early responders ($M = 10.7$, $SD = 9.9$) had fewer years working in the forestry field than late responders ($M = 17.5$, $SD = 10.8$), $t(50) = 2.36$, $p = .022$. Early responders ($M = 5.2$, $SD = 3.9$) also had fewer years of experience setting up black spruce timber sales than late responders ($M = 11.9$, $SD = 11.5$), $t(31) = 2.81$, $p = .009$. The results should be viewed with these differences in mind.

Forester's Organization and Duties (Corresponds to questions Q11-Q24.)

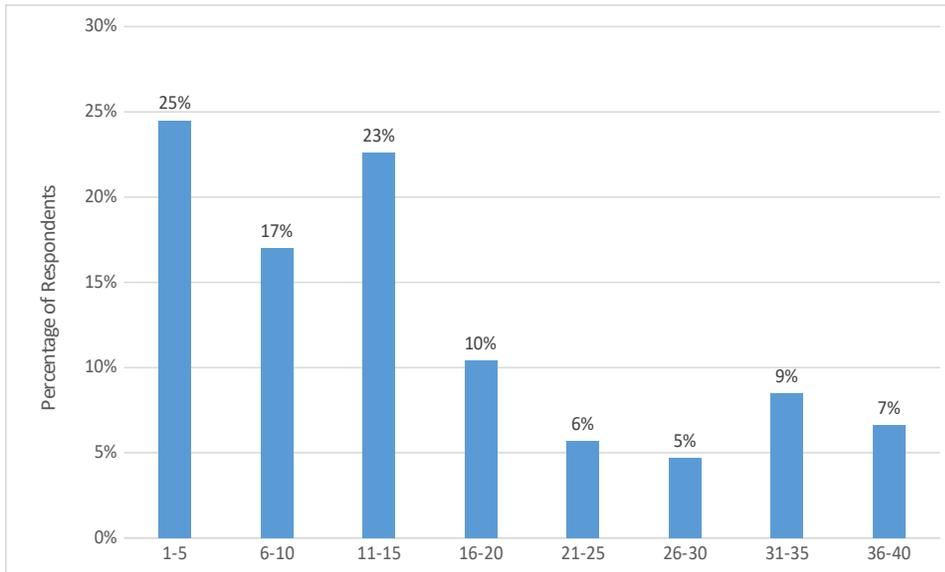
Fifty-six percent of respondents work for the Minnesota DNR; 31 percent for a county land department in Itasca, Koochiching, and St. Louis counties; with the remainder being employees of the USDA Forest Service (6%), private industry (4%), and tribal forestry departments (3%) (Figure 1).

Figure 1: Respondent Employer (N=108) (Q11).



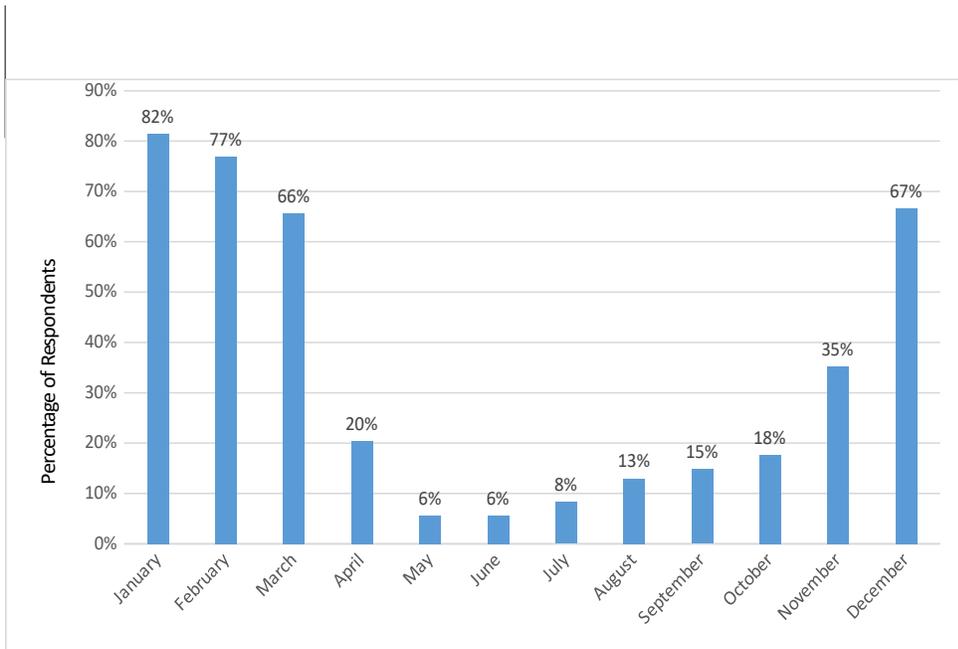
The average respondent has worked as a forester or in the forestry field for 15 years ($SD = 11$). When viewed categorically, one-quarter of the respondents had less than five years of experience, while on the other end of the experience spectrum, 21% have more than 25 years of experience (Figure 2). The majority of respondents (65%) had 15 or fewer years of experience.

Figure 2: Years Working in the Forestry Field (N=106) (Q12).



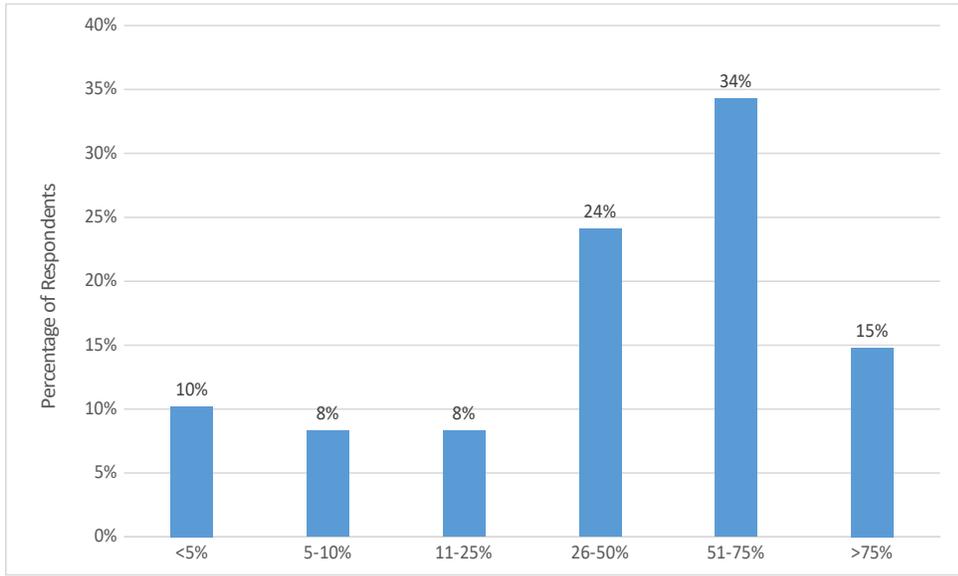
Respondents were asked to select the month(s) in which they are most likely to inventory/appraise a black spruce stand. The winter months were most frequently named (Figure 3). More than 75% of respondents indicated appraisals occur in January and February, followed by December and March, which were selected by at least 67% and 66% of respondents respectively. Inventories occurred least often in May and June.

Figure 3: Months of the Year in Which Inventory/Appraisal of a Black Spruce Stand are Most Often Conducted (N=80) (Percentages add to more than 100 because respondents could choose more than one month) (Q13).



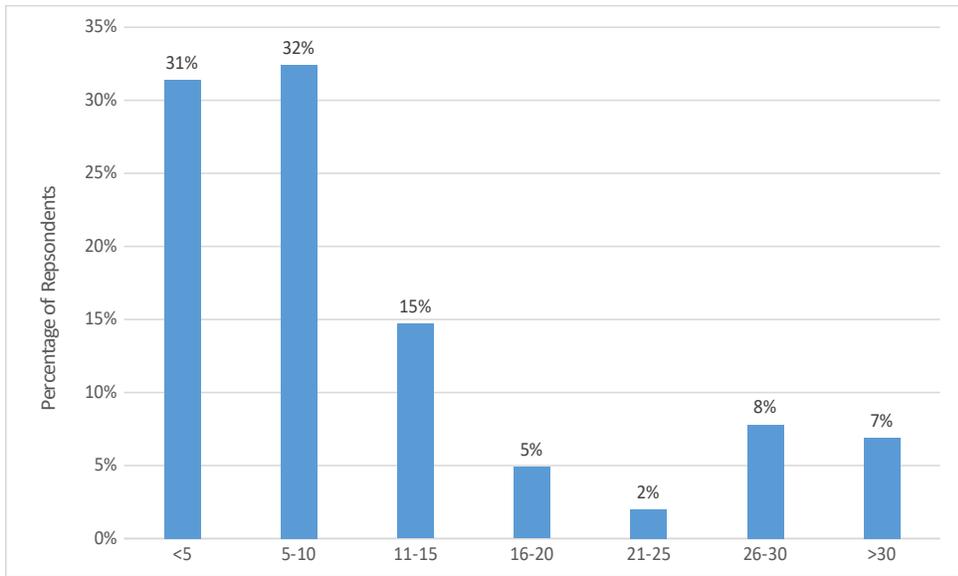
Considering all of their current job duties, respondents spent, on average, nearly half of their time (47%, $SD = 28$) focused on timber sales. When viewed categorically, 15% spent more than 75% of their time focused on timber sales, while 34% spent between 51% and 75% of their time in this activity (Figure 4).

Figure 4: Percent of Time Spent on Timber Sales Last Year out of All Job Duties (N=108) (Q14).



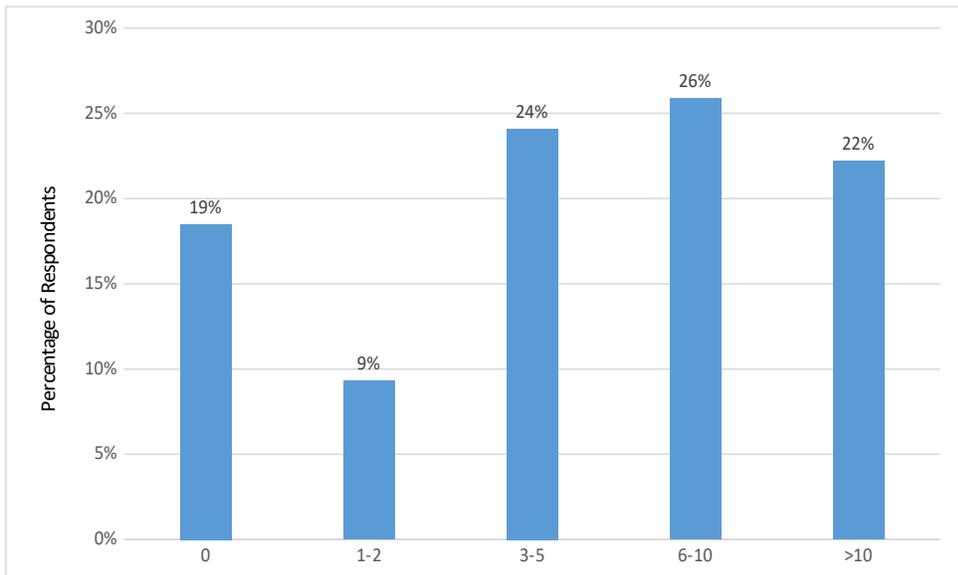
The average respondent had 11 years of experience ($SD = 10$) setting up, designing, or administering black spruce timber sales. When viewed categorically, nearly one third of respondents (31%) had fewer than five years of experience with black spruce timber sales while 17% had more than 20 years of experience (Figure 5). The majority of respondents (63%) had 10 or fewer years of experience setting up black spruce timber sales.

Figure 5: Years Setting-Up, Designing, and Administering Black Spruce Timber Sales (N=102) (Q15).



On average, respondents had set up eight total timber sales during the past year ($SD = 7$). Approximately half of the respondents (48%) had set up six or more timber sales in total during the past year, while 19% had not set up any timber sales during that time (Figure 6).

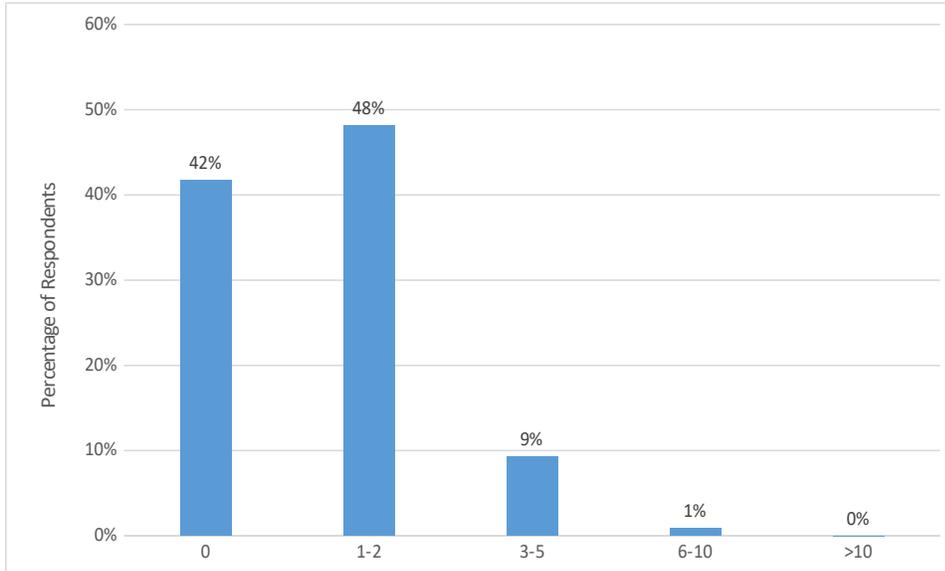
Figure 6: Total Number of Timber Sales Set Up During Past Year (N=97) (Q16).



Respondents were asked to indicate how many of the timber sales they set up or designed during the past year were (predominantly) black spruce. The average number of sales was 1.26 ($SD = 1.6$). Fifty-eight percent of respondents had set up at least one black spruce timber sale during the

past year (Figure 7). None of the respondents had set up more than 10 black spruce timber sales during the past year.

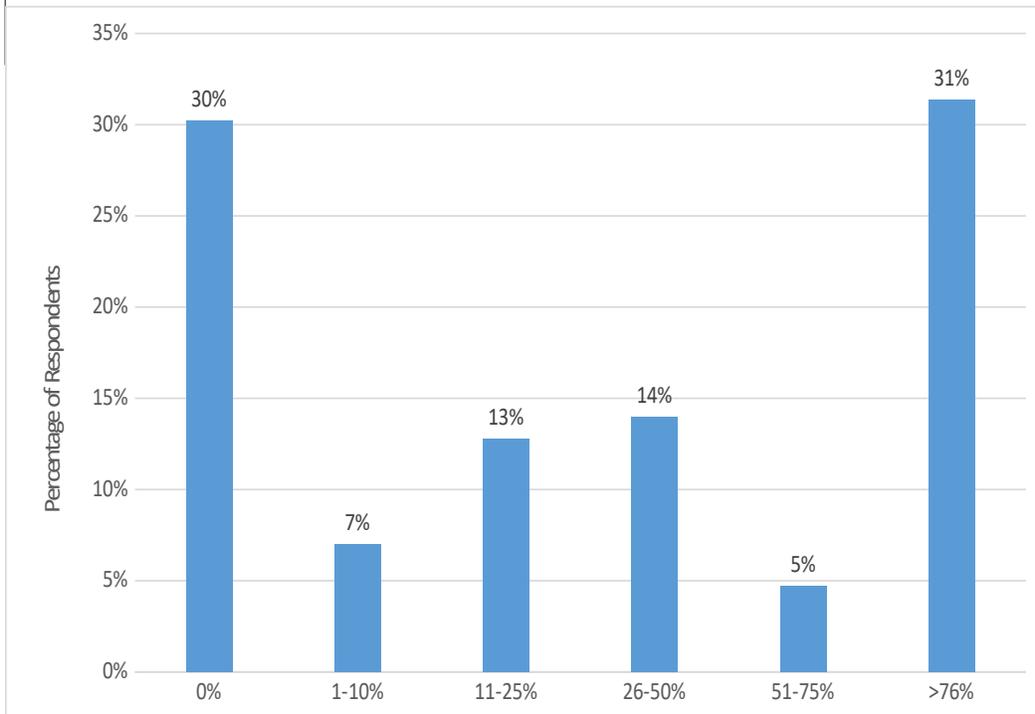
Figure 7: Number of Timber Sales Set Up During the Past Year that were Predominantly Black Spruce (N=97) (Q16).



Among respondents, 87% had set up, designed, or administered at least one black spruce sale containing DM at some point in their career (Q18).¹ On average, respondents indicated that 43% ($SD = 42$) of the black spruce timber sales they set up, designed, or administered during the past year contained DM. When examined categorically, 30% of respondents indicated none of their black spruce timber sales during the past year contained DM, while 31% indicated more than three-quarters of their black spruce sales had DM (Figure 8).

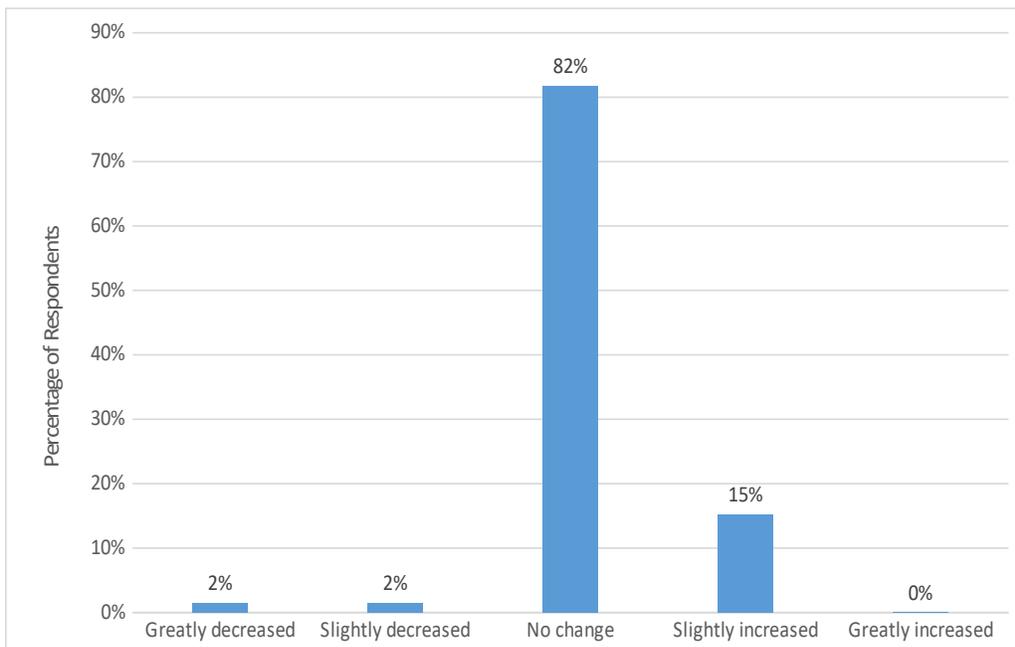
Figure 8: Percent of Black Spruce Timber Sales Set Up, Designed, or Administered During the Past Year that Contained Dwarf Mistletoe (N=86) (Q19).

