



CANADIAN FORESTRY PROFESSIONALS' PERCEPTIONS OF FOREST
MANAGEMENT AND CLIMATE CHANGE

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Degree of Honours Bachelor of Science in Forestry

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ABSTRACT

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Keywords: adaptation, climate change, forest management, forestry professionals, mitigation, perception

Gauging the perception of current and future professionals in the Canadian forestry sector is crucial to understanding how forests are managed in the thought of climate change. The aim of the study was to quantify how the perceptions of forest management and climate change differ between professional statuses. In addition, the study aims to determine professionals' attitudes towards climate change and whether current forestry practices are adequate to adapt and mitigate climate change. To achieve these objectives an online survey was sent out to forestry professionals across Canada, including first and fourth-year forestry students as well as more experienced foresters. In total, 109 completed surveys were submitted. Using the Mann-Whitney test it was determined that there was no significant difference in the perceptions between the different levels of forestry professionals. The responses were amalgamated to further analyze the responses. Climate change was perceived as real with impacts expecting to increase in the near future, not ample time to act. Clearcutting and continuous both perceived acceptable forest management techniques in the face of climate change. Current forestry practices perceived as not being sufficient to combat climate change, however main barriers to adapting and mitigating such cost, political motivation, and knowledge barriers were highlighted. Despite interest in adapting to and mitigating climate change, the unpredictability of the effects of climate change will hinder the abilities of forest managers. Since there is a willingness from foresters to implement climate change strategies, it is recommended that future research focus on identifying and breaking down the barriers to adaptation and mitigation.

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INTRODUCTION

A discussion that has continued to gain momentum over the past few decades has been about climate change. Across the globe, the impacts of climate change have become increasingly apparent, as disturbances increase in frequency, intensity, and severity (Parviainen *et al.* 2010; Kuuluvainen and Gauthier 2018). A large contributor to climate change has shown to be greenhouse gas (GHG) emissions, most notably, carbon dioxide (NRCAN 2016). The common goal, therefore, is to mitigate climate change through the reduction of atmospheric carbon. An important component of the carbon cycle are forests, which are believed to aid in maintaining a carbon balance through their natural processes (NRCAN 2016). The growth and renewal of forests have been shown to be elemental in sequestering atmospheric carbon, and have therefore been categorized as carbon sinks (NRCAN 2018). While forests are a valuable resource for storing carbon, they also release carbon through decay and disturbance events (NRCAN 2016), becoming a carbon source. In Canada, a large proportion of the land is forested and managed for various products and services. Forest management may then be considered as a tool for mitigating climate change. To properly manage these forests, Canadians must rely on the expertise of forestry professionals.

In relying on forestry professionals to manage the Canadian forests, it is important to gain an understanding of their perceptions of forest management and climate change. How they perceive these will affect how forests will be managed, since they are the ones in the field, making decisions, and implementing the different management strategies. It is therefore not only important to look at the science behind different management techniques and climate change, but how the professionals perceive it. Their perceptions

will impact what practices are incorporated into forest management. Looking at Canadian forestry professionals' perceptions may also help gain an understanding of areas of interest as well as highlight barriers to management.

HYPOTHESES

The first null hypothesis in this investigation is that there will be no significant difference in how the different levels of forest professionals perceive forest management and climate change. There is no significant difference in how professionals manage forests in the face of climate change.

OBJECTIVES

This study was created with various aims: (1) To determine attitudes towards climate change, current forestry practices, as well as the need for adaptation and mitigation of climate change; (2) To quantify how the perceptions of forest management and climate change differ between professional statuses (*i.e.*, first-year students, fourth-year students, experienced professionals); (3) To understand the goals of forest management; (4) To identify the perceived barriers to adapting and mitigating climate change through forest management.

LITERATURE REVIEW

In the past decade, the number of studies relating to the perceptions of climate change has increased considerably. Fewer articles, however, have focused on the perceptions of forestry professionals on climate change. The studies that do exist have emphasized perceptions of climate change, perceived correlation with socio-demographic information, believed impacts of climate change, the perceived need for adaptation, as well as recognized barriers. Literature has been collected from studies in Canada, in addition to other countries in Europe. Through various surveys conducted, it is widely believed by forestry professionals that climate change is real (Blennow and Persson 2009; Yousefpour and Hanewinkel 2015; Ameztegui *et al.* 2018; Andersson and Keskitalo 2018; Sousa-Silva *et al.* 2018). One study found respondents that believed in climate change did not think it was of importance in forest management (Andersson and Keskitalo 2018). This view was not shared among the other studies on the perceptions of climate change. In papers by Yousefpour and Hanewinkel (2015), as well as Ameztegui *et al.* (2018), climate change was viewed as a serious risk to forests and peoples' welfare.

To further investigate the perceptions of climate change and forestry, one study analyzed the relationship between perception and socio-demographic information of respondents. Ameztegui *et al.* (2018) collected information such as gender, age, education, income, institution, and geographic location and compared it against individual responses. They found that the most significant indicator of perceived current impacts was the province the respondent originated from and that the type of stakeholder best predicted perceived adaptation. The lack of studies on the correlation between

climate change perception and socio-demographic information, however, is a limitation. Further research should be conducted and compared to these results.

