INTEGRATED RESOURCE MANAGEMENT OPTIONS FOR THE JACK PINE BUDWORM (*CHORISTONEURA PINUS PINUS*) OUTBREAK AROUND PIKANGIKUM FIRST NATION

by

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April 27, 2023

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An Undergraduate Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Honours Bachelor of Science in Forestry

Faculty of Natural Resource Management

Lakehead University

April 27, 2023

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ABSTRACT

Thibadeau, J. 2023. Integrated resource management options for the jack pine budworm (*Choristoneura pinus pinus*) outbreak around Pikangikum First Nation. pp 51

Keywords: Jack pine budworm, *Choristoneura pinus pinus*, Biomass, Cultural burning, Fuel loading, Salvage logging, Wildfire, Jack pine, *Pinus banksiana*

The outbreak of jack pine budworm (*Choristoneura pinus pinus*) on the Whitefeather Forest was examined to identify a correlation between the large fires and the outbreak. Maps and literature regarding both disturbances were looked at and showed a correlation between the two disturbances. This information was then used to identify potential options for the use of the affected timber with salvage logging, slash pile burning, and cultural burning all being identified as potential uses that have additional value within the community.

ACKNOWLEDGMENTS

I would like to thank Dr. Jian Wang for his continued support through the development of this undergraduate thesis as well as Dr. Seung-il Lee for his contributions as a second reader. I would also like to thank my partner and family for their continued support through my undergraduate studies.

CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

Northwestern Ontario has been affected by an outbreak of *Choristoneura pinus pinus* commonly known as the Jack Pine Budworm. This insect belongs to the order Lepidoptera and their larvae cause widespread defoliation (CABI n.d.). If no control method is employed and larvae can defoliate a tree multiple years in a row the tree may face mortality. This species is an outbreak species and has booms in population every 8-10 years affecting large areas of forest land, eventually killing the trees (OMNRF 2022b).

The First Nation community Pikangikum, north of Red Lake has been affected by large fires to the point of having two evacuations in the summer of 2019 (OMENDM 2019). These fires began several years into the outbreak, prompting the questions “are these large fires related to fuel loading effects of the Jack Pine Budworm?” as well as “what can the community do if there is a connection”? The identification of these values will then be used to help the community better develop integrated resource management solutions for the Whitefeather Forest and communities within it.

The community has an up-and-coming sawmill as well as biomass facilities which have been purchased as a initiative to create jobs and be more self reliant (Cools 2020). These two facilities may have an opportunity to benefit the community in multiple ways, like economic gains, additional job creation, reductions in fuel loads when processing Jack pine budworm affected timber.

Older outbreak areas which may have seen an increase in downed woody debris, may also be examined for the opportunity of fuel reduction through slash pile burning. This process is known to free up ground space for re-establishing forest cover as well as increases a sites nutrient availability (Thorpe and Timmer 2004).

The old burns surrounding the community of Pikangikum will also be examined to see if there are opportunities to collect timber and biomass for the plants. Though another option may be the possible reinstitution of cultural practices. This community once practiced cultural burning for the production of food and they used wildfire killed timber as fire wood due to moisture loss. These sites will be assessed for the viability and safety.

2.0 LITTERATURE REVIEW

2.1 JACK PINE BUDWORM

The Jack Pine Budworm (*Choristoneura pinus pinus*) is a native crown defoliator of various pine species across Canada (OMNRF 2022b). This insect has been known to defoliate Red Pine (*Pinus resinosa*), White Pine (*Pinus strobus*), and Scots Pine (*Pinus sylvestris*), though it is considered North America's most destructive defoliator of Jack Pine (*Pinus banksiana*) (OMNRF 2022b), and NRCAN 2020). This insect is the larva of a moth belonging to the family Tortricidae in the order Lepidoptera (CABI n.d.). The distribution of Jack Pine Budworm (JPB) is vast ranging from northwestern Alberta to parts of the maritime provinces, this is because JPB exists through the entire range on its preferred host (Figure 1) (Robson et al. 2015).