¹ The 13% respondents who indicated that they had never set up, designed or administered a black spruce sale containing dwarf mistletoe skipped questions 19-24. However, their responses were not excluded from the analysis of other questions as a) some of those respondents had experience with black spruce timber sales (Q15), b) their responses about the most important/ most used indicator to identify dwarf mistletoe (Q6) were similar to those of other respondents, c) many questions were framed as “you/your organization” so a person could still respond for their organization (e.g., 26, 29, 31-33), and d) the authors assumed that those individuals had been exposed to information about black spruce management and dwarf mistletoe through their undergraduate education, organizational trainings and/or organizational policies.



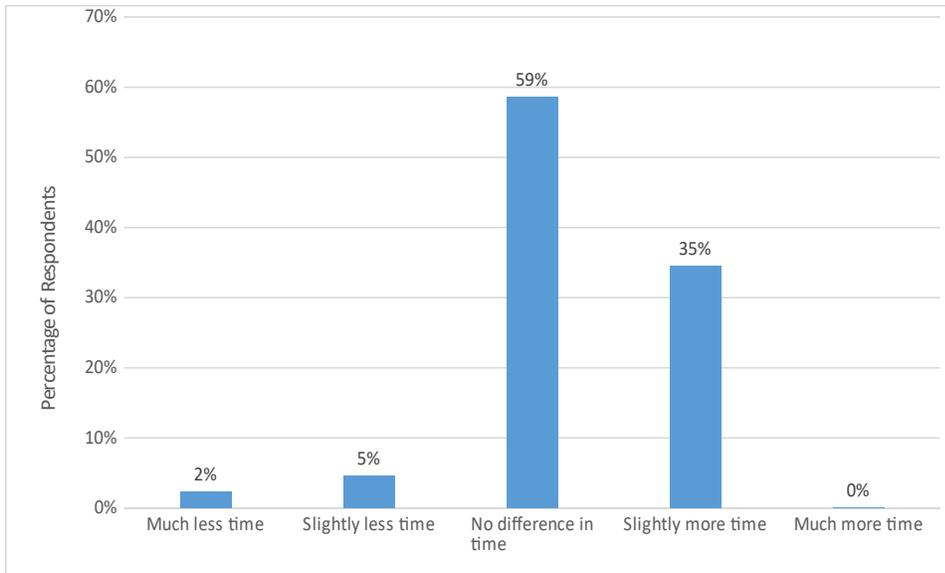
Respondents were also asked how the percent of black spruce timber sales containing DM they have set up, designed, or administered in their work area has changed in the past three years. The majority of foresters (82%) indicated no change, while 15% reported a slight increase (Figure 9).

Figure 9: Perceptions of 3-Year Change in Black Spruce Timber Sales Containing Dwarf Mistletoe Set Up, Designed, or Administered (N=66) (Q20).



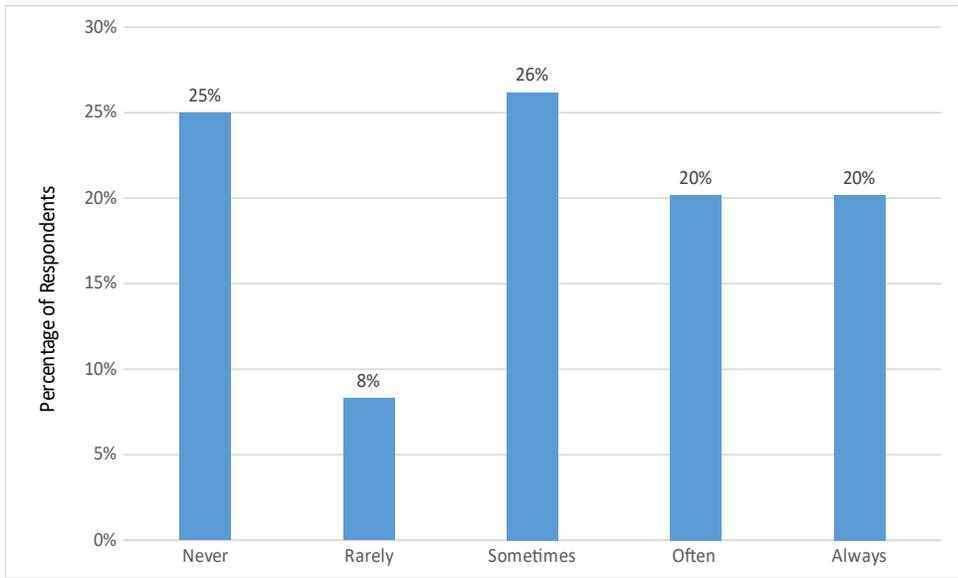
Several questions were asked to gauge the impact that the presence of DM has on designing, setting up and administering timber sales. More than half of the respondents (59%) indicated that there is no difference in the time required to set-up, design and administer a timber sale (including stand appraisal) with DM as compared to one without, while about one-third (35%) indicated it takes slightly more time (Figure 10).

Figure 10: Amount of Time to Set Up, Design, and Administer a Timber Sale with Dwarf Mistletoe Compared to One Without (N=87) (Q21).



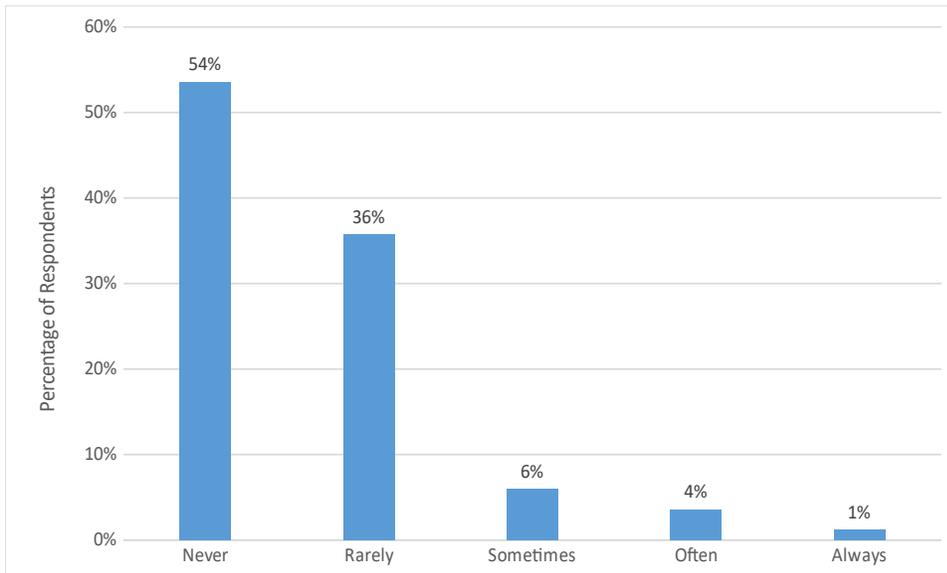
When asked how often they discussed DM and/or the treatment prescriptions with a logger/buyer during a pre-sale meeting on timber sales containing DM over the past year, 40% of respondents indicated they either often or always have that discussion (Figure 11). One-quarter, however, responded that they never discuss DM.

Figure 11: Frequency with Which Foresters Discussed Dwarf Mistletoe and/or the Treatment Prescriptions During a Pre-Sale Meeting on Their Timber Sales Containing Dwarf Mistletoe (N=84) (Q22).



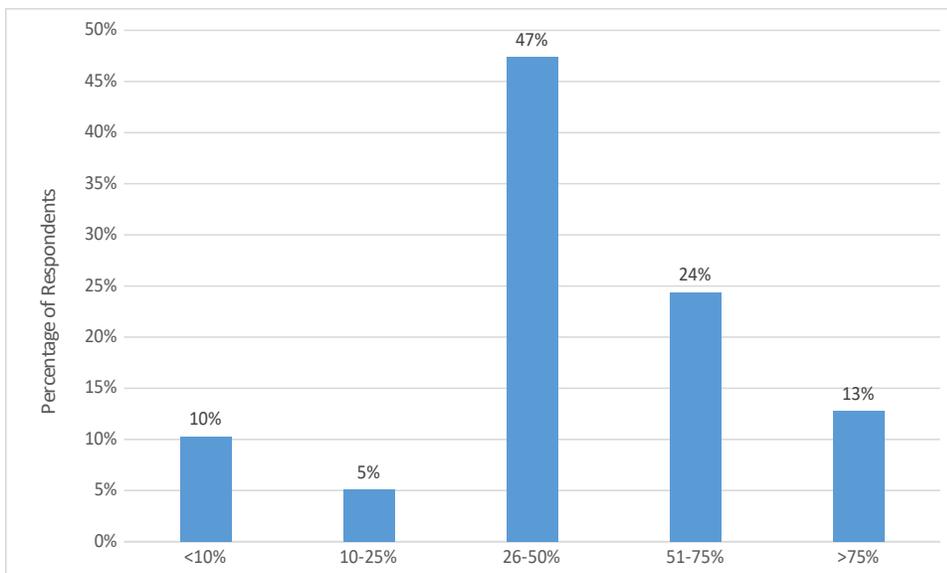
To get a sense of whether DM is being missed when a timber sale prospectus (a document made available to prospective bidders which summarizes key information about a timber tract being offered for sale) is prepared, respondents were asked to estimate, over the past year, how often a logger/buyer reports finding DM in a stand when it was not noted in the prospectus. Respondents generally reported this to be an infrequent event. Specifically, over half of the respondents (54%) indicated this never happened, while 36% indicated it rarely happened (Figure 12).

Figure 12: Frequency that Loggers or Buyers Reported Finding Dwarf Mistletoe in a Stand When it was Not Reported in a Timber Sale Prospectus Over the Past Year (N=84) (Q23).



On average, respondents indicated that the level of DM infection that a stand must reach before a tract won't sell at an auction is 50 percent (SD = 27). When viewed categorically, ten percent of respondents indicated infestations of less than 10% was enough to impact the sale of an infected black spruce stand, while 13% reported a stand needed to be more than 75% infected before a timber sale wouldn't be purchased. (Figure 13).

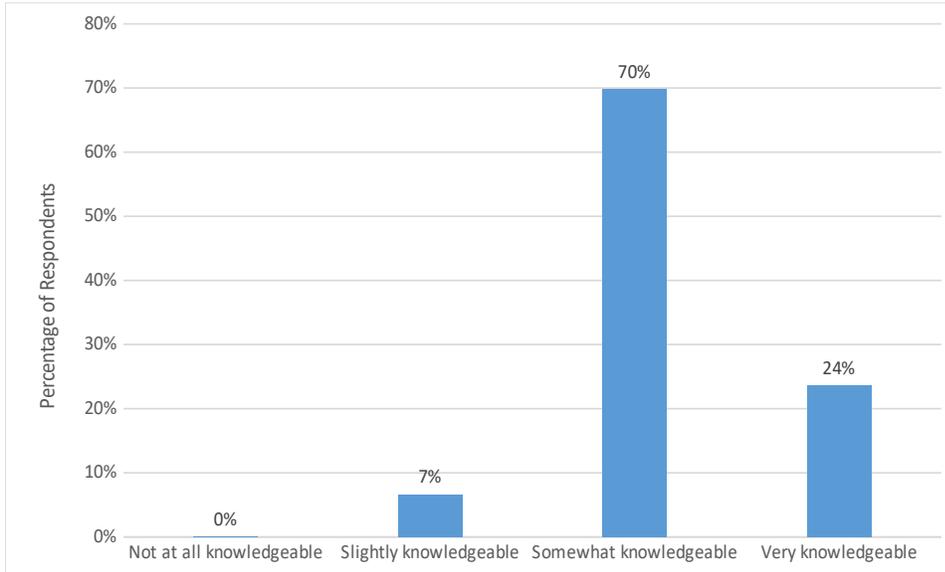
Figure 13: Average Percentage/Level of Dwarf Mistletoe Infection in a Black Spruce Stand at Which it Will Not Sell at an Auction/Sale (N=78) (Q24).



Perspectives on Dwarf Mistletoe (Corresponds to questions Q2-Q9)

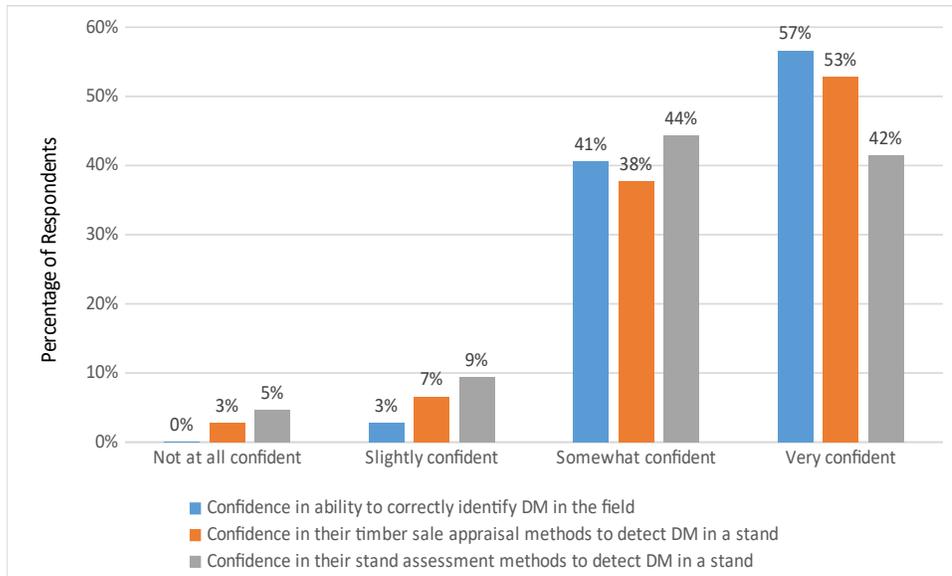
In general, foresters rated themselves as fairly knowledgeable about DM in Minnesota. Specifically, when asked about their level of knowledge about DM, 94% rated themselves as either somewhat or very knowledgeable (Figure 14). None of the respondents indicated they were not at all knowledgeable about DM.

Figure 14: Level of Knowledge about Dwarf Mistletoe in Minnesota (N=106) (Q2).



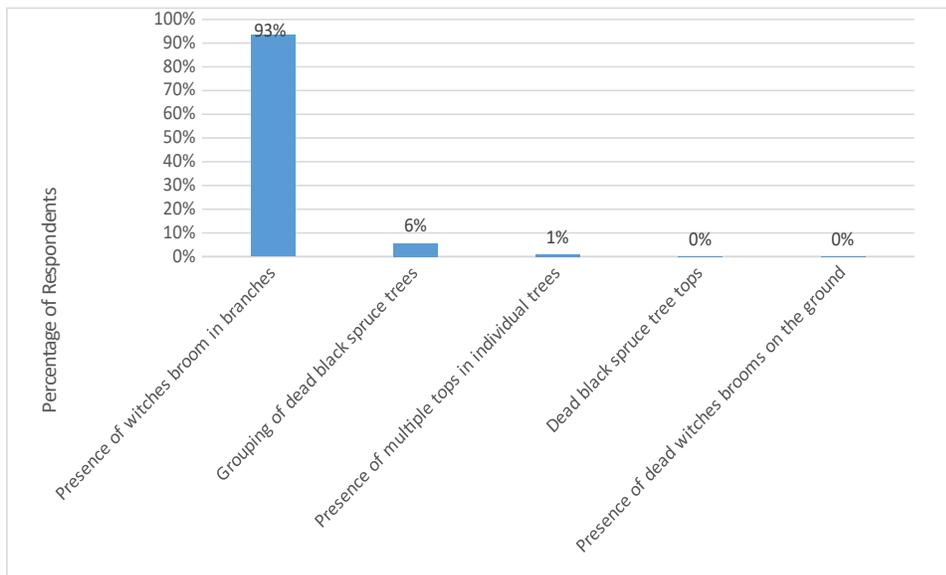
Foresters also reported being fairly confident in their ability to identify DM in the field. Specifically, over half of the respondents (57%) indicated they were very confident in their DM identification skills, while an additional 41% were somewhat confident. None of the respondents indicated they were not at all confident in their ability to identify DM in the field (Figure 15). When asked about how confident they were in their timber sale appraisal methods being able to detect DM in a stand, over half (53%) indicated they were very confident while 38% indicated they were somewhat confident (Figure 15). Respondents' degree of confidence in their stand assessment methods (inventorying for forest planning purposes) detecting DM in a stand was slightly lower than their confidence in the ability of their timber sale appraisal methods finding DM, but still relatively high. Specifically, 42% were very confident and 44% percent were somewhat confident in their stand assessment methods, while 5% were not at all confident (Figure 15).

Figure 15: Degree of Forester Confidence in Their Ability to Correctly Identify Dwarf Mistletoe in the Field (N=106), in Their Timber Sale Appraisal Methods to Detect Dwarf Mistletoe in a Stand (N=106), and in the Ability of Stand Assessment Methods to Detect Dwarf Mistletoe in a Stand (N=106). (Q3, Q4, Q5).



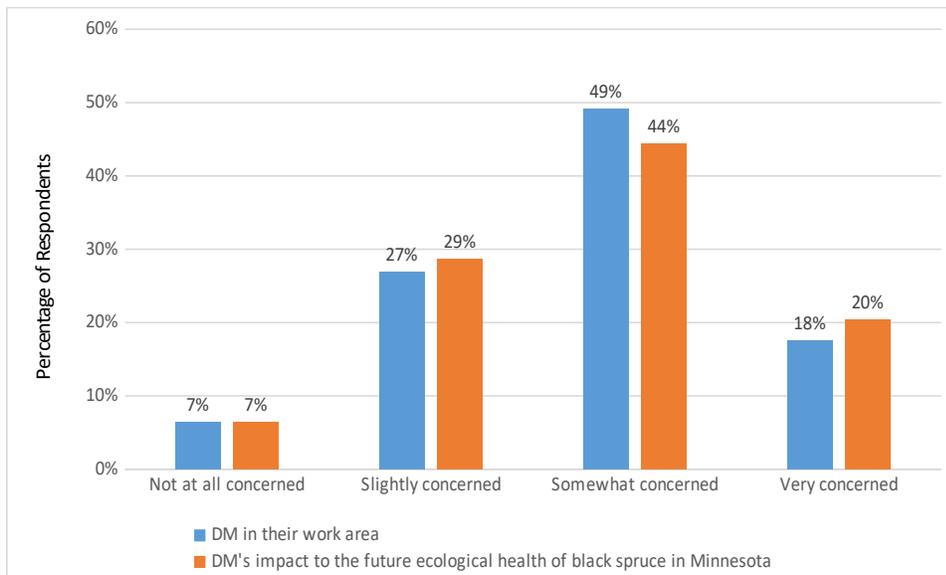
Respondents were provided a list of five factors, and asked which one they primarily use or think is the most important one to identify DM. Respondents overwhelmingly (93%) report relying on the presence of witches' brooms in branches (i.e., dense mass of branches from a single point) to aid in identification of DM (Figure 16).