An area of study that had been thoroughly researched was the expected impacts of climate change. A study by Andersson and Keskitalo (2018) revealed that foresters in Sweden were expecting beneficial changes to their forests as a result of climate change. It was perceived that there would be a longer growing season, thus improving timber yield. However, Andersson and Keskitalo (2018) did highlight that there were understood risks as well. The loss of productivity, an increase of pathogens and insects, wind, changes in climatic zones, more erratic weather events, and other impacts were suggested as probabilities (Brandt *et al.* 2013; Yousefpour and Hanewinkel 2015; Ameztegui *et al.* 2018; Sousa-Silva *et al.* 2018;). Various studies concluded that the impacts of climate change would also increase within the next century (Williamson *et al.* 2005; Ameztegui *et al.* 2018). In addition to climate change having a significant effect on forests, Williamson *et al.* (2005), found that there was a strong perception forest-based communities' well-being would also be affected.

Due to the expected impacts of climate change, studies have been conducted to determine the perceived need for adaptation. Research by Lawrence and Marzano (2013), Lindahl and Westholm (2012), as well as Andersson and Keskitalo (2018), suggest there is not a perceived need for climate change adaptation and mitigation. This is supported by respondents' general disbelief of climate change effects and the perception that combatting climate change should be done in sectors other than forestry. In contrast, many studies suggest adapting forest management is required. Studies by Forsius *et al.* (2013), Yousefpour and Hanewinkel (2015), as well as Sousa-Silva *et al.* (2018), suggest that species selection and increased variation in forest stands are

perceived as viable methods of adaptation. A different strategy highlighted by the respondents of the survey by Ameztegui *et al.* (2018) was to adapt to climate change by focusing on changes in the disturbance regime. While many studies show a willingness to adapt, it has also been perceived that there is no time to adapt, nor a high potential for forestry to effectively mitigate climate change (Yousefpour and Hanewinkel 2015; Ameztegui *et al.* 2018).

The reluctance of adaptation effectiveness held by some professionals is not the only issue evident from research on forest management and climate change. Despite efforts to adapt to climate change, there are various perception barriers that have hindered foresters' ability to implement the changes they wish to make. Barriers that have been discussed include policy, availability of information, technical assistance, and a lack of finances or financial incentives (Sousa-Silva *et al.* 2018). Another significant barrier is the uncertainty of climate change (Sousa-Silva *et al.* 2018; Williamson *et al.* 2005; Yousefpour and Hanewinkel 2015). The uncertainty of the effects of climate change makes decisions more difficult for foresters.

MATERIALS AND METHODS

SAMPLE

The survey distributed for this study was approved by the ethics committee within the Faculty of Natural Resources Management at Lakehead University. Respondents of the survey provided informed consent for their participation in the study. Candidates included in the study were experienced forestry professionals as well as first and fourth-year students in Canada. During the response period of February 8th and 22nd in 2019, 112 questionnaires were submitted. Of the 112, only 109 of the surveys were fully completed and used for data analyses. These responses were collected by contacting universities, provincial associations, as well as a national association, who distributed the questionnaire among members. The three Canadian universities selected for this study have accredited forestry programs by the Canadian Forestry Accreditation Board. This includes first and fourth-year forestry students from the University of Alberta, University of Northern British Columbia, and Lakehead University. To gain responses from more experienced professionals, each of the provincial forestry regulators under the Canadian Federation of Professional Forester Associations were contacted. Lastly, the Canadian Institute of Forestry (CIF) which has members nation-wide, was also sent the questionnaire.

SURVEY DESIGN

The questionnaire was constructed on the online platform, Google Forms. The link to the form was distributed via email, newsletter, and Facebook. The questionnaire was composed of 5 sections: (i) attitudes towards forests, (ii) diversifying and increasing

forest use, (iii) climate change attitudes, (iv) current forestry practices, and (v) climate change adaptation and mitigation. All of the questions in the survey were closed-ended, and most were rated based on the respondents' degree of agreement. Both 5 and 7-point Likert scales were used, in addition to an option for the respondent to answer "I don't know." At the end of each section, an open-comments area was also left for additional explanations if wished.

DATA ANALYSES

The responses that were specified using a Likert scale were regarded as ordinal variables, and differences were assessed across the professional levels. The data was analyzed therefore by the Mann-Whitney Test. It is a statistical method where the data does not fit a normal distribution, nor does it rely on numbers. Since the data is ordinal, this non-parametric test is based on assigned rankings. The critical Z value for infinity, 1.96, was used to determine significance, due to a large number of respondents.

The responses from the different professional levels were then amalgamated. After pooling all of the responses, they were compared based on the degree of agreement indicated by the Lickert scales. The results were displayed in graphs for a visual assessment and comparison.

RESULTS

To determine if there was a significant difference in the perceptions of the different professionals, the Mann-Whitney test was utilized. Due to the large assortment of questions, only one question's responses was used to demonstrate the difference in perception or lack thereof between first-year students, fourth-year students, and experienced forestry professionals. This is shown in Table 1. Equations [1] to [3] were used for this test:

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1 \quad \text{Equation [1]}$$

$$U' = n_1 n_2 - U \quad \text{Equation [2]}$$

$$Z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}} \quad \text{Equation [3]}$$

where n = the number of respondents, and R = the sum of the rankings assigned (Zar 2010:111). The raw data is presented in a table in Appendix I.