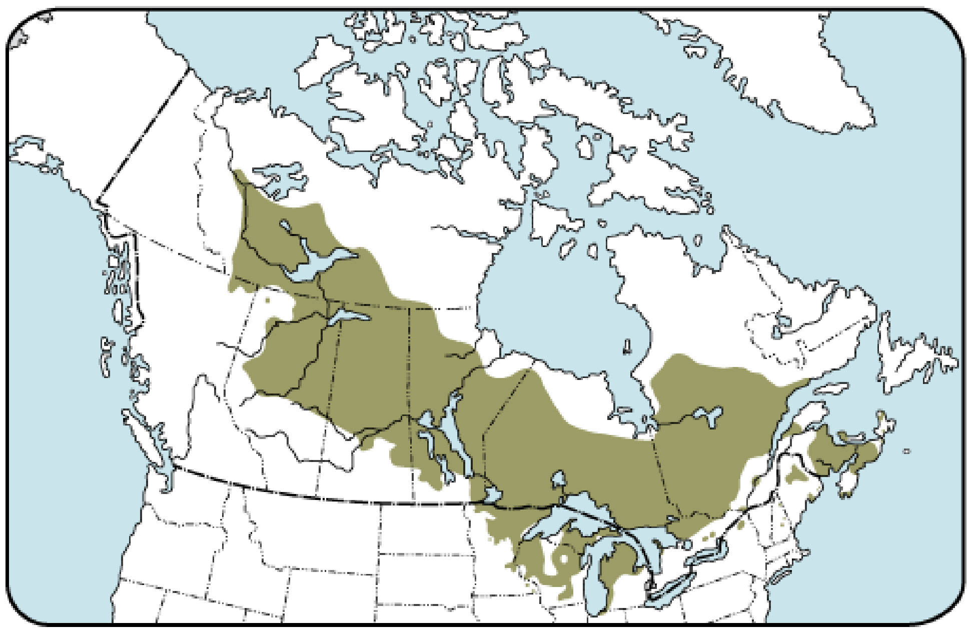

Figure 1. Jack Pine distribution map (NRCAN 2015).

The appearance of the JPB changes as it transitions through its instars, in the early stage's larva will be a light cream colour with a reddish-brown head which can be seen in Figure 2 (OMNRF 2022b). As they molt into the later instars the body colour transitions to a dark green-brownish banding with yellowing on the lower portion of the abdomen (OMNRF 2022b). Once the JPB has pupated and is a moth it will have mottled rust-coloured wings with a 15-24 mm wingspan (NRCAN 2020).

Figure 2. Young Jack Pine Budworm larvae (OMNRF 2022).

The JPB lifecycle sees them through 7 larval stages starting with the female moths laying egg masses of up to 40 eggs in a fish-scale arrangement on foliage (NRCAN 2020). After 10 -14 days the first instar larvae will emerge from their egg and will move to a safe overwintering location to create a silk shelter to molt in (NRCAN 2020). Once the insect has overwintered in its second instar, it will begin consuming pollen flowers early in the spring, continuously growing and molting until they reach their 7th instar. This process usually takes 6 weeks then the JPB will pupate within its feeding tunnel or on the shoot for 10 days (NRCAN 2020). At which point it will emerge as an adult continuing the lifecycle.

The JPB is an outbreak species that will have population peaks every 8-10 years in the province of Ontario (OMNRF 2022b). In outbreak years defoliation can cause the top kill and mortality of whole stands in just 2 years and the trees that do survive will have decreased growth rates for several years (NRCAN 2020 and Robson et al. 2015). Indications of JPB outbreak are mostly associated with the foliage, large amounts of larvae will consume foliage and pollen flowers in the upper canopy, and as the needles die, they accumulate silk and frass, and the crown will turn a brown/orange colour as seen in Figure 3. (OMNRF 2022b).

Figure 3. Jack Pine Budworm Damage on young tree (SME n.d.).

2.2 PIKANGIKUM FIRST NATION

Pikangikum First Nation is a relatively large remote community, with a current population of over 3000 people (WFI n.d.). This remote community lies approximately 100 km north of Red Lake, Ontario. In the summer the only access is via airplane, or through a 20km boat ride to Taxi Bay where access to Nunguessor Road begins, though it is still 90 km by bush road to the community of Red Lake. In the winter the community can be accessed by the use of ice roads that temporarily link northern communities to permanent infrastructure seen in Figure 4.