Figure 16: Most Important/ Most Used Indicator to Identify Dwarf Mistletoe (N=106) (Q6).



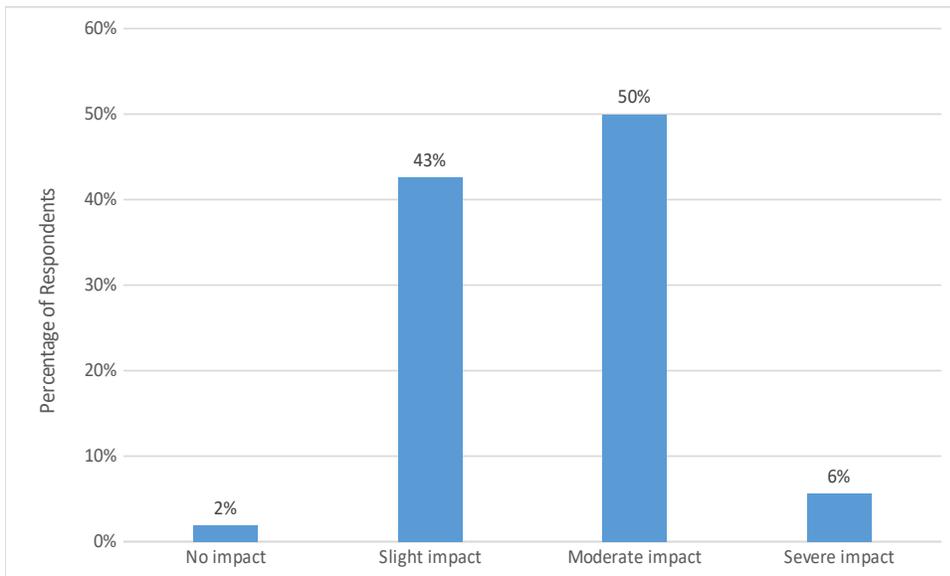
When asked how concerned they are about DM in their work area, the most common response, offered by almost half of respondents (49%), was that they were somewhat concerned (Figure 17). Approximately two-thirds (67%) of respondents are either somewhat or very concerned about DM in their work area. Respondents answered similarly when asked about how concerned they are about DM's impact on the future ecological health of black spruce in Minnesota. Specifically, the most common response, offered by 44% of respondent foresters, was that they were somewhat concerned about DM's impact on the future ecological health of black spruce in Minnesota. Nearly two-thirds (64%) of foresters are either somewhat or very concerned about DM's impact on the future ecological health of black spruce in Minnesota (Figure 17).

Figure 17: Degree of Forester Concern about Dwarf Mistletoe in Their Work Area (N=108) and Impacts to Future Ecological Health of Black Spruce in Minnesota (N=108) (Q7, Q8).



When asked about their perceptions of the degree of impact DM is having on black spruce timber production in Minnesota, half of respondents felt the impact was moderate while 43% viewed it as slight (Figure 18).

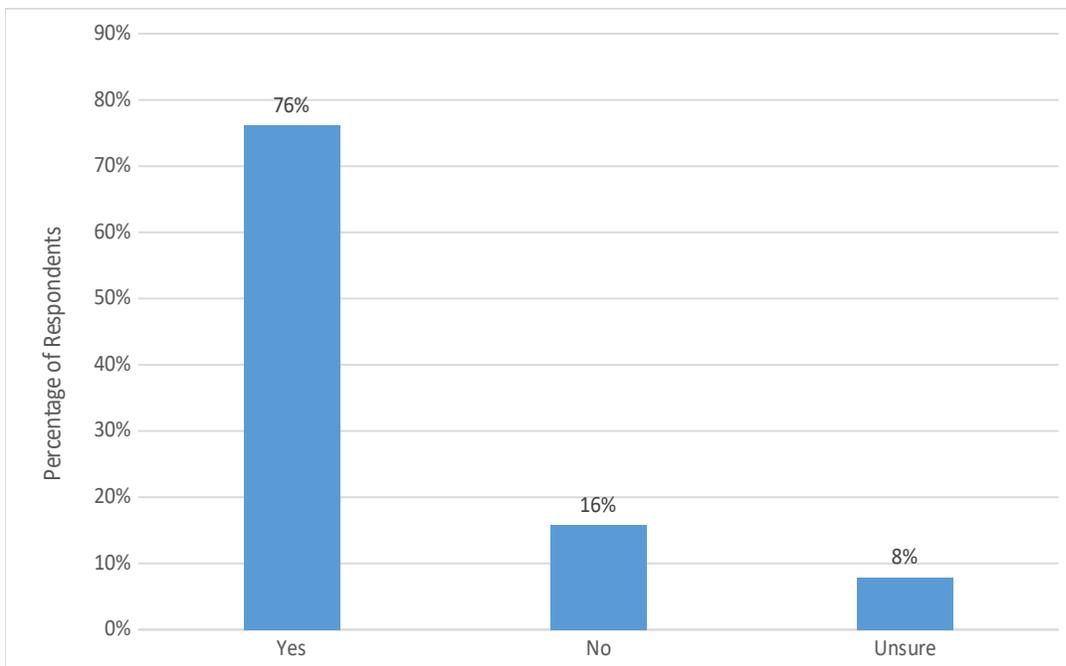
Figure 18: Perceived Impacts to Black Spruce Timber Production in Minnesota from Dwarf Mistletoe (N=108) (Q9).



Dwarf Mistletoe Treatment Perspectives (Corresponds to questions Q25-Q42)

The majority of respondents (76%) indicated that they/their organization has a guiding management document or written policies regarding DM management in black spruce timber sales (Figure 19).

Figure 19: Organization has a Guiding Management Document/ Written Policies Regarding Dwarf Mistletoe Management in Black Spruce Sales (n=101) (Q25).



Respondents were provided a list of nine DM treatments plus “Other” and asked to select all that they or their organization currently use or require in the timber sale prospectus to eradicate DM. Respondents could select multiple treatments. Four different versions of implementing the 5-foot cutting rule were the most commonly cited treatments used to eradicate DM (Table 2). The two most frequently selected approaches were to sever all black spruce stems over 5-feet tall regardless of whether DM is present (40%) or only sever all black spruce stems over 5-feet tall in stands containing DM (37%). Tramping or running over all non-merchantable black spruce stems over 5-feet tall in all black spruce stands or only those containing DM are also prescribed, but not as frequently as the severing activities. The only other treatment prescribed by at least 10% of respondents was establishing a harvested buffer between infected and non-infected stands. Of those who indicated that they prescribe the establishment of a harvested buffer strip between infected and non-infected stands, the average buffer width prescribed was 114 feet ($SD = 40$, $n=12$). When queried about the width of the reserve buffer strip around a DM-infected pocket, one of the two respondents who selected this treatment option indicated their prescribed buffer width was 132 feet (i.e., two chains).

Table 2: Treatments Currently Used or Required in a Timber Sale Prospectus to Eradicate Dwarf Mistletoe (Percentage of Respondents) (N=98). (Note, Numbers don’t round to 100 because respondents could select multiple treatments.) (Q26).

Treatment	Percentage of Respondents
In all black spruce stands, regardless of DM presence, sever all stems over 5-foot-tall	41
Only in black spruce stands containing DM, sever all stems over 5-foot-tall	37
Only in black spruce stands containing DM, tramp or run over all non-merchantable stems over 5-foot-tall	28
In all black spruce stands, regardless of DM presence, tramp or run over all non-merchantable stems over 5-foot-tall	22
Establish a harvested buffer strip between infected and non-infected stands	13
Clump black spruce leave tree reserves in groups located towards edge of harvest area in stands with DM presence	7
No management/no treatments used for DM	3
Reserve a buffer strip of non-infected black spruce trees around a DM-infected pocket	2
Leave DM-infected trees for reserve trees for silvicultural reasons	1
Other ²	9

² Other treatments included: Leave no reserves in black spruce stands, Leave no reserves in DM-infected black spruce stands, Disagreement over whether to leave reserves in DM-infected black spruce stands, If DM is present, cut or run over all DM-infected stems, When determining the sale boundaries, attempt to harvest or remove all DM-infected stands.

Respondents were also asked to rate how effective they think each treatment that they/their organization uses (and selected in Table 2) is at eradicating DM. At least half of the respondents indicated that the four most commonly cited treatments associated with the 5-foot rule and establishing a harvested buffer strip between infected and non-infected stands were reported to be somewhat to very effective at eradicating DM (Table 3). Severing all black spruce stems over 5-feet tall, with or without DM present, were the only treatments in which at least 20% of the respondents reported that it was very effective. Higher percentages of respondents rated the severing treatments as being very effective than rated the corresponding tramping treatments as being very effective. For example, 22% rated severing all stems over 5 feet tall only in stands containing DM as very effective, while only 4% rated tramping only in DM infected stands as very effective. However, there was also a fair amount of uncertainty expressed about treatment effectiveness. The percentages of respondents uncertain about effectiveness of different treatments ranged from 15% for harvested buffer strips between infected and non-infected stands to 30% for severing all stems over 5-feet tall regardless of DM presence in a black spruce stand. At least 30% of respondents rated some of the treatments as not at all effective: undertaking no management/treatment of DM (33%), clumping black spruce leave trees in stands with DM presence (43%), and leaving DM infected trees as reserve trees for silvicultural reasons (100%). Each of those treatments had a low number of responding foresters, however.

Table 3: Perceived Degree of Effectiveness of Dwarf Mistletoe Treatment Strategies (Percentage of Respondents) (N varies) (Q29).

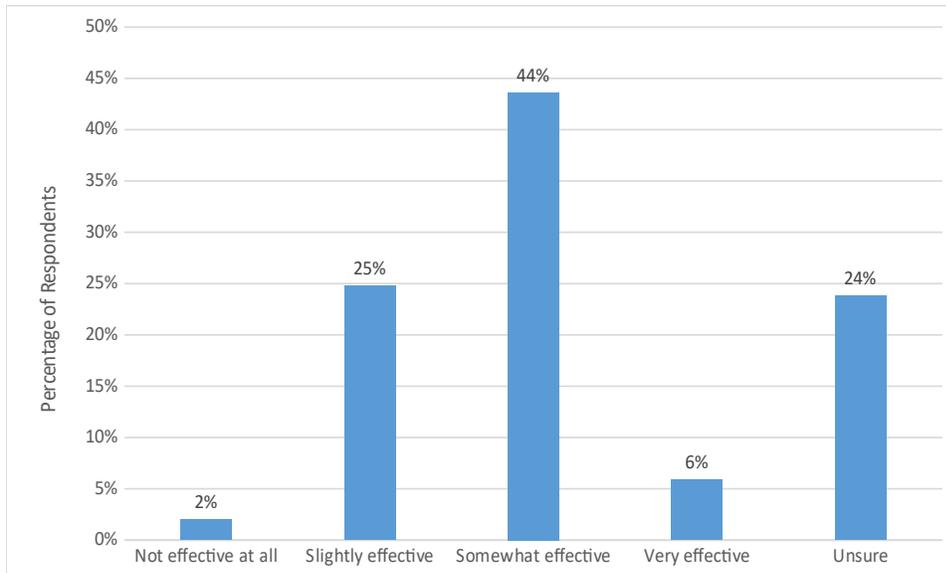
Treatment	Not at All Effective	Slightly Effective	Somewhat Effective	Very Effective	Unsure
In all black spruce stands, regardless of DM presence, sever all stems over 5-foot-tall (n=40)	0	3	43	25	30
Only in black spruce stands containing DM, sever all stems over 5-foot-tall (n=37)	3	16	35	22	24
Only in black spruce stands containing DM, tramp or run over all non-merchantable stems over 5-foot-tall (n=27)	4	15	52	4	26
In all black spruce stands, regardless of DM presence, tramp or run over all non-merchantable stems over 5-foot-tall (n=22)	5	18	32	18	27
Establish a harvested buffer strip between infected and non-infected stands (n=13)	15	8	54	8	15
Clump black spruce leave tree reserves in groups located towards edge of harvest area in stands with DM presence (n=7)	43	14	14	0	29

No management/no treatments used for DM (n=3)	33	33	33	0	0
Reserve a buffer strip of non-infected black spruce trees around a DM infected pocket (n=2)	0	0	50	0	50
Leave DM infected trees for reserve trees for silvicultural reasons (n=1)	100	0	0	0	0
Other (n=4) ³	25	25	50	0	0

³ Other treatments included: Doing nothing, Two-chain buffer which usually cannot be accomplished.

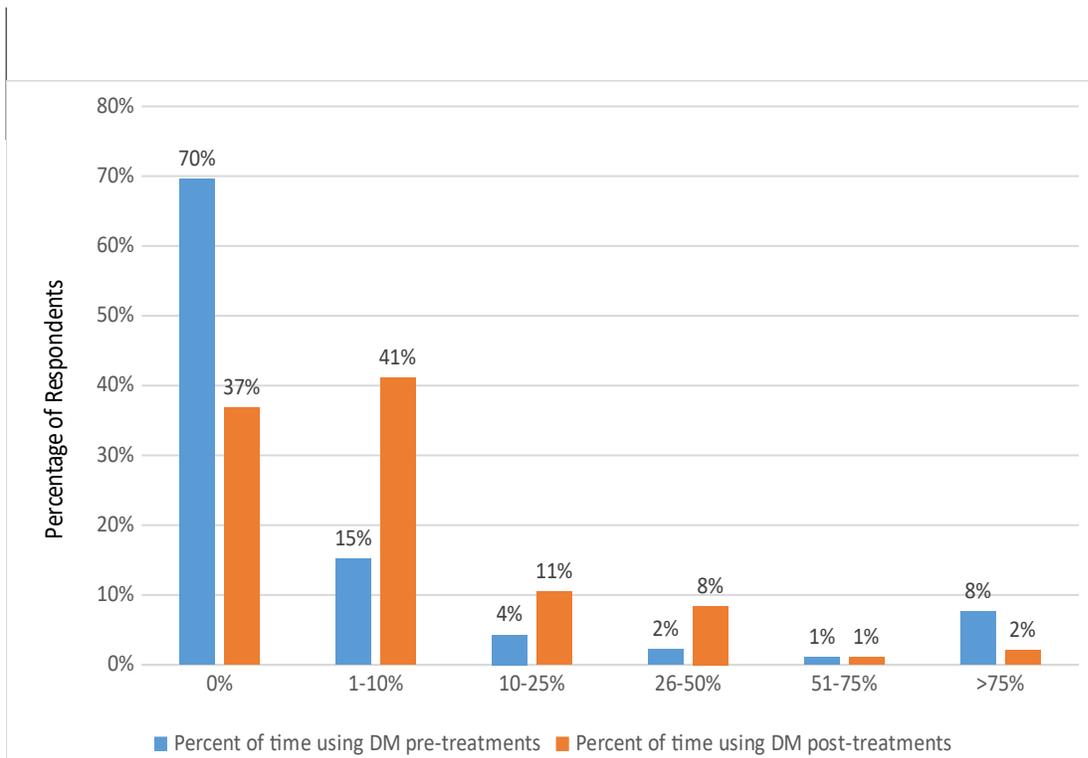
Respondents were asked to rate how effective they think current DM management efforts have been across Minnesota overall on a 5-point scale. The response selected by the greatest number of respondents (44%) was a rating of somewhat effective (Figure 20). Only two percent felt DM management efforts have not been effective at all, although almost one-quarter (24%) are uncertain of the overall effectiveness of DM efforts statewide.

Figure 20: Perceived Effectiveness of Overall Dwarf Mistletoe Management Efforts Statewide (N=101) (Q30).



Respondents were asked to indicate the percent of time that they/their organization implements either a DM pre-treatment prescription or prep work prior to a logger harvesting a black spruce timber sale, or a DM post-treatment prescription after a logger finishes a black spruce timber sale. The mean value for pre-treatments was 10% of the time ($SD = 26$). When examined categorically, the majority of foresters (70%) conduct no DM pre-treatment activities, while 15% conduct pre-treatment less than 10% of the time (Figure 21). The average percent of the time that the forester or their organization implemented a DM post-treatment prescription was also 10% ($SD = 19$). However, when viewed categorically, the distribution is different than the incidence of pre-treatment activities. The most frequently selected response option (41%) was post-treatments conducted between one and ten percent of the time. The percentage of respondents who indicated no post-treatment prescriptions was approximately half that of those who did not undertake pre-treatment activities (37% vs. 70%). Approximately 11% of respondents indicated they undertook either pre- or post-treatments more than 25% of the time.

Figure 21: Percent of Time You/Your Organization Implements Pre- (N=92) or Post-Harvest Treatments (N=95) for Dwarf Mistletoe on Black Spruce Timber Sales (Q31A&B).



In follow-up open-ended questions (Q32 and Q33), respondents were asked to describe the pre-treatment and post-treatment prescriptions they typically use on a black spruce timber sale. Sixteen respondents described pre-treatment activities. In general, the only pre-treatment activities reported are to discuss DM in the timber sale prospectus and make bidders and buyers aware of required treatments, especially the 5 foot cutting rule.

More respondents (n=46) offered information about the post-treatment prescriptions they typically use after a logger finishes a black spruce timber sale. The most common post-treatment prescription mentioned (n=25) was (winter) shearing to remove non-merchantable black spruce stems that had been missed (left standing or had sprung back up if they had been trampled / run over) during the harvest. Twenty-one respondents reported other methods or equipment used to remove missed stems or pockets of remaining DM, including severing, hand-felling, roller chopping, or brush sawing. A few of the respondents indicated that their post-harvest treatments are implemented in adjacent stands outside of the harvest area as a means to reduce the potential for infection in regenerating stands. One respondent wrote:

“If a pocket of mistletoe is noticed after a sale that is adjacent to the timber sale, a shearing contract can be set up if there is money available.”