Table 1. Mann-Whitney test calculated Z for the importance of different forest uses between first and fourth year students.

n1	R1	n2	R2
35	1891.5	74	4103.5
U	1328.5	U2	1261.5
		Z	0.2174149

The calculated Z value was 0.22. This was compared to 1.96. Since the Z was less than the critical value of 1.96, the hypothesis was failed to be rejected (FTR). Therefore

there is no significant difference between the perceptions of the first and fourth-year forestry students.

CLIMATE CHANGE ATTITUDES

In one section of the questionnaire, the respondents were asked various questions about how they perceive climate change. Respondents indicated their degree of agreement based on a 5-point Likert scale. These responses were simplified however, in Figure 1, to show whether they disagreed, were neutral, or agreed with the statement. Those unsure of their perception were also given the opportunity to select that they did not know. The majority of professionals agreed that climate change is real and that they understand the effects. Although the respondents mainly indicated that have received adequate information on climate change and the effects of it, there was a more variable response in whether the information is easy to obtain and is reliable. A higher proportion of respondents also disagreed with the statements that there is ample time to adapt to and mitigate climate change.

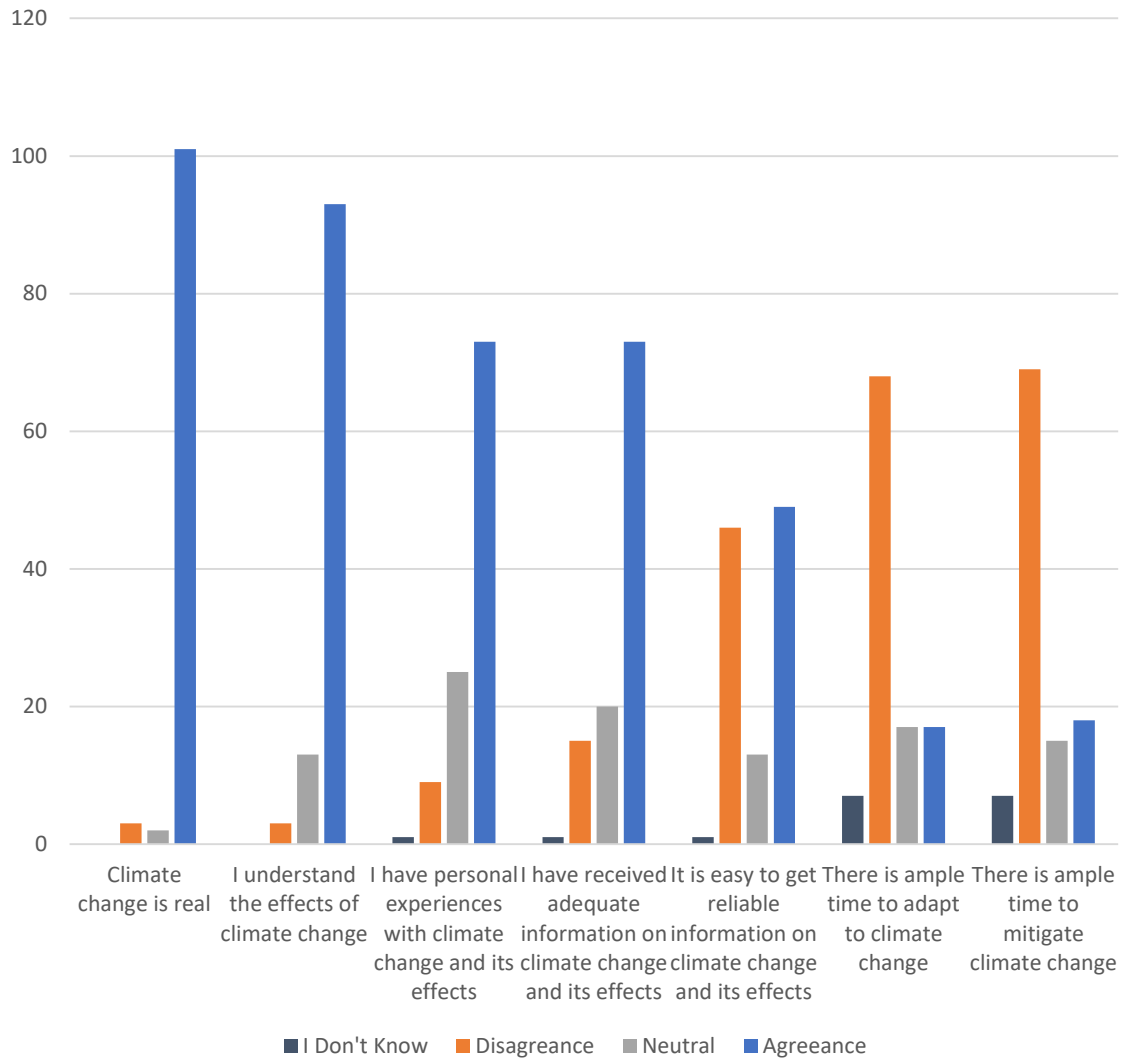


Figure 1. How forestry professionals perceive climate change.