Figure 4. Map of established winter roads (red dashed lines) In Northwestern Ontario, and their connections to all-weather roads (solid grey line) or secondary highways (solid red line) (MNDM 2019).

This community is located at the heart of the Whitefeather Forest, a boreal ecosystem consisting largely of Black Spruce (*Picea mariana*) and Jack Pine forested area (WFI n.d.). The stewardship of this forest is designated to the Whitefeather Forest Initiative (WFI) based out of Pikangikum in 2006. The WFI worked in collaboration with the Ontario Ministry of Natural Resources (OMNR) to develop a Land Use Strategy tailored to the values of the community (WFI n.d.). The “Keeping the Land” Land Use Strategy is the first of its kind and focuses on 3 main components starting with the Stewardship Strategy, which has a heavy focus on the community’s customary stewardship approach (PFN and OMNR 2006). Next is customary activities that will seek to protect lands for other cultural use like trapping, gathering, and fishing among other artisanal practices (PFN and OMNR 2006). The final component is economic development which will seek to develop new jobs within the community (PFN and OMNR 2006).

Pikangikum was not connected to the provincial power grid until 2018, and as a result the community had a longstanding reliance on diesel generators for power (OMENDM 2018). Since the connection to the grid community has wanted to further its commitment to reducing emissions and has received a grant to install 300 kW biomass boilers (Cools 2020). These boilers will be used to heat various buildings throughout the community and will provide jobs to individuals in the community (Cools 2020). The addition of theses boilers has helped facilitate the development of a “Multi-faceted wood gathering program- Cara Saunders” (Cools 2020). The program has individuals harvest timber for firewood or lumber production at the communities sawmill, logging waste as well as waste from the communities value added furniture business are used to fuel the boilers allowing for minimal waste of the resources the community relies on and has a spiritual connection with (Cools 2020).

This community has long understood and utilized prescribed fire for various reason (Miller, Davidson-Hunt, and Peters 2010). The elders of the community describe fires being lit and controlled for the promotion of new growth and improved feed stock (Miller, Davidson-Hunt, and Peters 2010). The burned areas promote succulent growth for various animal species to consume which made these areas better hunting grounds (Miller, Davidson-Hunt, and Peters 2010). Though in sandy or rockier sites it was understood that this burning would also promote blueberry production in the following summers (Miller, Davidson-Hunt, and Peters 2010). It is also a common practice to harvest fire killed trees for firewood as standing dead timber is drier and easier to process than live wood (Miller, Davidson-Hunt, and Peters 2010).

2.3 FIRE MANAGEMENT IN ONTARIO

Within Ontario, Wildfire is the most extensively managed natural disturbance. This is because it is a manageable disturbance, that has the ability to cause immediate social, and economic disruptions while also posing a risk to public health. The province of Ontario is divided into three fire management regions, Northwest, Northeast and Southeast (MNRF 2022(a)). The way the Northwest and Northeast regions are managed is quite similarly. Each has areas of Intensive Management or areas which receive full response suppression of all fires (Wang 2001). This is for the protection of travel corridors, public infrastructure, and forest resources. They also have a measured zones which receive modified response or full response based off cost benefits (Wang 2001).

Lastly there are Extensive zones which will receive little to no response with the exception of protecting identified values. These three response zones as seen in Figure 5 are no longer exclusively used for identification of response requirement but are still considered. The Southeast region differs in that it is entirely intensively managed, due to its high population and infrastructure density.