Aerial seeding of black spruce was mentioned by four respondents. Burning was mentioned by five respondents, but with some caveats about its effectiveness or impediments associated with using a prescribed burn. For example,

“Prescribed burning used to be a tool but is not common in the state anymore due to lack of funds and liability/risk concerns.”

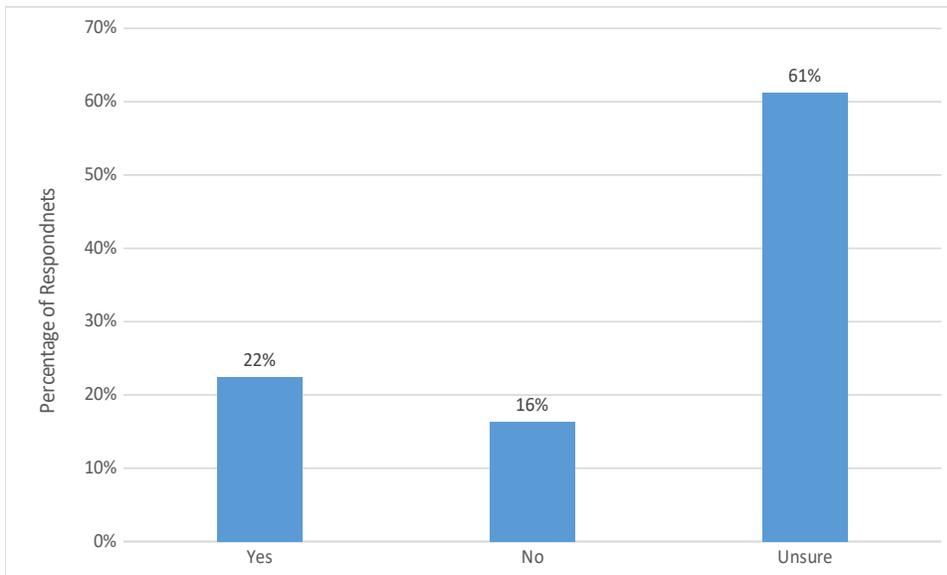
Several respondents also mentioned that post-harvest treatments are often constrained by budget.

“Funding is hit and miss, so not all infected areas get treated post-harvest.”

“I would like to use fire or a contract to sever all remaining trees, however I do not believe such post-treatments are often used due to costs.”

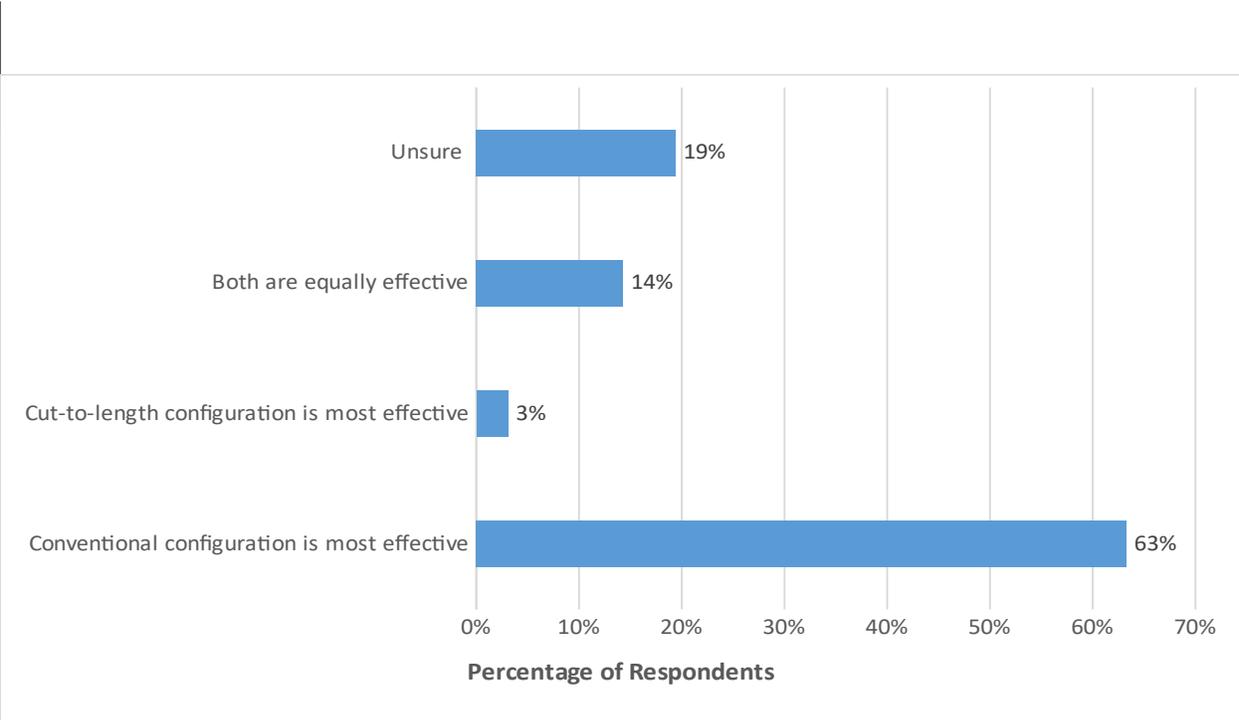
Respondents were asked whether they believe there are more effective DM treatment options that they or their organization are not recommending or requiring. While 22 percent of respondents reported they believe there are more effective treatment options than what they are currently recommending or requiring, the majority of respondents are not sure (61%) (Figure 22).

Figure 22: Belief that There are More Effective Dwarf Mistletoe Treatment Options that they or the Respondent’s Organization is Not Recommending or Requiring (N=98) (Q34).



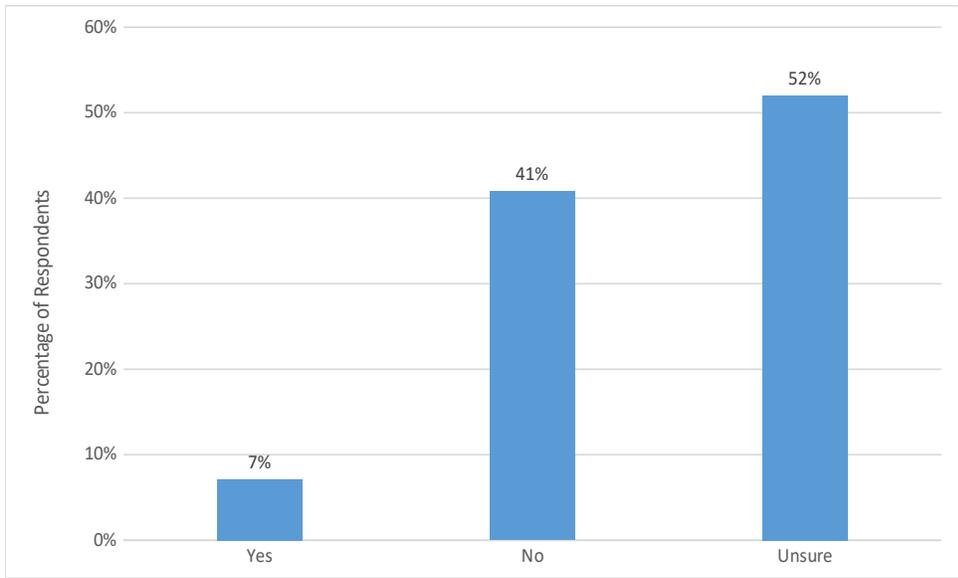
Several questions focused on perceptions of timber harvesting equipment efficiency were posed to respondents. In the first, respondents were presented with different harvesting equipment configurations and asked which they believed to be more effective at implementing DM treatments. Nearly two-thirds of respondents reported that conventional logging equipment with a feller-buncher and skidder is most effective at implementing DM treatments, while 3% rated cut-to-length (CTL) as most effective (Figure 23). However, nearly 20% were uncertain about equipment effectiveness.

Figure 23: Perceived Effectiveness of Different Harvesting Equipment Configurations at Implementing Dwarf Mistletoe Treatments (N=98) (Q35).



As a follow-up equipment question, respondents were asked whether they believe there are more effective equipment options (besides conventional or cut-to-length systems) that loggers/operators should be using when implementing DM treatments. Approximately 40% responded that they did not think so, although the most common response (52%) was that they were unsure about additional equipment options (Figure 24).

Figure 24: Perceptions that There are More Effective Equipment Options (Besides Conventional or Cut-To-Length) that Loggers Should Be Using to Implement Dwarf Mistletoe Treatments (N=98) (Q36).



In an open-ended question, respondents were asked to describe other DM options they would recommend (Q37). Many different treatments were identified (n=18) (Appendix 4). Using a brush mower / mulcher, burning the site, hand felling or using a brush saw to sever remaining stems, shearing, or chemical application were mentioned by more than one respondent. Burning was the most frequently-mentioned treatment, although one respondent noted that fire is a poor choice because of the peat and another indicated liability associated with prescribed fire as an impediment. Specific examples offered include:

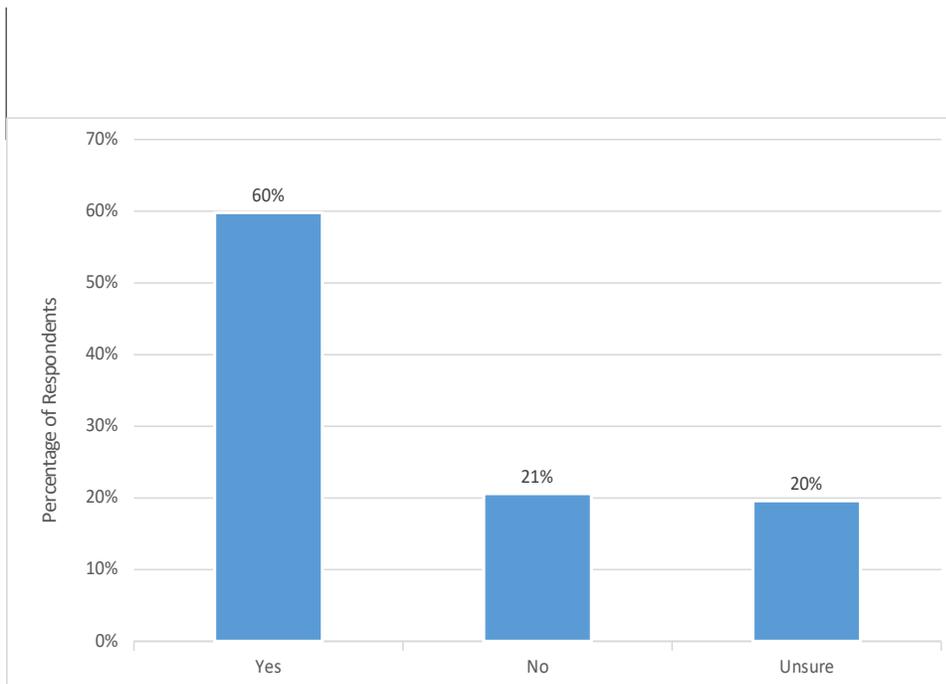
“Masticating head for anything that was not severed.”

“Shearing - the best time to shear a DM site is right after the logger is done felling when there is good frost in the ground.”

When queried about other equipment that they might recommend loggers/operators use (instead of conventional or cut-to-length systems) to implement DM treatments, few suggestions were offered. Four respondents indicated the possibility of using mowers, brush saws, roller-chopper, chemical application, or shearing non-merchantable stems with a bulldozer blade. (Q38)

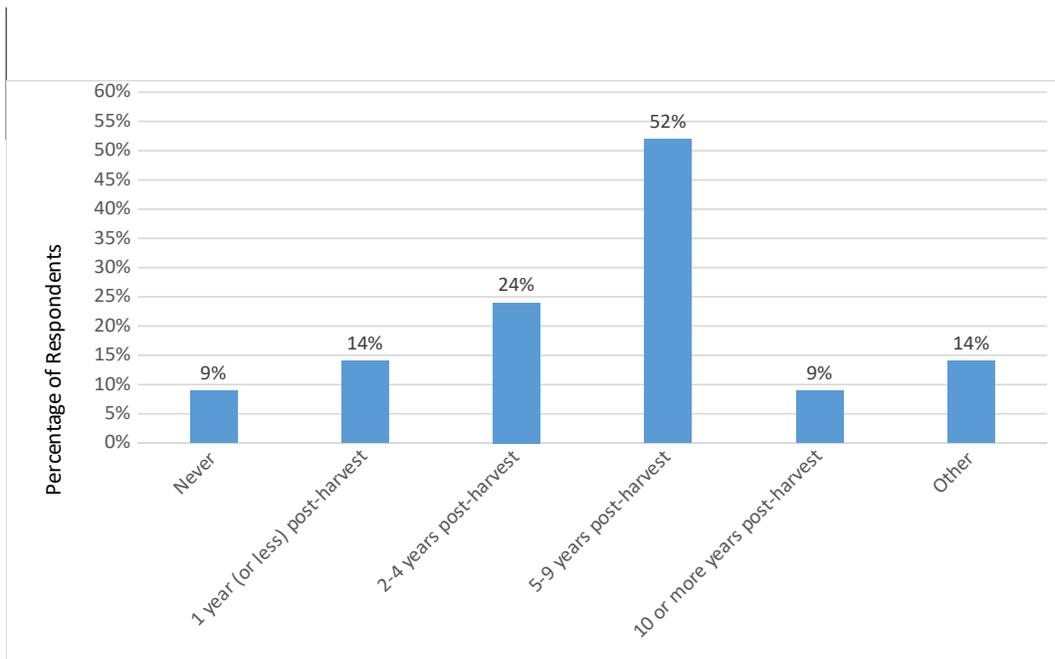
The majority of respondents (60%) indicated that they/their organization have an enforcement plan or policy in place if a DM treatment is not implemented as directed, while the remainder of the respondents were evenly split between those without an enforcement policy and those who were unsure (Figure 25).

Figure 25: Enforcement Plan/Policy in Place if Dwarf Mistletoe Treatment Not Implemented as Directed (N=97) (Q39).



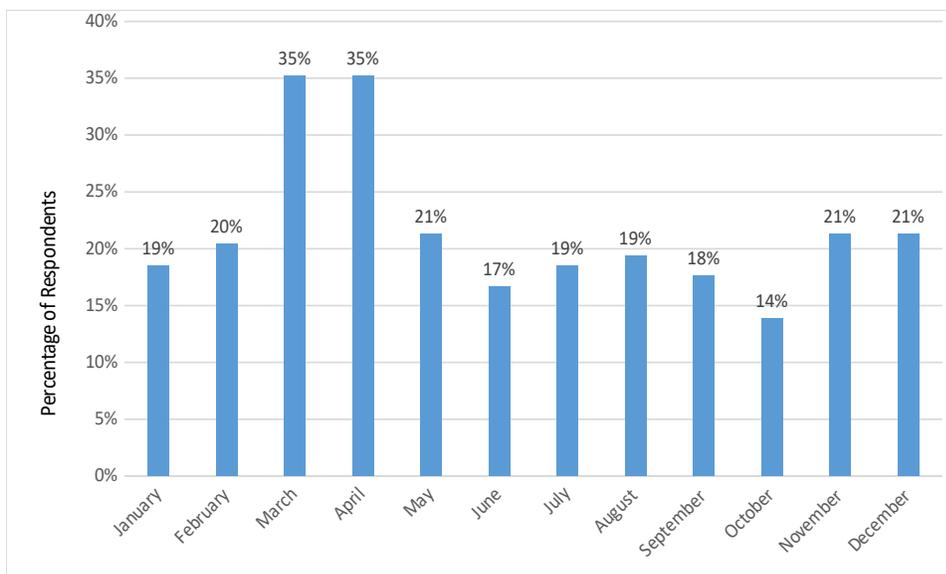
Respondents were asked to indicate when they re-evaluate/monitor a stand post-harvest that contained DM. They were presented six options, including never and other, and asked to indicate all that apply. Just over half of the respondents (52%) indicated that they re-evaluate or monitor a stand for the presence of DM 5-9 years post-harvest (Figure 26). The second most common reevaluation time-point was 2-4 years after harvest, selected by one-quarter of the respondents. Approximately nine percent of the respondents indicated that they never re-evaluate or monitor a stand post-harvest. The “other” comments indicated that regeneration checks are conducted post-harvest but those site visits don’t necessarily evaluate for the presence of DM as it isn’t very noticeable until later in the rotation.

Figure 26: Timing of Re-Evaluation/Monitoring of a Stand Post-Harvest with Dwarf Mistletoe (N=97) (Percentage of Respondents) (Percentages add to more than 100 because respondents could choose more than one timing option) (Q40).



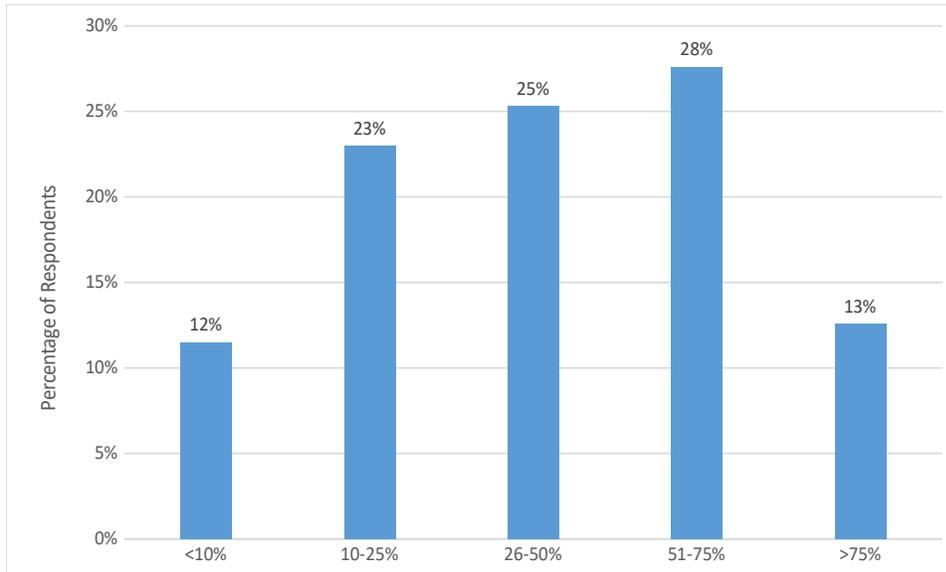
Respondents were also asked to indicate all of the months in which they typically monitor a stand post-harvest that contained DM. The two months in which post-harvest checks were most likely to occur are March and April, indicated each by 35% of respondents (Figure 27). The three next most common months for monitoring were May, November and December (21% of respondents each). Post-harvest checks in the remaining months were selected by between 14% and 20% of respondents.