The respondents were also asked to determine whether they believe various disturbances and weather events were likely to decrease, stay the same, or increase. The majority of professionals perceived that insect outbreaks, forest disease, forest fire, windthrow, drought, and flooding would increase due to climate change. The impacts of climate change on forest ecosystems were further explored when they were asked to provide a degree of agreement for various statements shown in Figure 2. First, it stated that climate change currently has a significant impact, next, that it will have a significant

impact within 50 years, and again but in a timespan of 100 years. Over 70% of professionals agreed that climate change was real, and the level of agreeance increased with an increase in time from the present. While many agreed that there were significant impacts of climate change, over 50% of respondents believed that these impacts are unpredictable. There was a larger variation in responses of whether forest management has the ability to mitigate climate change. Less than half perceived it can, less than a fifth perceived that it cannot, and approximately a quarter of professionals indicated they were neutral or did not know.

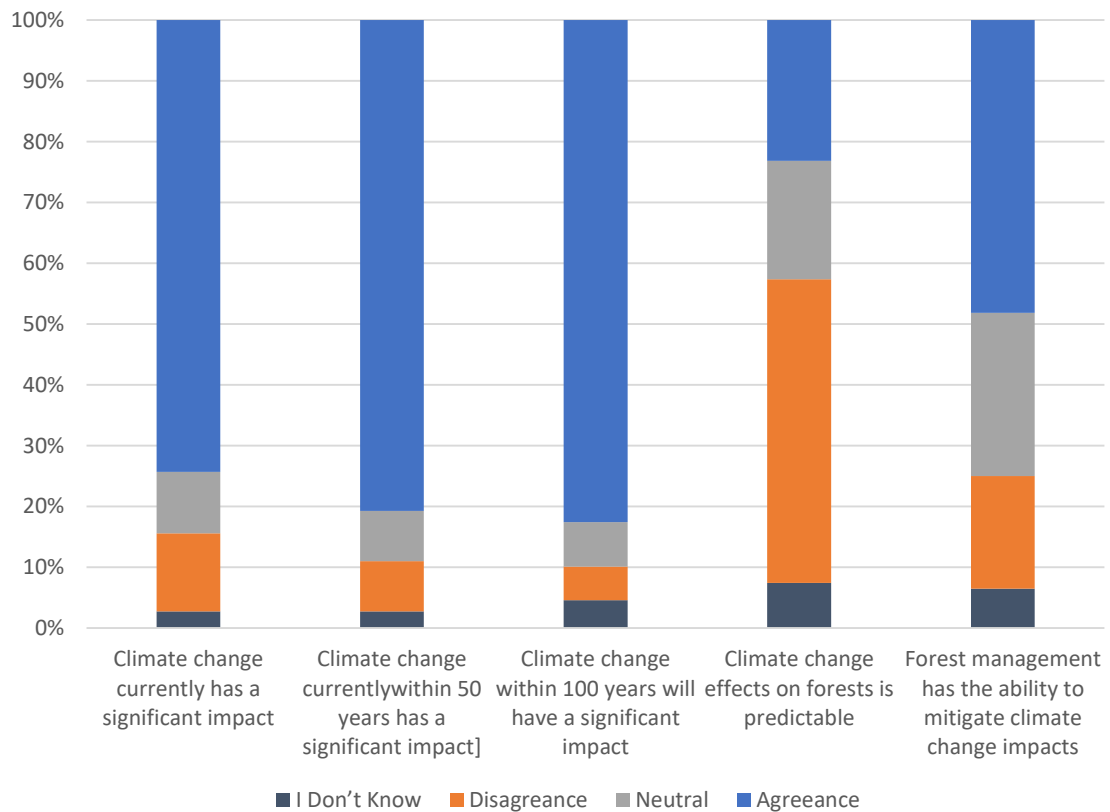


Figure 2. Perceived impacts of climate change on forest ecosystems.

CURRENT FORESTRY PRACTICES

To gain an understanding of Canadian forestry professionals' perceptions of current forest practices, respondents rated statements about clearcutting and continuous cover forestry on 7-point Likert scales. Similar results between clearcutting and continuous forestry were found for the following statements: they emulate natural disturbance well, they enable adequate carbon sequestration, and they are ethically and environmentally acceptable. The majority of respondents were in agreement with these three statements, as displayed in Figure 3 and 4.

Nearly 90% of the forestry professionals agreed that emulating natural disturbance was a goal for clearcutting. Similarly, approximately 87% of respondents agreed that clearcutting is economically and technically feasible. Less than half (38%) of the respondents, however, agreed that clearcutting is culturally and socially acceptable. These perceptions of clearcutting are evident in Figure 3.