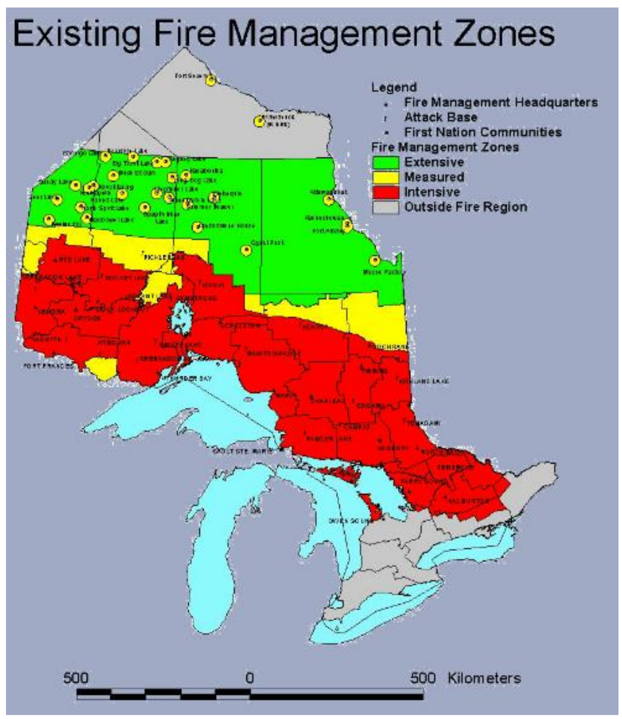

Figure 5. Fire management zones 2001 (Wang, J. 2001).

Fire return intervals are the amount of time it would take for wildfires to completely consumed a whole study area. For example, how many years it would take to burn a 10,000 ha area under regular burning conditions. Multiple studies support the statement that the fire return intervals of protected forests in the province of Ontario have increased from an average of less than 100 years to between 400 and 600 years with suppression (Ward, Tithecott and Wotton 2001). In northern conifer forest this reduction in fire on the landscape has been shown to have an effect on fire severity, increasing the severity of fire as the length of time since the last fire increases (Steel, Safford, and Viers 2015).

2.4 INSECT EFFECTS ON FUEL LOADING

It is known that forest disturbances create changes in the structure and composition of forest fuels. In the case of insect disturbance, the type of damage is dependant on the species and the life stage of the insect (Lundquist 2006). These disturbances are often caused by outbreak species which can kill or severely deteriorate entire stands, in the case the species composition of the stand is that insects main host species (Crotteau et. Al. 2018). Places which have been affected often have vast areas of standing dead or weekend trees, which result in continuous crown fuels ((Crotteau et. Al. 2018). Depending on the insect causing the damage the trees response may be different. When bark beetles attack a tree like the case of the Mountain Pine Beetle in western Canada, the galleries they create under the bark will girdle the tree (Crotteau et. Al. 2018 and MacLean 2015). This process results in the tree excreting flammable frass (woodchips and feces mixed), and pitch (sap) which may allow fire to climb a tree which will succumb to its injuries (Lundquist 2006, and Crotteau et. Al. 2018). In the case of lepidopteran insect pests like the Jack Pine Budworm defoliation is the main concern. As the insect epidemic increases their can be expanses of standing fuels with dead needles suspended in a sheet of silk and frass on most branches which can act as ladder fuels as seen in Figure 6 (OMNRF 2022(b)).

Figure 6. Jack Pine Budworm damaged trees (CBC News 2020).

These large expanses of standing dead or dying trees, retain less water than live trees making them more readily available to burn than a healthy forest. As decay within the stand occurs branches and whole trees will fall depositing debris (fuel) around the bases of other dead or dying trees which increases the downed woody debris on site (Watt et. Al. 2018). The amount of downed debris in a stand is important because after several years of accumulation the debris can reduce the herbaceous plant layer on the ground (Watt et. Al. 2018). Having a live herbaceous layer on the forest Floor has been shown to retain higher moisture contents and reduce the probability of crown fire ignition (Watt et. Al.

2018). This accumulation also ensures these fuels receive more sunlight further reducing the fuel moisture content at ground level. The debris can also be caught in in the branches of still standing trees creating “snag trees” and suspended fuels which increase the vertical fuel loading on site and act as ladder fuels for wildfire (Candau, Fleming, and Wang 2018).

Studies on the Spruce Budworm (*Choristoneura fumiferana*), a species once thought to be the same insect as the Jack Pine Budworm have shown there is a window after defoliation in which the likelihood of large fires increases (Watt et. Al. 2018). It has been observed that three to nine years of defoliation in these stands can raise the fuel load to a point where ignition probability and crown fire potential are both increased over unaffected stands (James et. al. 2016).