Figure 27: Months in Which Re-Evaluation/Monitoring of a Stand Post-Harvest with Dwarf Mistletoe are Conducted (N=80) (Percentages add to more than 100 because respondents could choose more than one month) (Q41).



On average, respondents indicated that 44% ($SD = 28$) of their organization's black spruce stands have had a forest inventory to assess stand conditions within the last 20 years. When broken out categorically, approximately 13% of respondents had inventoried more than 75% of their stands in the last 20 years while 12% had inventoried less than 10% of their stands (Figure 28).

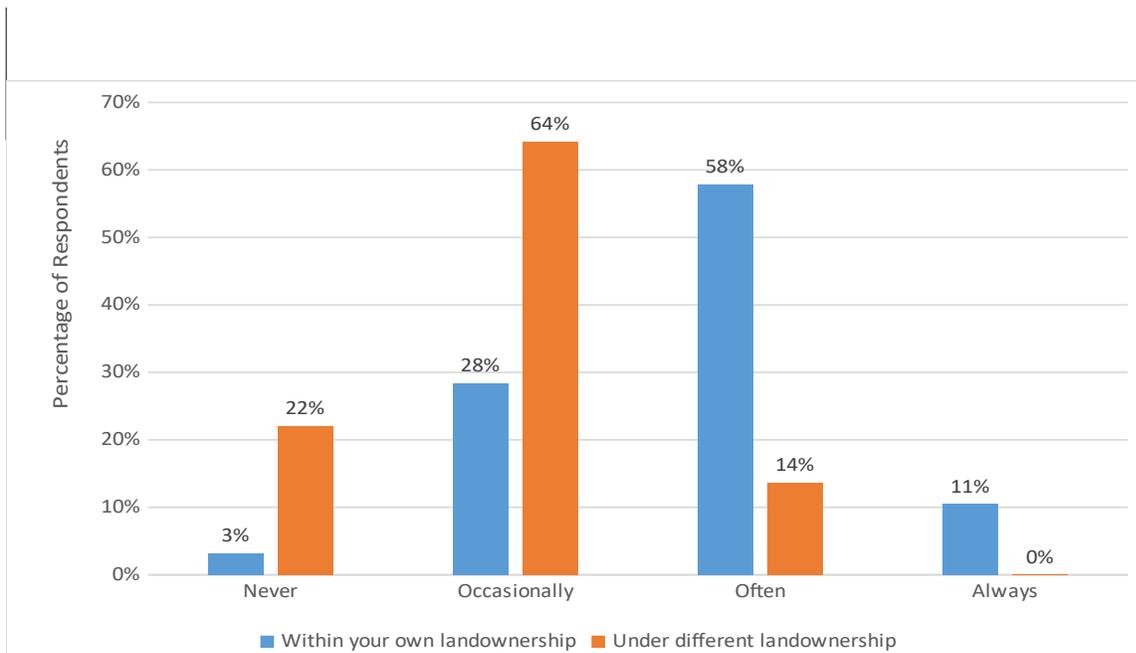
Figure 28: Percent of Respondent's Black Spruce Stands Inventoried in the Last 20 Years to Assess Stand Conditions (N=87) (Q42).



Coordination and Support (Corresponds to questions Q43-Q50)

To gauge cross-boundary DM treatment efforts, foresters were asked the extent to which they/their organization coordinates management of DM infected black spruce stands with adjoining black spruce stands within their own landownership (e.g., offer multiple stands or blocks for sale during a fiscal year on a single permit). Almost 60% indicated that they often do this, while 11% said they always coordinate management efforts within their organization (Figure 29). Respondents were also asked the extent to which their organization coordinates management of DM-infected black spruce stands with adjoining black spruce stands under different landownership (e.g., allow use of the same road access system or landing(s) for the different stands.). Cross-ownership coordination is less common than intra-agency coordination with 64% of foresters indicating they occasionally do this and 22% responding they never do this.

Figure 29: Frequency With Which the Forester's Organization Coordinates Management of Dwarf Mistletoe Infected Black Spruce Stands (N=95). (Q43, Q44).



Respondents were asked to consider a list of seven barriers and identify up to three that they think most affect loggers' ability to effectively implement DM treatments. The percentage of respondents who selected a barrier as one of their three is reported in Table 4. The two most commonly selected barriers were the loggers' loss of production due to additional time required to implement treatment(s) and poor black spruce ground conditions due to weather (e.g., winter too warm for ground to freeze) where 73% and 61%, respectively, of the respondents indicated that it was one of their three top barriers (Table 4). None of the other listed potential barriers were selected by more than 21% of the respondents. The potential barrier selected least often was inadequate information on DM identification. "Other" barriers identified were: low merchantable volume in DM pockets can result in less effective treatment, poor black spruce markets, and sales which are difficult to access.

Table 4: Forester Perceptions of Barriers That Most Affect Loggers' Ability to Effectively Implement Dwarf Mistletoe Treatments (N=92). (Percentages add to more than 100 because respondents could choose up to three barriers). (Q45).

BARRIER	Percentage of Respondents Who Selected the Barrier as One of Their Top Three
Loss of production due to additional time required to implement treatment(s)	73%
Poor black spruce ground conditions due to weather (e.g. winter too warm for ground to freeze)	61%
Loss of production due to impacts on equipment caused by implementing treatment(s)	21%
Inadequate communication regarding treatment requirements	20%
Inadequate equipment to implement treatment(s)	18%
Harvested/merchantable volume doesn't approximate appraised volume	18%
Inadequate information on dwarf mistletoe identification	11%
Other	8%

Respondents were also asked to consider a list of nine potential barriers and select up to three that most affect their/their organization's ability to effectively eradicate DM. The percentage of respondents who selected a barrier as one of their three is reported in Table 5. The barrier that was selected most often, by 62% of respondents, was insufficient time or financial resources to adequately address treatment/management (Table 5). Inadequate information on DM impacts and insufficient time or resources for follow-up monitoring were the next two most-commonly selected barriers, selected by 23% and 21% of respondents, respectively. Over one-quarter of respondents wrote in 'other' barriers. These included: overall timber sale or harvest volumes in some areas may be too low to offer a timber sale, conflicting values within an organization (e.g., DM provides diversity), adjacent stands with DM aren't being harvested, and inadequate follow-up post-harvest.

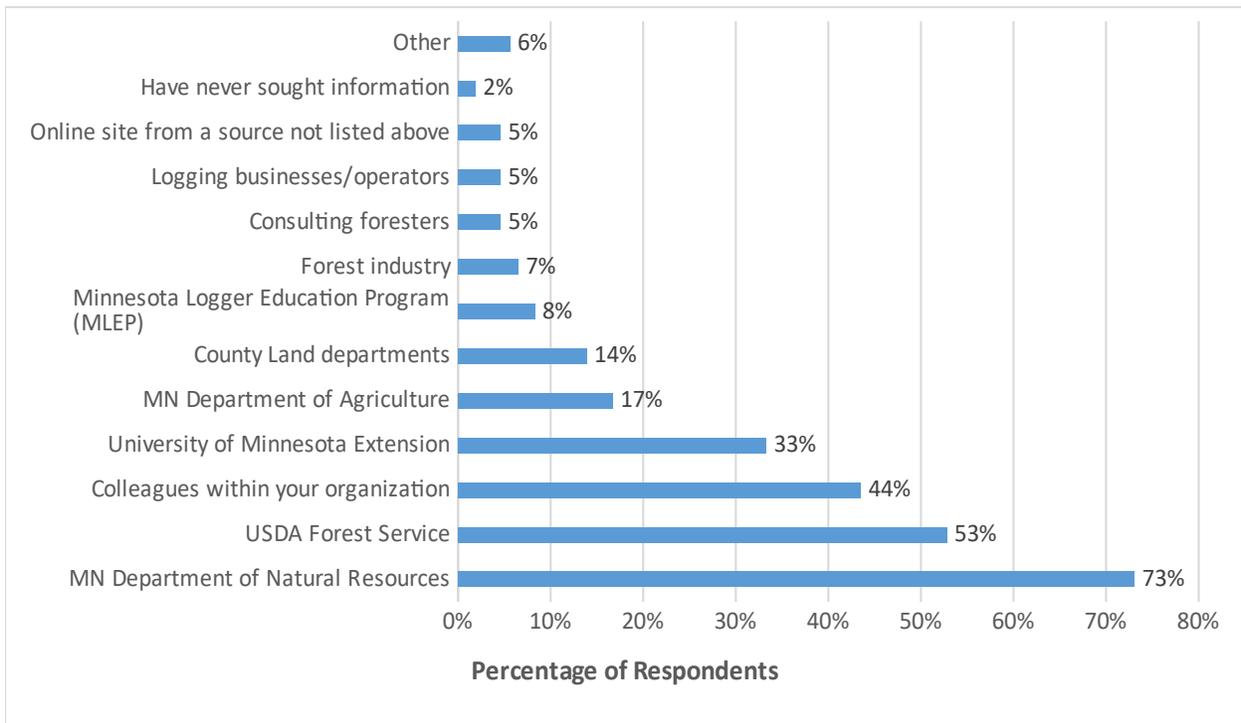
Table 5: Forester Perceptions of Barriers That Most Hinder Their/Their Organization's Ability to Effectively Implement Dwarf Mistletoe Treatments (N=92) (Percentages add to more than 100 because respondents could choose up to three barriers). (Q46).

BARRIER	Percentage of Respondents Who Selected the Barrier as One of Their Top Three
Insufficient time or financial resources to adequately address treatment/management	62%
Inadequate information on dwarf mistletoe impacts	23%
Insufficient time or financial resources for follow-up monitoring	21%
Inadequate equipment to implement pre- or post- treatment(s)	15%
Lack of loggers/buyers to implement treatment(s)	13%
Black spruce sales not selling on auction/sales	12%
Lack of loggers/buyers with appropriate equipment to implement treatment(s)	11%
Lack of enforcement abilities/penalties	9%
Inadequate information on dwarf mistletoe identification	7%
Other ⁴	28%

Foresters access information about DM and its management from a variety of sources. Respondents were presented a list of organizations, and asked to select all of which they get information from about DM and its management. The top four sources of information about DM and its management are the MN DNR (73%) USDA Forest Service (53%), colleagues within their organization (44%) and the University of Minnesota Extension (33%) (Figure 30). No other sources received more than 17% of the responses. “Other” listed sources included undergraduate school, the Minnesota DNR’s Forest Insect & Disease newsletter, journals, Society of American Forester meetings, and the UMN Sustainable Forests Education Cooperative.

⁴ Other identified include: Warm winters that prevent logging access, Too many DM-infected stands on the landscape to treat, Unmerchantable DM-infected black spruce stands are not economically feasible to harvest, Lack of black spruce inventory to identify DM, DM-infected non-merchantable stands near merchantable stands that act as infection sources, Lack of DM treatment policy, Differing divisional priorities regarding DM and black spruce management, Tribal desire to stay out of boreal areas.

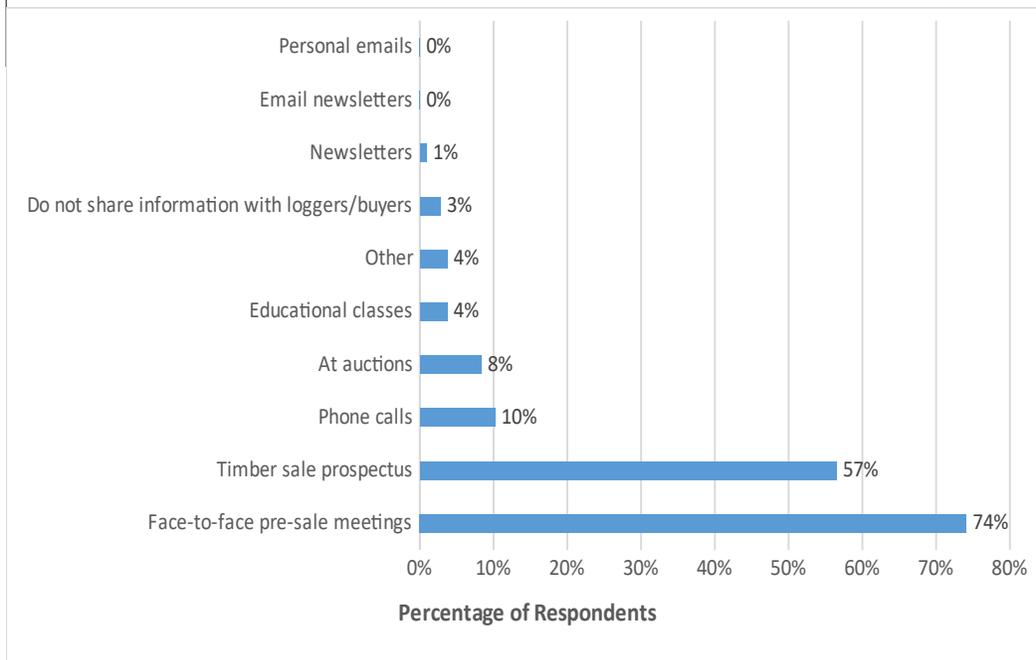
Figure 30: Sources of Information Consulted about Dwarf Mistletoe (N Varies) (Percentages add to more than 100 because respondents could choose multiple options). (Q47).⁵



Respondents were asked to select from a list all of the ways in which they disseminate information to loggers or buyers about DM. While a variety of options were included in the question, most respondents disseminate DM information in two primary ways: through face-to-face pre-sale meetings (74%) and through the timber sale prospectus (57%) (Figure 31). None of the other listed methods were selected by more than 10% of the respondents.

Figure 31: Methods of Disseminating Dwarf Mistletoe Information to Loggers and Buyers (N Varies) (Percentages add to more than 100 because respondents could choose multiple dissemination methods). (Q48).

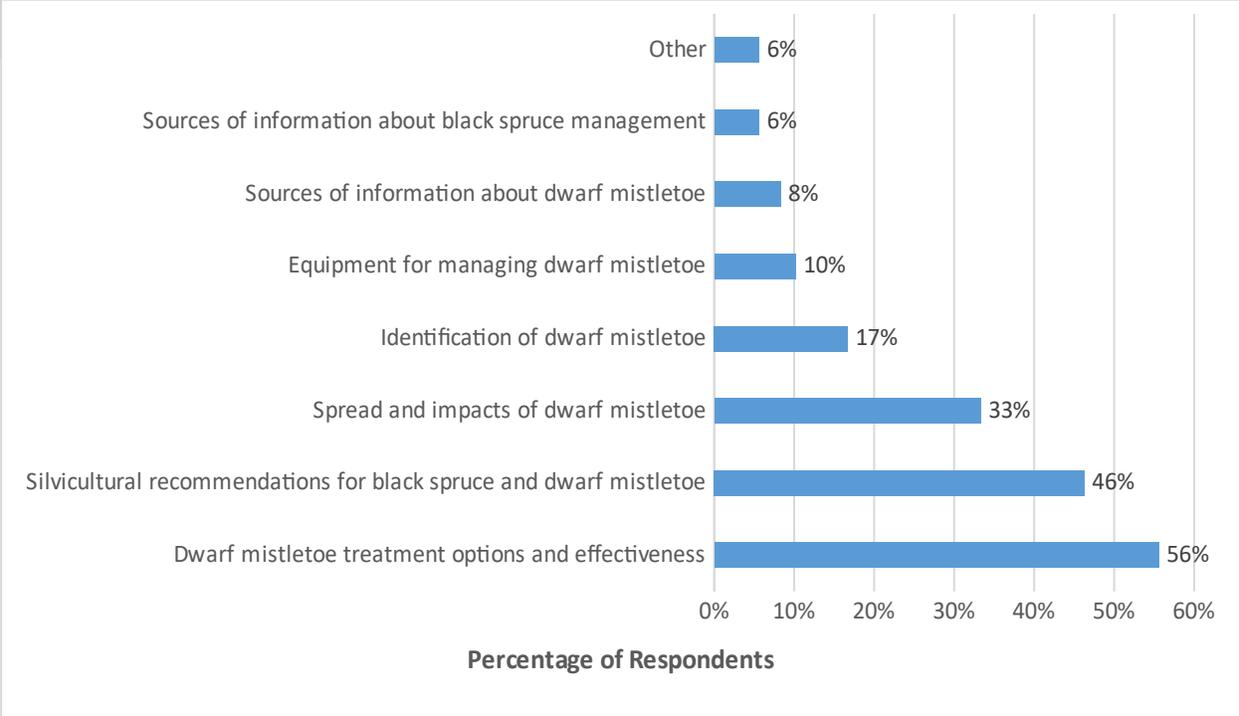
⁵ Other sources of information identified included academic journals, forestry school education, Forest Insects and Disease Newsletter.



To identify training needs, respondents were asked to select up to three topics that they or their organization need additional education on in order to improve DM management. The top three selected educational needs were: DM treatment options and their effectiveness (56%), silvicultural recommendations associated with black spruce and DM (46%) and information about the spread and impacts of DM (33%) (Figure 32). None of the other listed topics were selected by more than 17% of respondents. “Other” written-in topics included: funding and personnel, research which indicated that black spruce stands are in danger of losing volume and revenue, and research which examined the effectiveness of the 5-foot cutting rule.

Figure 32: Additional Education and Information Needs to Improve Dwarf Mistletoe Management (N Varies) (Percentages add to more than 100 because respondents could choose multiple educational needs). (Q49).⁶

⁶ Other additional needs identified: Ability to treat non-merchantable areas infected with DM, information about the long-term effectiveness of the 5-foot cutting rule, funding and personnel to inventory black spruce stands, research to show that managed black spruce stands are in danger of volume and revenue loss due to DM.



In an open-ended question (Q50), respondents were asked to describe what, if anything, they would change about DM best management practices and silvicultural recommendations. Seventeen respondents provided comments, with a diversity of recommendations offered across several themes. The need for better information was emphasized (e.g., costs and benefits of treatments, better aerial photography detection tools, creating a unified message about treatment effectiveness and retaining reserves). Several comments emphasized the need for a) better or more consistent policies and guidelines regarding approaches to DM (e.g., continuing to allow management based on site-specific needs and not through broad guidelines, b) bringing back the guidelines developed by the Albers (Mike and Jana Albers, retired DNR forest pest specialists) and applying them consistently from one DNR Area to the next, enforcing DM treatment requirements, and d) creating a policy to avoid conflicts about tree retention between resource managers who are managing different resources (i.e., forestry and wildlife)). Post-harvest treatments was another theme mentioned by respondents (e.g., using post-harvest treatments such as shearing, felling, burning, herbicides, creating more consistent funding for post-harvest treatments). Some suggested activities related to the design of timber sales (e.g., designing timber sales to incorporate harvesting stagnant timber as it commonly occurs near the edges of a sale where an infection will first occur, consistently incorporating the presence of DM within the timber sale in a timber sale prospectus with the silvicultural requirements). Two other suggestions that were offered were requiring conventional logging equipment and treating adjacent stands.