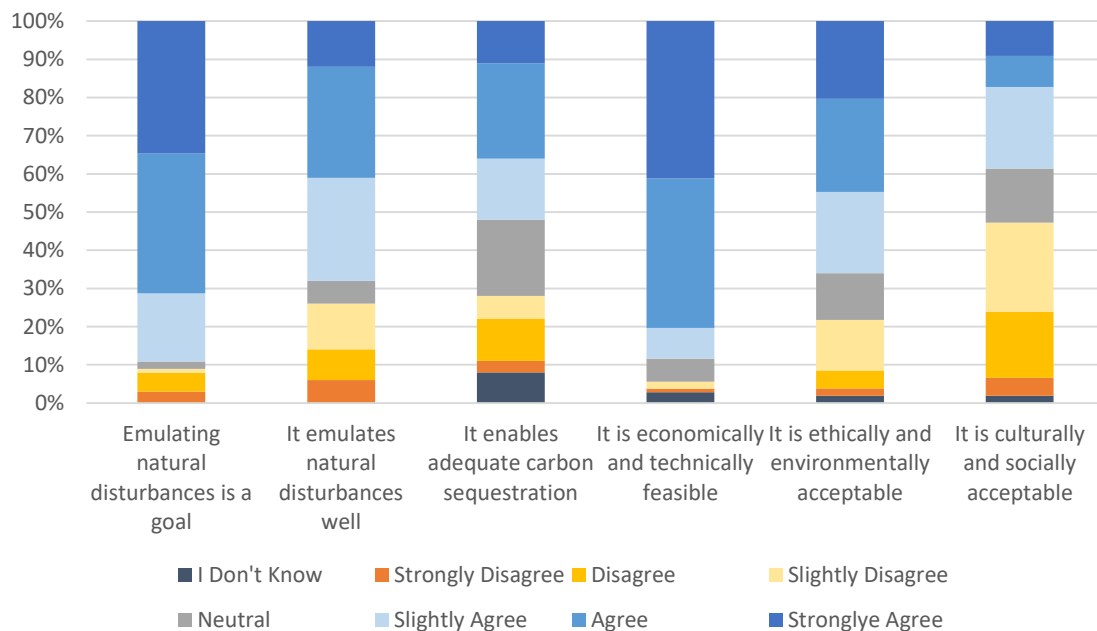


Figure 3. Perceptions of clearcutting.

The same statements were provided for continuous cover forestry, and the professionals gave their degree of agreeance for each. Over 60% agreed that emulating natural disturbance is a goal. Although continuous cover forestry was not perceived as economically and technically feasible by 50% of the respondents, approximately 73% believed that it is culturally and socially acceptable.

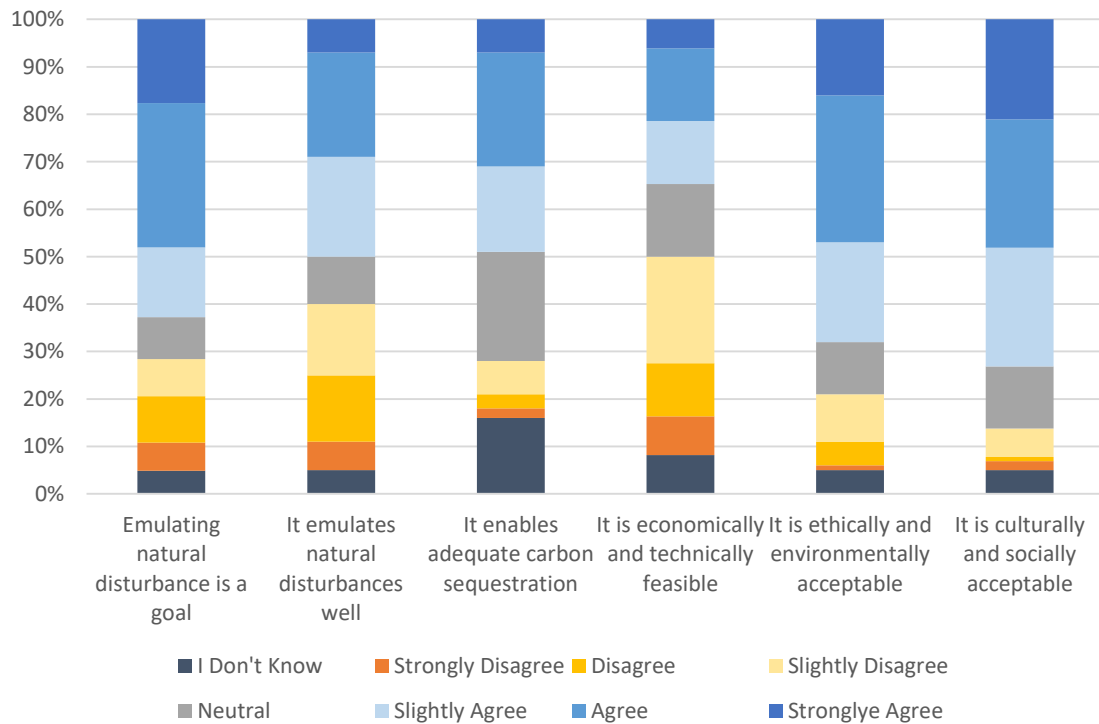


Figure 4. Perceptions of continuous cover forestry.

CLIMATE CHANGE ADAPTATION AND MITIGATION

Another 5-point Likert scale was used to determine the current need for adaptation and mitigation. In this section, nearly 50% of the respondents perceived that legislation does not take the impacts of climate change into account. Despite this, over 80% of the respondents believed that legislation and forestry practices need to consider climate change. Few professionals (approximately 10%) agreed that current forestry

practices are sufficient to combat climate change. Lastly, over half (approximately 58%) disagreed with the statement that it is easy to find information on how to adapt and mitigate climate change. These perceptions on the need for adaptation and mitigation are shown in Figure 5.