2.5 FIRE SMART

The Fire Smart Program was founded in 1990 by the Alberta Forest Service, its original committee was formed of various federal and provincial associations. It was developed for the purpose of producing action plans for dealing with urban interface wildland fires and as of 2021 is a division of the Canada Interagency Forest Fire Centre (CIFFC) (FSC 2023).

Since its conception the Fire Smart program has been working with communities, industries and individuals to create plans to protect properties and infrastructure from wildland fires. Fire Smart is a multi-faceted organization which is working on developing legislation, community protection and evacuation plans, as well as providing communities education opportunities.

Fuel reduction (vegetation management) around the home, is the most cost-effective way a homeowner can protect their home from wildfires. This can come in three forms, the first being fuel conversion which is the removal of volatile fuel types and replacement with less volatile fuels. For example, replacing spruce, pine, or fir trees near infrastructure with hardwood species which have lower chances of acting as ladder fuels and produce fewer spot fires. The second is fuel removal which means an area is completely cleared of forest fuels, this area is intended to act as a large fire break which may not completely stop a wildfire but will reduce the intensity with the exclusion of vertically arranged fuels allowing other control methods to be employed. The final vegetation management technique is fuel reduction. This method has individuals clean and tend forests surround infrastructure, common reduction techniques are to rake leaf and needle debris, pile and safely discard of broken and fallen limbs, and pruning of lower branches on conifer trees to remove ladder fuels.

Home and businessowners may also receive recommendations on the actual construction of their infrastructure, this is because it is known that different materials are more readily available to burn. A homes roof is often one of its most fire vulnerable locations because it is one of the most difficult to maintain and it is the highest point meaning embers raining down reach it first. For these reasons it is imperative to keep rain gutters and other accumulation points clear of debris. Selecting fire resistant materials like steal or other metals can reduce accumulation, eases cleaning and increases the time fire may contact a structure in the case some fuels that have accumulated do catch on fire.

Most Fire Smart tips for homeowners are things that would often go overlooked like recommendations, not to store building materials or different petroleum based fuels under a home or porch, to block ember access to the bottom of lifted homes or cabins with non-flammable materials (sheet metal), store petroleum fuels in one location when safe to do so as it is easier to protect one explosive location than 10, and do not exclusively rely on garden sprinklers to protect a home as most towns can’t support the water requirement of a large values set up off municipal water. The Red Lake water tower supported a professional values set up for a half hour before it had to be shut off to refill (values should be ran for hours straight prior to fire arrival to create the required “relative humidity (RH) bubble”), so in an actual emergency it is even more imperative to not misuse water resources.

2.6 SALVAGE LOGGING

The harvest of forests stands which have been affected by a natural disturbance is known as salvage logging. Salvage logging is a forest management practice which seeks to claim the economic value of timber affected by wind, fire, or insect events before the product is deteriorated past its use (Leverkus et. al. 2020). Salvage logging can have additional benefits as well, like the reduction of fuel loads, and the promotion of regeneration on select sites. The implementation of salvage logging has increased over the past decades as natural disturbance regimes have been disrupted.

The use of timber after salvage logging is dependant on the type of disturbance that occurred. In the event of a wildfire timber is often affected in a way which will not support structural construction uses. This means that the timbers value may be held as fuel wood for hog fuel plants or paper (International Paper Maker 1996). As the demand for renewable energy solutions increases this type of harvest may offer opportunities for companies to reclaim lost timber value from fires which occur in their wood supply. Though the economic viability is often derived from haul distances as the net energy production is low (Gautam et al. 2010). In some cases, this fire disturbed timber may also be able to be chipped for pulp production (International Papermaker 1996). Though in 2020 it was identified through personal communication with a logging supervisor that many contractors prefer not to chip burned salvage logs due to the additional wear on equipment, which is supported in Saint-Germain and Green's 2009 paper on salvage logging in the Boreal and Cordilleran Forests.