The most common theme offered in the comments related to the conflicts between foresters and wildlife managers about leave tree retention within clearcut sites. While foresters want to eliminate all black spruce from a site which are 5 feet or taller to address the forest health concerns, wildlife managers often want to retain leave trees for wildlife benefits (e.g., habitat, biodiversity). Two example quotes illustrate this viewpoint:

“If it is as big of a tree killer as it is made out to be, we should eliminate the 5% reserve rules for spruce and any other host species on site.”

“We need a policy and not guidelines when it comes to mistletoe management. It's ridiculous what wildlifers and ecologists come up with for reasons to leave diseased trees out on the landscape these days...They want a diseased forest and we want a healthy forest.”

In a final open-ended question (Q51), respondents were asked to share any other thoughts about DM. Twenty-nine respondents provided comments, largely related to impediments in implementing DM treatments. Categories of comments included: financial factors (e.g., public agency foresters don't have adequate resources to alter stand trajectories very much beyond what they would otherwise achieve naturally, cost sharing programs are needed to help smaller forms of government treat mortality pockets/edges/stagnant timber outside of timber sale boundaries by winter shearing under favorable conditions), timber volume issues on sales (the most difficult infected stands to manage are those with numerous un-merchantable stems because the merchantable volume is low, some regenerating stands are so badly infected that they are unlikely to have sufficient merchantable volume when harvested, low merchantable volume stands are often difficult to sell and need additional treatments), DM treatment issues (e.g., professional backgrounds within an organization can make it difficult to expand a timber sale if new infection areas are found during an active timber sale, mixed ownerships make it difficult to adequately control DM, smaller infested trees are often not sheared off and spring back during a winter harvest, and there are often inadequate fuels to burn a site post-harvest), ground conditions aren't always frozen enough to effectively shear a site, and impacts of DM on long-term productivity of black spruce stands are unknown. Open-ended responses to questions 50 and 51 are listed in Appendix 4.

Discussion

Overview of Respondent Characteristics and Experiences with Black Spruce Sales and DM

More than half of the respondents work for the MN DNR Division of Forestry. While the average respondent has more than 15 years of experience working as a forester, nearly one in four have fewer than 6 years of experience. Respondents are generally very experienced with activities associated with black spruce timber sales (e.g., design, set-up, administration), averaging 11 years of experience setting up black spruce sales, although one-third of respondents have less than five years of experience with black spruce sales. The low level of experience among this segment of respondents may be a result of their newness to the profession and/or not having worked for very long in an area containing black spruce. Almost 60 percent of respondents have set up at least one black spruce timber sale within the past year, and on average they spend about half of their time on timber sales. The majority of respondents have been involved with a black spruce timber sale with DM at some point in their career, while 70% of respondents had timber sale activity in the past year within a black spruce stand containing DM. While most respondents have experience with black spruce sales and DM, there is a segment of foresters who are newer to the profession and/or setting up black spruce sales with DM who might benefit from additional information and training about DM impacts and treatment efforts.

Overview of Research Question 1: Are Foresters Able to Identify Dwarf Mistletoe?

Respondents generally believe they are knowledgeable about DM, can correctly identify it in the field, and that their timber sale appraisal and stand assessment methods are effective at detecting the presence of DM in black spruce timber stands. However, higher percentages of respondents were very confident in their ability to either correctly identify DM in the field or in their timber sale appraisal methods than were very confident in their stand assessment methods detecting DM. Given this finding, it may be useful to examine timber stand assessment methods relative to

DM to learn why identification confidence among foresters is lower relative to other identification steps and what could be done to improve effectiveness of stand assessment efforts.

The presence of witches' brooms is the indicator used by almost all respondents to identify the presence of DM. However, a few noted that the presence of witches' brooms hasn't resulted in black spruce mortality in their timber stands. Respondents most commonly obtain information about DM and its management from within their organization, the USDA Forest Service, and colleagues. Information disseminated to loggers and buyers most commonly occurs through on-site pre-sale meetings and the timber sale prospectus. Given the purpose of those two sources, the information which is being disseminated to loggers is likely regulatory in nature (e.g., apply the 5-foot cutting rule) and specific to the job site rather than informational or educational in nature (e.g., what is DM, what causes it, how does it spread, how quickly does it spread is it a problem, what does it do to a tree?). A variety of educational needs were identified. Potential topics include indicators of DM, the historical presence and impacts of DM in Minnesota, spread rates, treatment options, and effectiveness of those treatments. Slightly more than half of respondents are interested in learning about DM treatment options and their effectiveness, suggesting there is a need for communication, training and education about DM identification and treatment, as well as research and monitoring that helps document treatment effectiveness. Open-ended comments provide additional insight into foresters' identification skills, information needs, and viewpoints:

“It's important to also be able to identify the DM during the growing season. Black spruce stands with infection may not always exhibit witches' brooms, and mortality pockets may not have developed.”

“There is a general need to educate "new" foresters on dwarf mistletoe, and other diseases such as diplodia, hypox, trunk rot and red rot in a variety of species. These are diseases that are still present...not something from the past. New foresters need to realize that these "historic" diseases have recommended sanitation practices that should be followed, even if the outward appearance of signs are not always present in a stand.”

“We have rarely detected pockets of dead and downed spruce within our stands. The witches' brooms are fairly common, but the fatal effects have not been noticeable so far.”

Overall, while respondents generally feel able to identify DM, open-ended survey responses suggest there are outreach, education and training needs among foresters who prescribe DM treatments. Our study queried foresters about their self-assessed ability to identify DM in the field. To confirm whether foresters' assessed level of identification skills are accurate, field-based training might focus on an identification component to ensure that foresters and loggers are correctly identifying DM across different stages of infection and that individuals performing stand assessments in black spruce stands are looking for and recording the presence of DM. Finally, given that black spruce grows in a limited part of the state, training about DM and its treatments would be important to emphasize for foresters new to the black spruce region.

Overview of Research Question 2: Do Foresters Understand the Need to Eradicate Dwarf Mistletoe in Black Spruce Where Timber Production is the Objective?

None of the survey questions directly queried respondents about whether they think DM-infected trees *should* be removed when timber production is the objective. Some indications of their attitudes towards this research question can be gleaned by examining several of the survey questions in concert, as well as the open-ended questions that invited respondents to share additional thoughts about DM. Taken together, they suggest that there is some disagreement or tension between foresters and ecologists or wildlife biologists regarding the impacts/value of DM. While most foresters apply the 5-foot cutting rule to “flatten” a site and control DM to promote forest health, other resource professionals support leaving some vertical structure through leave trees for wildlife purposes. In a black spruce stand, that vertical structure retained following a harvest will most likely be black spruce. However, windthrow must be considered when planning black spruce timber sales and leave tree consideration in the Lake States because the species has a shallow rooting system which will cause residual stems of black spruce to be ephemeral (Johnson 1977, Burns and Honkala, 1990). Research that measures or predicts DM spread as a result of leave tree practices could provide important information about the impacts and trade-offs that result from balancing timber and wildlife considerations in DM-infected stands.

The following comments provided by respondents illustrate the tension over leave tree practices:

“Conflicting viewpoints on the value of eradicating DM is also a problem. There are some arguments that DM provides biodiversity and habitat values.”

“There is ongoing debate about ... where/amount of reserves to leave if any, and desires for less intensive treatments for habitat values.”

“It's ridiculous what wildlifers and ecologists come up with for reasons to leave diseased trees out on the landscape these days...They want a diseased forest and we want a healthy forest.”

Differences of opinion also seem to arise between different divisions within an organization as to how to address DM, particularly when comparing ecological versus economic value/impacts of DM. This suggests that it could be useful for organizations to develop more uniform direction as to how to handle DM. Illustrative quotes include:

“We need a policy and not guidelines when it comes to mistletoe management.”

“The DNR has guidelines that Mike and Jana Albers developed, but the use of them is being lost as time goes by and varies from DNR Area to Area.”

“Folks concerned about non-timber values would like to see no management guidelines for mistletoe”

A third theme expressed in the open-ended comments is that DM is a long-established element of the black spruce system that doesn't do significant harm. While most foresters are at least

somewhat concerned about DM in their work area and its impact on the future ecological health of black spruce in Minnesota, most respondents also believe that DM's impact to black spruce production will be slight to moderate. Written comments in the open-ended questions provide further detail on these perceptions:

“Ecologically I do not see mistletoe as a "problem," just another facet of the forest. I do see it as a problem economically, or from a timber perspective.”

“I wonder if DM is as bad as research suggests, assuming that: DM has been a historical component of spruce for hundreds or thousands of years, and...Despite this history, many unaffected healthy spruce forests still exist and those with infections are usually localized.”

“At the end of the day this is a native pest that only causes moderate volume loss, so devoting a large amount of money/resources to fighting it doesn't seem necessary.”

“I think trying to eradicate dwarf mistletoe is a losing battle. In my work area it is in almost all stands, in small infection zones, and doesn't seem to be greatly impacting our black spruce resource.”

“My mentor, with 25 years of experience beyond mine, now retired, was not worried about mistletoe. He said that it was slow moving and easily controlled through harvest.”

“There are a lot more people who don't believe mistletoe is an issue and we are seeing pockets of infected trees being left on site.”

Most of the respondents indicated that their organization has a guiding management document or written policies regarding DM management in black spruce timber sales. Thus, foresters are likely following these guidelines when preparing timber sales, which doesn't allow us to completely understand their attitudes on whether they think DM should or could be removed. However, overall, it appears that foresters hold a variety as viewpoints as to whether it makes sense, ecologically or economically, to attempt to eradicate DM in black spruce stands. Moreover, uncertainty and skepticism about how damaging or concerning DM is in black spruce systems was expressed by some respondents. These attitudes may influence actions that are taken or prescribed by some foresters in dealing with DM. Research and field work that could better document long-term ecological and economic impacts of DM and treatment effectiveness might reduce this uncertainty and give foresters more confidence and direction as to effective DM treatment strategies under timber production goals.

Overview of Research Question 3: Are the Dwarf Mistletoe Eradication Treatments Designed by a Forester Implemented as Designed?

Most respondents require that the 5-ft rule be implemented (i.e., black spruce stems which are 5 feet and taller must be severed or run over as a condition of the timber sale. The conventional equipment configuration with a feller-buncher or chainsaw and one or more skidders was reported by 63% of respondents as being more effective at implementing DM treatments. Few

(3%) felt that the cut-to-length system was more effective. The majority of respondents indicated that their organization has an enforcement plan or policy in place if a DM treatment was not implemented as directed, although 20% of respondents were uncertain. However, no survey question directly asked foresters how often they think DM treatments were correctly implemented, and few comments in the open-ended question were directed toward this topic.

As one indication of how well the prescribed DM treatments are carried out by the logger, 78% of respondents indicated that on 10% or fewer of their sites do they implement a post-sale treatment. Post-sale site treatments could be used if the treatments weren't implemented as designed or could be implemented to provide further DM control. The most commonly mentioned post-treatment was winter-shearing (or use of other tools such as roller chopping or brush sawing) to remove black spruce trees that may have been missed in the logging treatment phase. One respondent offered:

“If/when anything is done, it typically is either shearing of un-merchantable stems with a dozer/KG blade or hand-felling. Prescribed burning used to be a tool but is not common in the state anymore due to lack of funds and liability/risk concerns.”

However, it is also possible that post-sale treatments are infrequently applied because of budgetary constraints or access issues (see Overview of Research Question 4 below) rather than because prescribed treatments are effectively implemented. Open-ended comments address this point.

“I would like to use fire or a contract to sever all remaining trees, however I do not believe such post treatments are often used due to costs.”

“If a pocket of mistletoe is noticed after a sale that is adjacent to the timber sale a shearing contract can be set up if there is money available.”

Fire was a commonly mentioned potential post-harvest treatment strategy to address DM in survey comments. While it is also reported to be an effective and economical way to kill residual trees and to prepare the site for black spruce regeneration (Johnston 1977), it may not be a particularly effective or viable option, especially for organizations that don't have fire-fighting capability. The amount of slash produced from a harvest in a DM-infected stand may not be adequate for a prescribed burn when the stand is full-tree skidded as occurs using conventional equipment (Johnston 1977). Given that post-harvest monitoring checks are focused on confirming whether adequate regeneration is occurring, it is unclear how much is being done to determine whether treatments are carried out as prescribed or whether DM is eradicated from a harvested stand as a result of treatments. Expanding the emphasis of post-harvest monitoring to include these other checks could enhance our understanding of how well prescribed treatments are implemented as well as how effective they are. Johnston (1977) recommended that harvested areas should be checked in 10 years post-harvest to make sure the disease is under control.

Overview of Research Question 4: Are There Impediments to Implementing Dwarf Mistletoe Management Treatments?

A variety of impediments to implementing DM management treatments, both for foresters and loggers, were identified in our study, including financial, administrative, informational, policy-related, and ground conditions. A loggers' loss of production due to additional time required to implement treatment(s) and poor black spruce ground conditions due to weather (e.g., winters have been too warm for the ground to freeze) were the top two barriers which respondents perceived most affect loggers' ability to effectively implement DM treatments. One respondent offered:

“We attempted to have the logger as part of the sale terms either snip, shear or roller-chop all of the sub-merchantable spruce (almost 70 acres of a 160 acre sale). That was unbearable economically, and we received no bids.”

Respondents offered some suggestions for addressing these barriers, including cost share or incentives, an extension of the time to complete the timber sale, or a lower base (reserve) price for black spruce tracts with DM based on the estimated salvageable timber volume/acre. One respondent offered:

“Loggers would need an incentive to treat non-merchantable infected areas such as a reduction in overall sale cost or a treatment cost of so much per acre of infected area.”

For foresters, insufficient time or financial resources to adequately address treatment/management was the top barrier limiting their ability to effectively eradicate DM. Inadequate financial resources limit the extent to which post-sale treatments (e.g., felling, shearing residuals) can be applied. Low merchantable timber volumes where DM has already caused significant mortality limit the ability of a forester to offer some areas for sale and thus to be treated commercially.

Where an organization involves multiple disciplines (i.e., forestry, wildlife) in the design of a timber sale, conflicting management objectives constrain the ability of a forester to implement the 5-foot cutting rule across a clearcut site. Minnesota's forest management guidelines within a clearcut area recommend retaining residual live (leave) trees and snags (dead trees) to provide for wildlife requiring perches, tree cavities and bark-foraging sites (Minnesota Forest Resources Council, 2013). Leave trees can be retained either in clumps which are at least ¼-acre in size over at least 5% of the timber sale area or as 6-12 scattered leave trees per acre. Leave trees should be at least 6 inches in diameter at breast height (DBH) (4.5 feet above ground), about 50% of the leave trees should be greater than 12 inches DBH and at least 1-2 trees per clump or per acre should be greater than 18 inches DBH (or the largest size class available). While black spruce is commonly clearcut, a forester's perspective is that retaining leave trees for wildlife purposes is counter to the 5-foot rule because DM won't be eradicated. Many comments were provided in the open-ended question about differing opinions between foresters and wildlife biologists as to how to address DM in black spruce systems and impediments created by these differences.

Open-ended comments reveal other viewpoints on barriers that foresters face in successfully implementing DM management practices. One of the barrier themes was related to the type of equipment used and specifically, the limited effectiveness of cut-to-length equipment.

“Do not allow cut-to-length equipment to cut a Dwarf Mistletoe infected stand (if requiring to use the 5' rule) or results will be disappointing.”

“Cut-to-length and forwarding operations are very limited in their ability to 1) cut down smaller diameter trees and 2) run over/crush smaller diameter trees.”

Johnston (1977) recommends clearcutting black spruce and creating an isolation (buffer) strip around an infected area which extends 1 – 2 chains into an area that appears to be entirely uninfected. One respondent noted the same in a comment:

“I think a harvested buffer around the infestation should be standard procedure for our stands. It is recognized as a good idea, but not formally required.”

While creating a buffer around an infection may be feasible on an ownership that has uninfected areas surrounding the infected area, mixed ownerships in an area can make it difficult to adequately control DM. Specifically:

“Some large land holders in my work area do not enforce the 5' rule which is adjacent to state land. So, their adjacent stands with mistletoe does affect our (state) land.”

“The difficulty in managing black spruce across ownership lines reduces the effectiveness of the treatment and promotes continual and increasing DMT forest health issues.”

There may be a variety of ways to address these barriers identified by foresters. Organizations with competing goals related to DM management need to provide clear directions and accompanying rationale to staff so that they know how to implement reserve tree guidelines for leave trees and snags in black spruce timber sales. Mapping the mistletoe infestation within the stand can allow foresters to leave reserves in uninfected parts of the stand where they will last longer and not affect the health of the regeneration. Simulation modelling of DM spread could help foresters recognize when mistletoe in adjacent stands might threaten their stand, and foster cooperation to work within and across ownerships to more effectively treat DM in targeted areas. Incentives for timber sales in infested stands may be beneficial in ensuring these sales are purchased and harvested, which is the mechanism for the DM to be treated. Lowering stumpage base (reserve) prices may encourage purchase of those tracts. Finally, respondents indicated that they perceived the biggest impediment to loggers' ability to carry out the DM treatments was a loss of production due to the additional time to implement the treatments. Estimates of this additional time, and thus costs, to logger are unknown. Research to gather this information would be useful in helping to estimate incentives levels needed to compensate loggers for the impact of implementing DM treatments.

Overview of Research Question 5: Are the Prescribed Dwarf Mistletoe Management Treatments Effective?

Foresters expressed some uncertainty about the effectiveness of individual DM treatments, as well as the overall statewide effort to control DM. While most respondents feel that the 5-ft rule (using either severing or trampling treatments) is at least somewhat effective, there is a fair amount of uncertainty surrounding treatment effectiveness. One likely reason for this uncertainty is because post-harvest checks are conducted to evaluate whether the stand has regenerated, not to gauge the effectiveness of the DM treatments. Once regeneration in a harvested black spruce stand has been confirmed, the stand is unlikely to be visited for decades. Given the long rotation period of black spruce, a forester or logger may only visit the same black spruce stand once in their career. Thus, foresters typically don't know whether DM was effectively eradicated post-harvest. One respondent indicated:

“Once the sale is harvested, and checked for proper regeneration, the stand is not visited until next rotation (90 years or so), forest inventory could catch mistletoe infection, but the inventory data gathered likely will not show substantial data on the effectiveness of the treatment.”