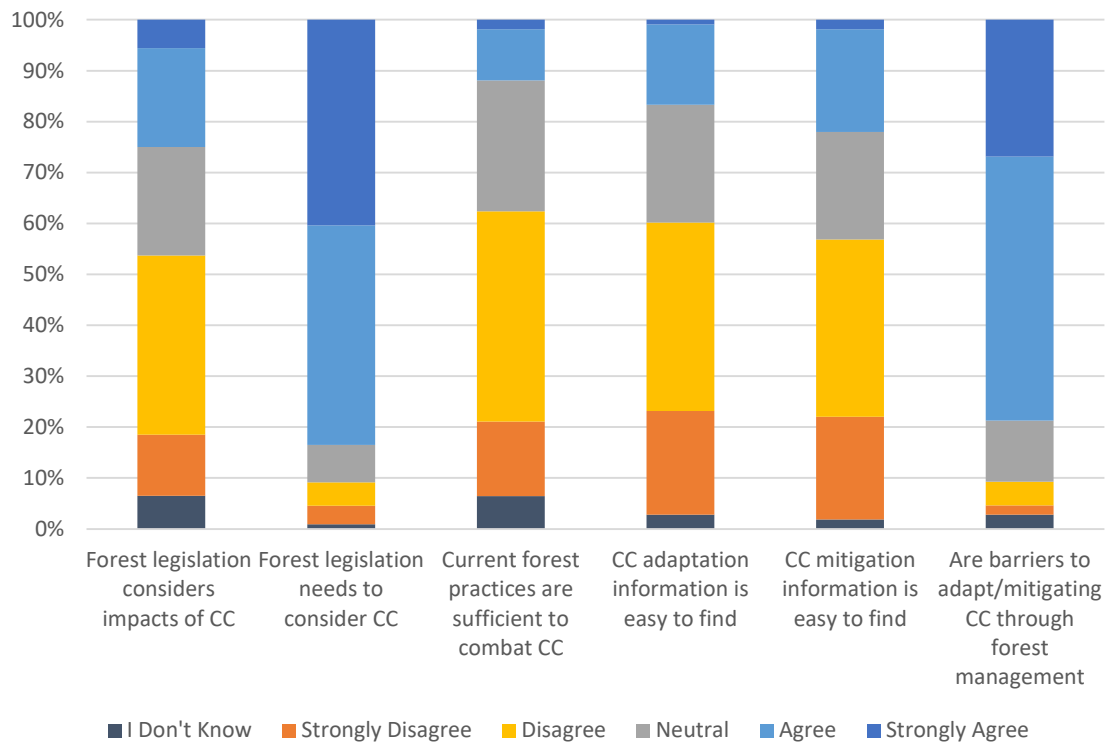


Figure 5. The perceived current need for adaptation and mitigation.

After establishing the need for adaptation and mitigation to climate change through forest management, the barriers to adaptation and mitigation were assessed. A 5-point Likert scale was used. The two factors which were perceived as the greatest barriers were cost (70% agreed) and political motivation (69% agreed). The lack of knowledge, lack of information, as well as the state of the economy were also considered to be barriers by approximately 45% of the professionals. Fewer professionals believed tradition (35% agreed), social pressure by society (34% agreed),

and social pressure among forestry professionals (26% agreed) were barriers. The factor least perceived as a barrier by the respondents was self-motivation (20% agreed).

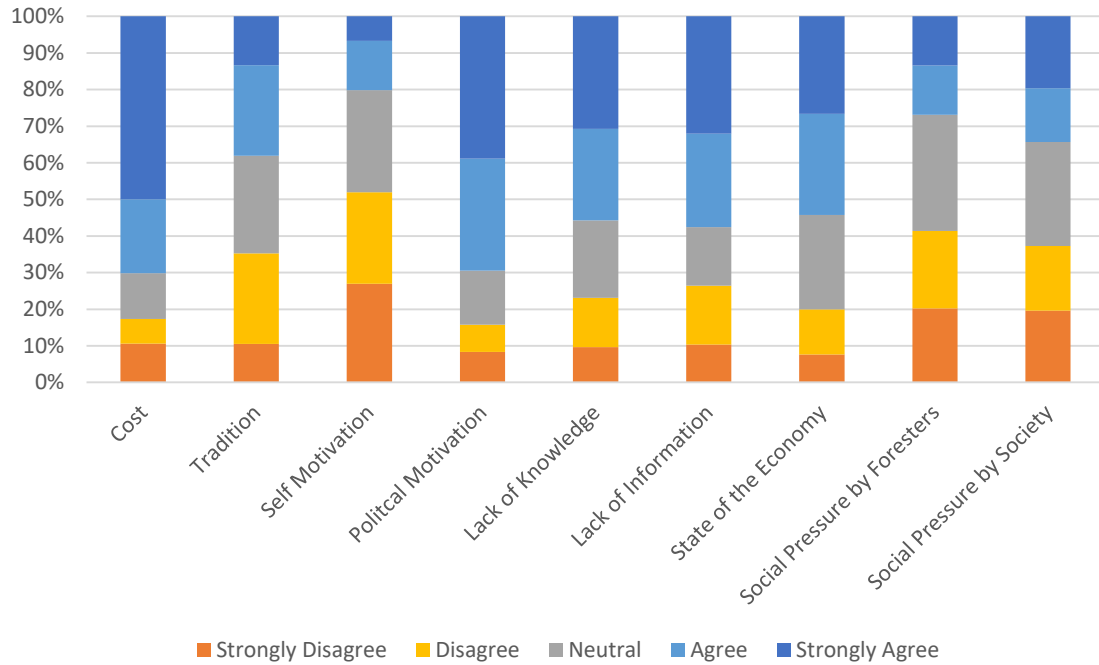


Figure 6. The perception of various factors as barriers.

DISCUSSION

The way that current and future foresters manage Canadian forests will likely depend on their perceptions of forest management and climate change. In the survey created for this study, respondents indicated whether they were a first-year forestry student, a fourth-year forestry student, or a more experienced forestry professional. Using the Mann-Whitney test to determine if there was a difference in their perception, it was concluded that there is no significant difference between the professional levels. Using a similar nonparametric test, it was determined in a similar study that the type of stakeholder (*i.e.*, industry, government, academia, student, *etc.*) was the best predictor for the perceived need of adaptation of forest management to climate change (Ameztegui *et al.* 2018). Results may have differed since the groupings of the foresters in this study were less specific. Information regarding the respondents' professional field (*i.e.*, small industry, large industry, government, entrepreneur) was gathered in this survey, therefore future research could further compare the socio-demographic information gathered to the responses.

CLIMATE CHANGE ATTITUDES

The insignificant difference between professional levels allowed for responses to be analyzed together. As shown in the results, the majority of respondents believed that climate change was real and that they understood what the effects of climate change were. Effects included disturbances such as insects, disease, wildfire, windthrow, drought, flooding; All were perceived to increase. Some of the respondents expressed that forest disturbances are interconnected, and that frequency, as well as the intensity of

these disturbances, are expected to increase. These perceptions may be associated with the personal experiences many of the respondents indicated they had with climate change. The link between forest disturbances has been supported in other research (Brecka *et al.* 2018), as well as the expected increase in severity, frequency, and intensity of disturbances (Parviainen *et al.* 2010; Kuuluvainen and Gauthier 2018). Although the general consensus was that disturbance will increase in various ways, it was also expressed that there are perceived variations in how different locations will be impacted. In a large and diverse country like Canada, some areas may become warmer and drier, while others become colder and wetter. It has been supported in literature that the western, central, and eastern boreal will be affected differently by climate change (Gauthier *et al.* 2014), leading to uncertainty (Ameztegui *et al.* 2018; Gauthier *et al.* 2014). The variation in effects depending on geographical location validates the respondents' claims of climate change effects being unpredictable. In future, therefore, studies should be conducted in smaller geographic regions within Canada to have a better sense of perceived effects in those more specific areas.

Although the effects of climate change were perceived as unpredictable, it was believed that climate change had immediate significant impacts. This perception was held in various other studies (Ameztegui *et al.* 2018; Gauthier *et al.* 2014), in addition to the expected increasingly significant effects over the next 100 years (Ameztegui *et al.* 2018). The perceived current effects of climate change may have affected the perception that there was not ample time to adapt or mitigate. The lack of time to adapt and mitigate was found in another Canadian study (Ameztegui *et al.* 2018). There was also uncertainty whether forest management has the ability to adapt or mitigate climate change impacts at all. Since definitions of what adaptation and mitigation involve were

not included in the survey, the question was open to interpretation and may have resulted in a larger variation in the level of agreement. This perception, however, may lead professionals to not consider climate change in their forest management plans, if they expect that it will not contribute to mitigation.

CURRENT FORESTRY PRACTICES

Both clearcuts and continuous cover forestry are methods used by Canadian professionals to manage forests. Understanding the goals and objectives of forest management can aid in determining which method is best suited to the land (Bergeron 2004). In addition to the overall objectives, respondents noted it is important to take the forest type into consideration, such as the site, silvics, natural disturbance regime, species composition, and more. Therefore, it is not possible to directly compare the two methods, and determine an overall best practice, neither is universal.

Respondents mainly agreed that emulating natural disturbance was a goal for clearcutting, however, less thought it was a goal for continuous cover forestry. This trend was also evident when the professionals provided a level of agreement for whether each method emulates natural disturbance well. It was indicated in the comments section of the survey, however, that the two practices emulate different types of disturbance, depending on the forest type and region. Greater knowledge of one system over the other may have therefore impacted the responses.

Since both clearcut and continuous cover forestry systems have a place in Canadian forestry, they were equally perceived as being ethically and environmentally acceptable practices. Despite this, only half of the respondents perceived that clearcutting and continuous cover forestry enables adequate carbon sequestration. In

another study comparing the carbon capabilities of even versus uneven-aged forestry, they deemed that optimal carbon storage would occur by postponing thinnings (Assmuth and Tahvonen 2018). This, however, would also depend on the forest type and region.