DM may not become apparent in a regenerating stand for several years post-harvest. As those stands are infrequently revisited once they are successfully regenerated, information is lacking about the true health of the stand prior to the time when it is mature and ready for a timber harvest. Several respondents indicated in open-ended questions that aerial photography or remote sensing techniques could be useful in helping to detect the presence of DM throughout the life of a black spruce timber stand. However, it has been suggested that black spruce mortality centers do not show up well on aerial photographs until the stand is old at least 60 years (Fred Baker, personal communication, 12/20).

In open-ended comments, one or more respondents reported that they have no idea how effective their DM treatments are at the field level, that implementing a treatment is unlikely to be effective if adjacent landowners don't manage their stands, and that the use of cut-to-length equipment has limited ability to fell, run over and crush smaller diameter trees. Given this uncertainty about treatment effectiveness, respondents expressed interest in learning more about long-term effectiveness of the DM management efforts they are undertaking. The following quote illustrates this point:

“Land managing agencies desperately need more scientific information (retrospective and prospective research) on effectiveness of DM management practices (e.g., 5-foot cutting rule, shearing, forestry mowing, roller chopping) and impacts of DM on long-term productivity of black spruce stands.”

Our findings suggest there is an information gap about effectiveness of DM treatments and whether DM survives in harvested and treated black spruce stands. Research and monitoring could help fill that gap. Without additional requirements or incentives to revisit DM treated stands more frequently, it seems unlikely that post-harvest stand visit frequency would increase which could also serve to enhance understanding of DM treatment effectiveness. Pre-harvest treatments are rare. While post-harvest treatments occur more often, the ability to implement those treatments is limited by availability of funding and site conditions which may require frozen soil. Many respondents indicated they would consider prescribing more post-harvest treatments if more funding were available to do so. However, it isn't clear whether this interest in

post-harvest treatments is because foresters think the prescribed treatments weren't implemented properly, weren't effective, or if they believe that more and/or different treatments need to be done in order to eradicate DM. Conventional logging equipment with a hot saw was seen as being a more effective way of treating DM as cut-to-length equipment has limited ability to fell and to run over and crush smaller diameter trees. Cut-to-length equipment also leaves slash across the site which can hinder satisfactory regeneration by burying good seedbeds such as sphagnum moss (Johnston 1977). Given respondents' clear impression that cut-to-length equipment is not very effective in removing DM, harvests that were conducted using this type of equipment might be ones to prioritize for post-harvest monitoring and treatments under limited budgets.

Respondents indicated that they often coordinate a DM treatment within their ownership but rarely with adjacent landowners. The lack of coordination of DM treatments across sales and ownerships was viewed by some foresters as an impediment to effective DM control. A theme in the open-ended question was that treatments won't be effective if an adjacent tract isn't treated. One forester wrote:

“I often wonder how effective these treatments are. I do know that when one of our spruce swamps with mistletoe are harvested, but the adjacent landowners don't manage theirs, our treatment isn't going to matter all that much. That is frustrating, but I don't have a good solution, either.”

This study has highlighted information gaps that could be addressed through research education, research and monitoring on DM in black spruce to better understand the economic and ecological importance of the disease and its host as well as our understanding of the effectiveness of DM treatments. In addition, this study has also identified some topic areas in which information about DM is known, but foresters may not yet be aware of the latest research and information. For example, forest pathologists have a good understanding of DM spread and mortality rates (personal communication Fred Baker, 1/21; Baker and French, 1981; Baker and French, 1991). Reviewing and updating the information and training on DM management used by foresters, through the sources identified in this survey, could help reduce some of the uncertainty about DM and its management expressed by foresters in this research.

Implications for LPDM in Jack Pine

Finally, we offer some implications of our findings to the potential arrival of LPDM in jack pine stands in Minnesota. Foresters may need to shift their attitudes to recognize that this new, invasive DM species will be more lethal in jack pine than they are used to with DM in black spruce. As a result, different timing (e.g., flexibility to schedule harvests in infected areas, season of operation), intensity, and/or types of treatments may be needed to deal with this DM, and research will be needed to understand effectiveness of treatments in this new system. Education, training and outreach may be needed to make foresters aware that while LPDM may look similar to ESDM in black spruce (e.g., witches' brooms), it is a different species that could have greater impacts. Jack pine is an important commercial timber species in Minnesota with higher average stumpage prices per cord than black spruce (Minnesota Department of Natural Resources, 2020).

The best approach to managing LPDM in Minnesota is to prevent it from establishing here. Educating foresters and loggers to be aware of and to recognize it will aid in its early detection.

In addition the jack pine forest type is more widespread in Minnesota than black spruce (Table 6). As a result, foresters and loggers who conduct black spruce harvests may not also work in jack pine systems in Minnesota. So, while respondents reported substantial knowledge and experience with DM in black spruce, that may not be true of foresters and loggers who work in jack pine systems. More forester education and training about DM (e.g., identification, impacts, standard treatment approaches) may be needed than our results might indicate when considering DM in jack pine systems. We may not be able to assume that knowledge and experience with DM in black spruce would directly translate to knowledge and experience with DM in jack pine if it is a different set of loggers and foresters.

Table 6: Comparison of black spruce and jack pine stumpage volume sold in cords during 2019 by county land departments in Minnesota (Minnesota Department of Natural Resources, 2020).

County	Black spruce volume (cords)	Jack pine volume (cords)
Aitkin	0	0
Becker	0	1,455
Beltrami	536	3,283
Carlton	0	0
Cass	1	1,178
Clearwater	0	0
Crow Wing	0	150
Hubbard	30	1,802
Itasca	7,422	3,798
Koochiching	17,089	2,315
Lake	785	0
Pine	0	95
St. Louis	22,218	5,823

Respondents identified barriers that loggers face in their ability to effectively implement DM treatments, which included production losses due to the additional time required to implement the treatments and lack of frozen ground to work in black spruce stands as needed. One positive aspect of jack pine systems is better access due to their relatively dry soil environment which may provide longer seasonal operability to conduct harvests and treatments. In comparison, black spruce grow in swampy areas, and frozen ground conditions are needed when harvesting and conducting DM treatments.

Respondents indicated a primary barrier for foresters in treating DM is insufficient time or financial resources to adequately address treatment/management, particularly application of post-harvest visits and treatments. Respondents expressed a fair amount of uncertainty about the effectiveness of DM treatments. A majority of foresters are also uncertain as to whether there are more effective treatment prescriptions or equipment configurations other than those that are typically employed. These findings suggest there is a need to monitor the effectiveness of DM treatments in black spruce systems. In addition there also will be a need to understand whether

the same treatments and equipment configurations used to treat DM in black spruce systems will be effective in jack pine systems, particularly in light of the different ecosystems in which each grows.

Respondents indicated the inability to coordinate harvests and treatments across organizational/ownership boundaries presents a challenge to effective, landscape-scale approaches to DM control in black spruce systems. This cross-boundary issue may also be a challenge with LPDM in jack pine systems, as will the issues raised about leave trees for wildlife purposes. While we anticipate that the findings from the survey will be broadly applicable to dealing with LPDM in jack pine systems, some specific issues may need to be considered or adapted to working with this emerging invasive pest.

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Appendix 1: Initial Email Invitation to Foresters

Hello,

I would like to invite you to participate in an **online survey** to help us understand your perspectives and experiences with dwarf mistletoe in Minnesota's black spruce stands. The survey is part of a research project led by the University of Minnesota and funded by the Minnesota Invasive Terrestrial Plants and Pest Center. This project is aimed at improving detection and management efforts of dwarf mistletoe in black spruce stands.

You are receiving this email because you are a forester in our study area. Your engagement in this process is incredibly valuable and we kindly request your participation. The survey should less than 20 minutes to complete, and is completely confidential. If you are interested in completing our survey, please click on the link below.

[\\$!://SurveyLink?d=Take%20the%20Survey}](#)

If you are interested in learning more about the project, or if you have specific questions please contact me.

Sincerely,

Sarah Fellows
Research Associate
Department of Forest Resources
University of Minnesota
919-961-5268
fello067@umn.edu

Appendix 2: Final Email Invitation to Foresters

Hello,

This is a reminder [alt: your FINAL reminder] to please participate in an **online survey** to help us understand your perspectives and experiences with dwarf mistletoe in Minnesota's black spruce stands. The survey is part of a research project led by the University of Minnesota and funded by the Minnesota Invasive Terrestrial Plants and Pest Center. This project is aimed at improving detection and management efforts of dwarf mistletoe in black spruce stands.

You are receiving this email because you are a forester in our study area. Your engagement in this process is incredibly valuable and we kindly request your participation. The survey should less than 20 minutes to complete, and is completely confidential. If you are interested in completing our survey, please click on the link below.

[\\$!://SurveyLink?d=Take%20the%20Survey}](#)

If you are interested in learning more about the project, or if you have specific questions please contact me.

Sincerely,

Sarah Fellows
Research Associate
Department of Forest Resources
University of Minnesota
919-961-5268
fello067@umn.edu

Appendix 3: FORESTER SURVEY

Dwarf Mistletoe Forester Survey

Q1 Perspectives on Dwarf Mistletoe

Q2 How would you rate your level of knowledge about dwarf mistletoe in Minnesota?

- Not at all knowledgeable
- Slightly knowledgeable
- Somewhat knowledgeable
- Very knowledgeable

Q3 How confident are you in your ability to correctly identify dwarf mistletoe in the field?

- Not at all confident
- Slightly confident
- Somewhat confident
- Very confident

Q4 How confident are you in your timber sale appraisal methods to detect dwarf mistletoe in a stand?

- Not at all confident
- Slightly confident
- Somewhat confident
- Very confident

Q5 How confident are you in your stand assessment methods (inventorying for forest planning purposes) to detect dwarf mistletoe in a stand?

- Not at all confident
- Slightly confident
- Somewhat confident
- Very confident

Q6 Out of this list of dwarf mistletoe indicators, which do you primarily use/think is the most important to identify mistletoe? Please choose one.

- Presence of witches' broom in branches (dense mass of shoots from a single point)
- Presence of multiple tops in individual trees
- Dead black spruce tree-tops
- Grouping of dead black spruce trees
- Presence of dead witches brooms on the ground

Q7 How concerned are you about dwarf mistletoe in your work area?

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Very concerned

Q8 How concerned are you about dwarf mistletoe's impact to the future ecological health of black spruce in Minnesota?

- Not at all concerned
- Slightly concerned
- Somewhat concerned
- Very concerned

Q9 How much of an impact do you think dwarf mistletoe is having on black spruce timber production in Minnesota?

- No impact
- Slight impact
- Moderate impact
- Severe impact

Q10 Your Organization and Duties

Q11 What type of agency or industry do you work for?

- Federal
- State
- County
- Tribal
- Private Industry

Q12 How many years have you been working as a forester and/or in the forestry field?

Click and move slider to make your response - even if your response is 0.

0 10 20 30 40 50 60 70

Number of Years	
-----------------	--

Skip To: End of Block If How many years have you been working as a forester and/or in the forestry field? Click and move sl... = Number of Years

Q13 During what months are you most likely to inventory/appraise a black spruce stand? Select all that apply.

- January
- February
- March
- April
- May
- June

- July
- August
- September
- October
- November
- December

Q14 On average, considering all of your current job duties, what percent of your time during the past year was spent focused on timber sales? (Including cruising the sale, sale design & layout, administration, etc.)

Click and move slider to make your response - even if your response is 0%.

0 10 20 30 40 50 60 70 80 90 100



Skip To: End of Block If On average, considering all of your current job duties, what percent of your time during the past... = Percent of time

Q15 How many years have you set up, designed, or administered black spruce timber sales?

Click and move slider to make your response - even if your response is 0.

0 10 20 30 40 50 60 70



Skip To: End of Block If How many years have you set up, designed, or administered black spruce timber sales? Click and mov... = Number of Years

Q16 How many of the timber sales you set up or designed during the past year were (predominantly) black spruce?

- Number of predominantly black spruce sales set up last year

-
- Total number of sales set up last year
-

Q17 Dwarf Mistletoe in Timber Sales

Q18 Have you ever set up, designed, or administered a black spruce sale **containing dwarf mistletoe?**

- Yes
- No

Skip To: End of Block If Have you ever set up, designed, or administered a black spruce sale containing dwarf mistletoe? = No

Q19 Approximately what percent of the black spruce timber sales you set up, designed, or administered during the past year contained dwarf mistletoe?

Click and move slider to make your response - even if your response is 0%.

0 10 20 30 40 50 60 70 80 90 100

Percent of black spruce with dwarf mistletoe

Display This Question:

If How many years have you set up, designed, or administered black spruce timber sales? Click and mov... [Number of Years] >= 3

Q20 How has the percent of black spruce timber sales **containing dwarf mistletoe** you set up, design, or administer in your work area each year changed in the past 3 years?

- Greatly decreased
- Slightly decreased
- No change
- Slightly increased
- Greatly increased
- N/A - not in same work area/with current organization for 3 years

Q21 If everything else were equal, how much time does it take to set up, design, and administer a timber sale (including stand appraisal) with dwarf mistletoe as compared to one without?

- Much less time
- Slightly less time
- No difference in time
- Slightly more time
- Much more time

Q22 Over the past year, how often did you discuss dwarf mistletoe and/or the treatment prescriptions with a logger/buyer during a pre-sale meeting on timber sales containing dwarf mistletoe?

- Never
- Rarely
- Sometimes
- Often
- Always

Q23 Over the past year, how often does a logger/buyer report finding dwarf mistletoe in a stand when it was not noted in the timber sale prospectus?

- Never
- Rarely
- Sometimes
- Often
- Always

Q24 On average, what percentage/level of dwarf mistletoe infection must a black spruce stand reach for it to not sell on an auction/sale?

Click and move slider to make your response - even if your response is 0%.

0 10 20 30 40 50 60 70 80 90 100

Percent of stand infected with dwarf mistletoe



Q25 Do you/your organization have a guiding management document or written policies regarding dwarf mistletoe management in black spruce timber sales?

- Yes
- No
- Unsure

Q26 What treatment(s) do you/your organization currently use or require in the timber sale prospectus to eradicate dwarf mistletoe? Check all that apply.

- Only in stands containing dwarf mistletoe, sever all stems over 5-feet-tall
- Only in stands containing dwarf mistletoe, tramp or run over all nonmerchantable stems over 5-feet tall
- In all black spruce stands, regardless of whether dwarf mistletoe is present, sever all stems over 5-feet-tall
- In all black spruce stands, regardless of whether dwarf mistletoe is present, tramp or run over all nonmerchantable stems over 5-feet-tall
- Reserve a buffer strip of non-infected black spruce around a dwarf mistletoe infected pocket
- Establish a harvested buffer strip between infected and non-infected stands, primarily between the harvest site and adjacent infected nonmerchantable sites
- Clump black spruce leave tree reserves in groups located towards the edge of the harvest area in stands where dwarf mistletoe is present
- Leave dwarf mistletoe infected trees for reserve trees for silvicultural reasons
- No management/no treatments applied for dwarf mistletoe.
- Other - please describe _____

Display This Question:

*If What treatment(s) do you/your organization currently use or require in the timber sale prospectus...
= Reserve a buffer strip of non-infected black spruce around a dwarf mistletoe infected pocket*

Q27 Typically, how wide is the reserve buffer strip of non-infected trees around an infected pocket? (in feet)

Display This Question:

*If What treatment(s) do you/your organization currently use or require in the timber sale prospectus...
= Establish a harvested buffer strip between infected and non-infected stands, primarily between the harvest site and adjacent infected nonmerchantable sites*

Q28 Typically, how wide is the harvested buffer strip between the adjacent infected and non-infected stands? (in feet)

Carry Forward Selected Choices from "What treatment(s) do you/your organization currently use or require in the timber sale prospectus to eradicate dwarf mistletoe? Check all that apply."

Q29 How effective do you think the treatment(s) you/your organization use have been to eradicate dwarf mistletoe?

	Not effective at all	Slightly effective	Somewhat effective	Very effective	Unsure
Only in stands containing dwarf mistletoe, sever all stems over 5-feet-tall	<input type="radio"/>				
Only in stands containing dwarf mistletoe, tramp or run over all nonmerchantable stems over 5-feet tall	<input type="radio"/>				
In all black spruce stands, regardless of whether dwarf mistletoe is present, sever all stems over 5-feet-tall	<input type="radio"/>				
In all black spruce stands, regardless of whether dwarf mistletoe is present, tramp or run over all nonmerchantable stems over 5-feet-tall	<input type="radio"/>				
Reserve a buffer strip of non-infected black spruce around a dwarf mistletoe infected pocket	<input type="radio"/>				
Establish a harvested buffer strip between infected and non-infected stands, primarily between the harvest site and adjacent infected nonmerchantable sites	<input type="radio"/>				
Clump black spruce leave tree reserves in groups located towards the edge of the harvest area in stands where dwarf mistletoe is present	<input type="radio"/>				
Leave dwarf mistletoe infected trees for reserve trees for silvicultural reasons	<input type="radio"/>				
No management/no treatments applied for dwarf mistletoe.	<input type="radio"/>				
Other - please describe	<input type="radio"/>				

Q30 Overall, how effective do you think current dwarf mistletoe management efforts have been across all Minnesota?

- Not effective at all
- Slightly effective
- Somewhat effective
- Very effective
- Unsure

Q31 What percent of the time do you/your organization...

Click and move slider to make your response - even if your response is 0.

0 10 20 30 40 50 60 70 80 90 100

implement a dwarf mistletoe pre-treatment prescription or prep work prior to a logger beginning a black spruce timber sale	
implement a dwarf mistletoe post-treatment prescription after a logger finishes a black spruce timber sale	

Display This Question:

If What percent of the time do you/your organization... Click and move slider to make your response... [implement a dwarf mistletoe pre-treatment prescription or prep work **prior** to a logger beginning a black spruce timber sale] > 0

Q32 What are the prep work/pre-treatment prescriptions you/your organization typically uses prior to a logger beginning a black spruce timber sale? Please describe.

Display This Question:

If What percent of the time do you/your organization... Click and move slider to make your response... [implement a dwarf mistletoe post-treatment prescription **after** a logger finishes a black spruce timber sale] > 0

Q33 What are the post-treatment prescriptions you/your organization typically uses after a logger finishes a black spruce timber sale? Please describe.

Q34 Do you believe there are more effective dwarf mistletoe treatment options that you/your organization are not recommending or requiring?