Another important aspect to consider for forest management practices is the economic and technical feasibility of the method. Nearly all of the professionals in the survey agreed that clearcutting is both economically and technically appropriate, in addition to half of the professionals disagreeing continuous cover forestry was economically and technically feasible. One of the respondents commented that the high cost of employing workers and machinery is not covered by small diameter wood. This insinuates an accounting stance, where professionals may economically consider continuous cover forestry as the cost of thinning, rather the investment of releasing the trees for increased growth. Silviculture as a cost versus silviculture as an investment has been discussed in other research, whereby foresters commonly believe it to be a cost (Luckert 2002).

Despite the stance professional foresters have on clearcutting and continuous cover forestry, social and cultural expectations may differ. It was perceived by half of the respondents that clearcutting was not socially nor culturally acceptable. In contrast, nearly three-quarters of the respondents believed continuous cover forestry was. A similar result was found in a Finland study, where non-foresters more negatively viewed clearcutting than foresters (Valkeapää and Karppinen 2013). All of the other practices, however, were positively viewed in the Finland study (Valkeapää and Karppinen 2013). Respondents commented that the poor social view of clearcutting is likely due to the association of it with poor practices in other countries and that educating the public would increase awareness and social acceptability. People who are unaware of the

details of clearcutting nor natural processes in forests may believe the only environmentally friendly option is continuous cover forestry. While it is important to consider social and cultural preference and perception, what is socially or culturally acceptable may not be what is best for the forest. Overall, sustainable forest management in the face of climate change must consider economical, ecological, and socio-cultural objectives to determine an acceptable practice (Axelsson and Angelstam 2011).

CLIMATE CHANGE ADAPTATION AND MITIGATION

Due to only half of the respondents perceiving clearcuts and continuous cover forestry adequately sequester carbon, nearly half believed current practices were insufficient to combat climate change. This result was found in another study (Ameztegui *et al.* 2018) where three-quarters of the respondents had believed current practices were insufficient. Although there was an urge to adapt and mitigate climate change through forest management, the majority of foresters perceived that there were significant barriers.

Since it was determined that there is a strong perception of barriers to adapting and mitigating climate change, the potential barriers were further explored. The strongest barriers against adapting and mitigating climate change through forest management were perceived as cost and political motivation. A lack of knowledge and information were also perceived by half of the professionals as being a barrier. The weakest barrier perceived was a lack of self-motivation, and it may be that forestry professionals in Canada do believe in adapting and mitigating climate change. With the right tools and lack of other barriers, they may then be self-motivated. Since all options were provided in the survey, only a limited number of barriers were presented for rating by the

professionals. Additional barriers listed in the comments section include the availability of a skilled workforce for variable times of the year, true collaboration amongst wood supply chain partners and other forest resource users, as well as how to change a system in a positive manner without knowing the true effects and what you need to change. In future research, these additional barriers should be included for consideration. To adapt and mitigate climate change, should consider what does adaptation mean, should consider the effects and uncertainty of climate change, and should come up with some adaptive management strategies to best achieve the goal.

CONCLUSION

The first research question that drove this thesis was: are there differences in perception between current and future foresters? Using the Mann-Whitney test it was determined that there are not any significant differences in the perceptions of different levels of professionals (*i.e.*, first-year students, fourth-year students, and experienced professionals). The second research question in the study aimed to answer was if climate change affects how professionals in Canada manage forests? Although there is a suspected increase in impacts to forest ecosystems due to climate change over time, the perception that the effects are unpredictable will make decision-makers more uncertain on how to manage forests. Additionally, there are some serious barriers perceived by professionals that will hinder the ability of foresters to adapt management to climate change. Overall, there are some limitations to this study, and as highlighted in the discussion there are various factors that must be further researched in the future.

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APPENDIX

APPENDIX I

Table. Raw data with rankings for Mann-Whitney test.

How important do you think the following forest uses are?					
First		Fourth			
2	0	1	1	7	54.5
2	8	2	8	7	54.5
2	8	2	8	8	60
2	8	2	8	8	60
2	8	2	8	8	60
3	24	2	8	8	60
3	24	2	8	9	66
3	24	2	8	9	66
3	24	2	8	9	66
3	24	3	24	9	66
4	35	3	24	11	82
4	35	3	24	11	82
5	39	3	24	11	82
5	39	3	24	11	82
6	46.5	3	24	11	82
6	46.5	3	24	11	82
7	54.5	3	24	11	82
7	54.5	3	24	11	82
8	60	3	24	11	82
9	66	3	24	11	82
9	66	3	24	11	82
9	66	3	24	11	82
10	71	3	24	11	82
10	71	4	35	11	82
10	71	5	39	12	96.5
11	82	5	39	12	96.5
11	82	5	39	12	96.5
11	82	6	46.5	12	96.5
11	82	6	46.5	12	96.5
11	82	6	46.5	12	96.5
12	96.5	6	46.5	12	96.5
12	96.5	6	46.5	13	105.5
12	96.5	6	46.5	13	105.5
13	105.5	6	46.5	13	105.5
13	105.5	6	46.5	13	105.5
		7	54.5	13	105.5
		7	54.5	13	105.5