- Yes
- No
- Unsure

Q35 Which of the following harvesting equipment configurations do you believe is more effective at implementing dwarf mistletoe treatments?

- Conventional configuration (feller-buncher or chainsaw with a skidder) is more effective
- Cut-to-length configuration (feller-processor with a forwarder) is more effective
- Both are equally effective
- Unsure if one configuration is more effective than the other

Q36 Do you believe there are more effective equipment options (besides conventional or cut-to-length systems) that loggers/operators should be using when implementing dwarf mistletoe treatments?

- Yes
- No
- Unsure

Display This Question:

If Do you believe there are more effective dwarf mistletoe treatment options that you/your organization... = Yes

Q37 What other dwarf mistletoe treatment option(s) would you recommend or try? Please describe.

Display This Question:

If Do you believe there are more effective equipment options (besides conventional or cut-to-length... = Yes

Q38 What equipment would you recommend loggers/operators use (instead of conventional or cut-to-length systems) to implement dwarf mistletoe treatments? Please describe.

Q39 Do you/your organization have an enforcement plan or policy in place if a dwarf mistletoe treatment was not implemented as directed?

- Yes
- No
- Unsure

Q40 When do you re-evaluate/monitor a stand post-harvest that contained dwarf mistletoe?

Select all that apply.

- Never
- 1 year (or less) post-harvest
- 2-4 years post-harvest
- 5-9 years post-harvest
- 10 or more years post-harvest
- Other - please describe _____

Skip To: Q42 If When do you re-evaluate/monitor a stand post-harvest that contained dwarf mistletoe? Select all... = Never

Q41 During what months do you typically re-evaluate/monitor a stand post-harvest that contained dwarf mistletoe? Select all that apply.

- | | |
|-----------------------------------|------------------------------------|
| <input type="checkbox"/> January | <input type="checkbox"/> July |
| <input type="checkbox"/> February | <input type="checkbox"/> August |
| <input type="checkbox"/> March | <input type="checkbox"/> September |
| <input type="checkbox"/> April | <input type="checkbox"/> October |
| <input type="checkbox"/> May | <input type="checkbox"/> November |
| <input type="checkbox"/> June | <input type="checkbox"/> December |

Q42 What percent of your organization's black spruce stands have had a forest inventory to assess stand conditions within the last 20 years?

Click and move slider to make your response - even if your response is 0%.

0 10 20 30 40 50 60 70 80 90 100



Q43 To what extent do you/your organization coordinate management of dwarf mistletoe infected black spruce stands with adjoining black spruce stands within your own landownership? (For example - offer multiple stands or blocks for sale during a fiscal year on a single permit.)

- Never
- Occasionally
- Often
- Always

Q44 To what extent do you/your organization coordinate management of dwarf mistletoe infected black spruce stands with adjoining black spruce stands under different landownership? (For example - allow use of the same road access system or landing(s) for the different stands.)

- Never
- Occasionally
- Often
- Always

Q45 What barriers do you think most affect **loggers'** ability to effectively implement dwarf mistletoe treatments? Drag up to 3 choices to the box.

Top barriers loggers' face

- Inadequate information on dwarf mistletoe identification
- Inadequate communication regarding treatment requirements
- Inadequate equipment to implement treatment(s)
- Poor black spruce ground conditions due to weather (e.g. winter too warm for ground to freeze)
- Their loss of production due to additional time required to implement treatment(s)
- Their loss of production due to impacts on equipment caused by implementing treatment(s)
- Harvested/merchantable volume doesn't approximate appraised volume
- Other - please describe

Q46 What barriers most affect **you/your organization's** ability to effectively eradicate dwarf mistletoe? Drag up to 3 choices to the box.

Top barriers you face

_____ Inadequate information on dwarf mistletoe identification

_____ Inadequate information on dwarf mistletoe impacts

_____ Insufficient time or financial resources to adequately address treatment/management

_____ Insufficient time or financial resources for follow-up monitoring

_____ Inadequate equipment to implement pre- or post- treatment(s)

_____ Lack of enforcement abilities/penalties

_____ Black spruce sales not selling on auction/sales

_____ Lack of loggers/buyers to implement treatment(s)

_____ Lack of loggers/buyers with appropriate equipment to implement treatment(s)

_____ Other - please describe

Q47 Where do you get information about dwarf mistletoe and its management? Check all that apply.

- Minnesota Logger Education Program (MLEP)
- USDA Forest Service
- MN Department of Agriculture
- MN Department of Natural Resources
- County Land departments
- University of Minnesota Extension
- Consulting foresters
- Forest industry
- Logging businesses/operators
- Colleagues within your organization
- Have never sought information
- Online site from a source not listed above -please specify

Other - please specify _____

Q48 How do you disseminate information to loggers/buyers about dwarf mistletoe? Check all that apply.

- Timber sale prospectus
- At auctions
- Face-to-face pre-sale meetings
- Newsletters
- Email newsletters
- Personal emails
- Phone calls
- Educational classes
- Do not share information with loggers/buyers
- Other - please specify _____

Q49 What additional education do you/your organization need to improve dwarf mistletoe management? Please select up to three.

- Identification of dwarf mistletoe
- Spread and impacts of dwarf mistletoe
- Silvicultural recommendations associated with black spruce and dwarf mistletoe
- Dwarf mistletoe treatment options and their effectiveness
- Equipment for managing dwarf mistletoe
- Additional sources of information about dwarf mistletoe
- Additional sources of information about black spruce management
- Other - please specify _____

Q50 What (if anything) would you change about dwarf mistletoe BMPs and silvicultural recommendations? Please describe.

Q51 Do you have any additional comments or perspectives about dwarf mistletoe?

Appendix 4: Open-End Comments

Survey Q37 ("What other dwarf mistletoe treatment option(s) would you recommend or try? Please describe.)

brush mower
burning or chipping
Fire is a poor choice because of the peat

Dragging chains, tree length skidding, special funding to go back in after the harvest.

I think a harvested buffer around the infestation should be standard procedure for our stands. It is recognized as a good idea, but not formally required.

There are some members of our staff that set up a lot of black spruce, but I am not one of them. I've heard about using ASV mulching heads post-harvest to eradicate residual living spruce. Masticating head for anything that was not severed.

Mulching with an ASV and a forestry mowing implement has proven effective in the Pine Island State Forest (see the Great Lakes Silviculture Library prescription for post-harvest treatment of standing black spruce). This method is most effective on more easily accessed sites.

With adequate frozen ground conditions and low snow depth, roller chopping may be a cheaper alternative to shearing, mulching, or brush saw work. Abundant slash lopped and scattered across the site may limit the effectiveness of the treatment. Field trials have not been attempted to date. Hand crews can be utilized to fell infected spruce when the acreage or the number of trees involved is small. The use of chainsaws, brush saws or sandviks can cut and fell trees that are not completely killed during felling and skidding operations."

Post-harvest treatment with a brush saw crew severing all remaining stems.
Post-harvest treatment, including shearing and chemical treatments.
Prescribed burning following harvest of a merchantable stand.

Seed a productive site after harvest, wait for 5 to 10 years for trees to begin to reach spruce top size (2 to 6 feet in height), and have a spruce top contract that requires all spruce trees to be cut. Seed again after spruce top harvest. Future spruce top sales would have a spacing clause of 6'x6' on best formed spruce.

severing all spruce stems in spruce dominated stands regardless of previously noted infection
Shearing - the best time to shear a dmt site is right after the logger is done felling when there is good frost in the ground. They usually have a dozer - if we could just get them to use a KG blade and take the time to do it, post-harvest shearing would be a good treatment, I think.

The state could take a more proactive approach to making sure infected areas are treated. Loggers would need an incentive to treat non-merchantable infected areas such as a reduce in overall sale

cost or a treatment cost of so much per acre of infected area. From what I have seen foresters will treat mistletoe that they see adjacent to their sale if it is merchantable size trees infected. We should be more proactive in treating areas that could be a little further away from our timber sales even if its in non-merchantable timber. Currently it is up to the forester if they want to do that or not.

There is potential for aerial spraying at the same time as seeding to kill any residual trees. The 5' rule is a good requirement but far from perfect.

Also larger timber sales, perhaps hundreds of acres or at least the size of the basin for smaller stands would be effective as adjacent stands often re-infect the regen."

They always recommend burning the site after harvest. The counties have no firefighting capabilities and liability is an issue.

We are limited to work on Tax Forfeited property. If the disease is on the adjacent private property as well, and they don't want to cut their black spruce your management is limited.

We are now harvesting primarily 70 to 90 year old second growth stands - they are good sites with not much mistletoe and little volume loss, ten years ago we were cleaning up some old growth spruce on poor sites and some of that had significant DWT, I don't see it as a major problem going forward, we try to get rid of it when we harvest, but can't justify doing anything outside of that - the damage when present is just not that bad

Survey Q38 What equipment would you recommend loggers/operators use (instead of conventional or cut-to-length systems) to implement dwarf mistletoe treatments? Please describe.

brushing, mowing, chemical. Not loggers necessarily, I believe in order to get effective control of DMT another contractor will need to be paid to re-enter a site to specifically target the DMT.

Don't know. Maybe some kind of mowing attachment in addition to the saw.

I think roller-choppers pulled behind a dozer or a large-enough skidder have the potential to be more cost-effective than traditional harvesting systems, but admittedly that idea is not backed up by experience or science (yet.)

shear unmerchantable stems with dozer blade post-harvest

Survey Q50 (“What (if anything) would you change about dwarf mistletoe BMPs and silvicultural recommendations? Please describe.”)

Recommend post-harvest treatments, IE shearing & RX burning and what is needed for success. 5' rule seems ineffective since DM can live on trees <5'.

Address it on EVERY timber sale prospectus. Identify the silvicultural requirements, and ENFORCE them. Don't let loggers so a poor job of compliance, sanitation treatments should be reflected in the appraised stumpage rate, which allows the forester to leverage the work to be completed since lower stumpage rates were applied.

Continue to allow us to manage stand on its individual needs not broad set guidelines. Example: if a stand has mistletoe and the best chance at reducing the risk is not having reserve. Allow us to not have reserves.

Find a color (bands) combination of aerial photo to identify mistletoe.

I think that if stem felling of residual trees on sites and treating adjacent sites with mistletoe was a more consistent practice we might be able to at least control infection enough to end up with a merchantable stand. Would need consistent funding.

I try to take into my sales as much ""stagnant"" spruce land as I can without deterring a logger from purchasing the sale. My hope here is that the stagnant area will first be infected with mistletoe as it is closer to the edge of the sale, and the productive ground more interior of the sale will get a chance to grow trees before the mistletoe reaches that far. This will hopefully reduce mistletoe infection due to wind dispersal to trees on productive ground, however may not affect dispersal from other agents such as squirrels or birds.

Fire would be a nice option.

If it is as big of a tree killer as it is made out to be, we should eliminate the 5% reserve rules for spruce and any other host species on site. Is there any other options that can be used to help stop the spread such as herbicide or other mechanical treatments?

Nothing, they seem reasonable. At the end of the day this is a native pest that only causes moderate volume loss, so devoting a large amount of money/resources to fighting it doesn't seem necessary. Much of black spruce up north is 150 plus so as these get harvested and replaced by younger stands I think the prevalence of BSMT will decline.

Require conventional logging equipment

The DNR has guidelines that Mike and Jana Albers developed, but the use of them is being lost as time goes by and varies from DNR Area to Area. There needs to be a resurgence of effort and information sharing regarding black spruce.

There is ongoing debate about effectiveness of DMT treatments, where/amount of reserves to leave if any, and desires for less intensive treatments for habitat values. A unified and strong voice from agencies and the Universities would help field staff, planning efforts, and specification enforcement.

This is just one of many issues that daily effect our forest management operations. For example we also deal with noxious weeds, insects pests, new recreational trails, dumping of garbage, concerned, threaten and endangered species found within our timber management areas etc. etc. etc.

We need a policy and not guidelines when it comes to mistletoe management. It's ridiculous what wildlifers and ecologists come up with for reasons to leave diseased trees out on the landscape these days...They want a diseased forest and we want a healthy forest.

We need more and better information to weigh the cost and benefits of dmt treatments. Would be nice to see regenerated stands that have been managed for mistletoe and how effective those treatments were.

Responses to Open-Ended Survey Question Q51 (“Do you have any additional comments or perspectives about dwarf mistletoe?”)

The stands are often of low volume to sell and if harvested often require additional treatment. When a winter shear is done the smaller infested trees often are not sheared off and spring back up. Often if you would like to burn the site has inadequate fuels.

I wonder if DM is as bad as research suggests, assuming that:

1. DM has been a historical component of spruce for hundreds or thousands of years, and,
2. Despite this history, many unaffected healthy spruce forests still exist and those with infections are usually localized.

Please include natural stand history in educational resources to put today's disease load in perspective; public agency foresters do not have many resources to alter stand trajectories considerably beyond what they would otherwise achieve naturally.

There is a general need to educate "new" foresters on dwarf mistletoe, and other diseases such as diploia, hypox, trunk rot and red rot in a variety of species. These are diseases that are still present...not something from the past. New foresters need to realize that these "historic" diseases have recommended sanitation practices that should be followed, even if the outward appearance of signs are not always present in a stand.

Thanks for the opportunity to provide input.

Very difficult to control because of mixed ownership, some always gets missed.

It seems like most stands have some dwarf mistletoe infection. Some regenerating stands are so badly infected that they are unlikely to be merchantable when mature. The larger cuts we have been doing lately may slow infection to regeneration due to less edge adjacent to other infected stands.

Ecologically I do not see mistletoe as a "problem", just another facet of the forest. I do see it as a problem economically, or from a timber perspective. There are a lot more people who don't believe mistletoe is an issue and we are seeing pockets of infected trees being left on site. We need better communication on proper techniques with proven results. If what we are doing is not effective, then what will be?

We just need better inventory data so that we can catch those stands that are on the verge of becoming non-marketable due to the infections; instead of just waiting for them to come up for timber sale evaluation in 20 years to find that they are not marketable due to us waiting too long. In a perfect world we could catch the ones transitioning to non-marketable and then dozer shear the non-marketable ones to get them back into better timber production stands. However due to the finances and our vast land base containing Black Spruce this is quite the challenging task. From what I see in the field our current timber sale spec of sever all Black Spruce >5' works quite nicely to address our mistletoe infestations. At least our harvested stands are being improved, it could be worse honestly!

Keep information coming to the field foresters. Some large land holders in my work area do not enforce the 5' rule which is adjacent to state land. So, their adjacent stands with mistletoe does affect our(state) land.

My mentor, with 25 years of experience beyond mine, now retired, was not worried about mistletoe. He said that it was slow moving and easily controlled through harvest. However, this survey has me encouraged to double check the regeneration on some of our problems stands that were harvested.

Mortality pockets/edges/stagnant timber outside of timber sale boundaries should also be treated by winter shearing under favorable conditions. Cost sharing programs should be available to help smaller forms of government take on these tasks.

I started in Littlefork and DMT control was at the forefront because of the high amount of black spruce we managed, and while present in other areas of the state, less emphasis is put on controlling it. The difficulty in managing black spruce across ownership lines reduces the effectiveness of the treatment and promotes continual and increasing DMT forest health issues.

Please get ecologists and wildlife students into silviculture and teach them forest management because there is a huge gap between what works and what doesn't when it comes to forest management right now. They basically think we're ruining the forest by harvesting and growing healthy trees.

Land managing agencies desperately need more scientific information (retrospective and prospective research) on effectiveness of EDM management practices (e.g., 5-foot cutting rule, shearing, forestry mowing, roller chopping) and impacts of EDM on long-term productivity of black spruce stands.

It's important to also be able to identify the DMT plant during the growing season. Black spruce stands with infection may not always exhibit witches brooms and mortality pockets may not have developed.

My role is generally planning NEPA and writing prescriptions when it comes to mistletoe. We have asked our stand examiners to look for it. My concern is with the public, of whom some have suggested dwarf mistletoe is not a concern. Arguments proposed to me have said we should not be cutting black spruce in favor of Moose thermal cover even if we have mistletoe in the stand. This may be an educational need.

Ground conditions are not always frozen enough to effectively shear a site.

Managing dwarf mistletoe often entails harvesting large acreages because the infection is present throughout the area.

The toughest infected stands to manage are those with numerous unmerchantable stems. At the field level, I really have no idea how effective our DMT management practices are, good or bad.

I have never set up a pure black spruce sale but have worked where black spruce is a component of my timber sale. It is common to see dwarf mistletoe on the fringes of my sales and include it within the sale

Do not allow CTL equipment to cut a Dwarf Mistletoe infected stand (if requiring to use the 5' rule) or results will be disappointing.

I think trying to eradicate dwarf mistletoe is a losing battle. In my work area it is in almost all stands, in small infection zones, and doesn't seem to be greatly impacting our black spruce resource.

Difficult to ID when it is at early stages

I am concerned about a couple of your questions. What percent/ level of infection depends as much on how long the stand has been affected as how much is present. It comes down to salvageable volume for operability constraints. Poorly worded. How effective is our treatment? Relative to what we can do (not burning the site) it is our best option. It does not eradicate the infection.

Cut-to-length and forwarding operations are very limited in their ability to 1) cut down smaller diameter trees and 2) run over crush smaller diameter trees.

We have rarely detected pockets of dead and downed spruce within our stands. The witches' brooms are fairly common, but the fatal effects have not been noticeable so far.

Dwarf mistletoe is relatively slow moving. Usually see small pockets and harvest with surrounding black spruce timber. The black spruce rotation age is 90 to 100 years and it is difficult to see if silvicultural techniques are working to slow mistletoe. I have setup black spruce sales 30 years ago and trees are only 20 feet tall as of today. I feel if you get a fully stocked and vigorously growing black spruce stands there shouldn't be an issue. Of course this is just my opinion based off empirical knowledge.

I often wonder how effective these treatments are. I do know that when one of our spruce swamps with mistletoe are harvested, but the adjacent landowners don't manage theirs, our treatment isn't going to matter all that much. That is frustrating, but I don't have a good solution, either.

Sometimes we are being held back by other divisions not wanting to expand a sale area due to their views on adding timber when mistletoe is found after sale starts/ wasn't observed by sale appraiser but administrator.

Due to the long growth cycle of black spruce, following up and tracking a mistletoe site that has been treated is difficult to do in one person's career span. Once the sale is harvested, and checked for proper regeneration, the stand is not visited until next rotation (90 years or so), forest inventory could catch mistletoe infection, but the inventory data gathered likely will not show substantial data on the effectiveness of the treatment.

To see results I would assume there has to be a program to target mistletoe stands from treatment year to full maturity and how do you keep that going for 100 years??