When the forest disturbance being harvested is an insect outbreak there may be more the options as there isn't an instant change in the composition of the timber. In the case of wood boring insects, the damage presented does not always prevent the timber from being used for construction grade saw logs (Saint-Germain and Greene 2009). If the damage or outbreak is caught early before other vectors start causing degradation, the insects may only cause what is known as “limited” degradation which will result in value loss but still retains its structural properties allowing for use as lumber (Saint-Germain and Greene 2009). Being that the Jack Pine Budworm does not bore but defoliates there is less of a chance for other vectors to enter the timber, and defoliation may be required for multiple consecutive seasons to result in mortality giving managers more time to respond. Of course, deteriorated insect damaged sites may still be harvested for pulp wood but with time the water content is lost from the dead standing timber which lowers the value in a weight/volume system (Saint-Germain and Greene 2009). Biomass is an option for areas which have past the thresholds for use as pulp or saw logs. In the case of biomass production the lower moisture content of more deteriorated trees can have beneficial effects as the thermal conversion process works best when the biomass being used has a moisture content of around 10% (Mansuy et al. 2018 and Anerud et al. 2021).

The reduction of fuel loads is a common objective of salvage logging as all disturbance types inevitably result in an increase in downed woody debris. For wind events this is an instant result while fire and insect disturbed stands often remain standing for several years after disturbance (Leverkus et. al. 2020). Salvage logging is an effective way to prevent the future build up of this debris and fuel loads as it removes the stems which will fall in the years post disturbance (Leverkus et. al. 2020). This harvest has been noted to increase the amount of fine fuels on the disturbance site which has the potential to increase ground fire intensity for a short period time after harvest (Leverkus et. al. 2020).

However, the reduction of fuel load goal may be considered a success as the overall build up of future course debris will have been mitigated and once the fine fuels deteriorate the sites fire risk will reduce (Leverkus et. al. 2020).

2.7 SLASH PILE BURNING

Slash pile burning is a forestry practice which involves the burning of residual or waste materials after the harvest of a forest stand. These piles are made of the tops, and limbs of the trees harvested on site as well as the stumps of trees which were removed for road construction. Slash pile burning has the ability to reduce a sites fuel load by removing the material from a cut block. This also facilitates easier reforestation efforts for tree planters, by removing debris from the block planting locations may be easier to identify and injuries from navigating the debris may be mitigated (BCFSC 2013).

It has been observed that Jack Pine, and White Spruce (*Picea glauca*) seedlings establish better in fire scars than in control plots which have full vegetative cover (Thorpe and Timmer 2004). These seedling are benefitting from the increased access to the nutrients Nitrogen, Phosphorus and Potassium (N,P,K) which would have otherwise been unavailable on the site (Thorpe and Timmer 2004). The increased access to these nutrients had noticeable effects on the root and height development, producing up to 155% of the biomass experienced on the control sites (Thorpe and Timmer 2004). The seedlings planted in the fire scars also exhibited reduced mortality having only 1.5% while the control sites had 17% perish (Thorpe and Timmer 2004).

Fire has long been used for the purposes of vegetation renewal and the encouragement of new growth. Many indigenous communities have been utilizing prescribed burning to encourage the growth of important medicinal and edible herb/fruit species (Roy-Denis 2015). Slash pile burning may provide habitat for culturally significant species that can only germinate after a fire occurs, one such species is known as Fireweed (Chamerion angustifolium) and it has been used as an anti-inflammatory by various indigenous groups (Roy-Denis 2015, Jonsson and Nihlgard 2004).

For effectiveness of burn slash piles are recommended to be at least as tall as they are wide (CSFS 2015). However, there are multiple variable effecting how a pile will burn. The composition of the pile has a large effect on what how a pile will burn. When piles are primarily Trembling Aspen (*Populous tremuloides*) based it may be more difficult to effectively remove the biomass. This due to aspens lack of fine fuels (small twigs and branches), its thicker bark at maturity (drip torch fuel will run off for longer periods of time making ignition difficult), and the large boles which aren't in the centre of the pile may leave large partially burned residuals around the outside of the burn scar (a fire ring). When piles are conifer based there is a higher abundance of fine fuels and large woody debris with other flammable compounds, which support easier ignition and higher consumption rates than hardwood piles. For this reason, when harvest occurs on mixed wood sites it is recommended piles be strategically mixed with deciduous and conifer debris. Another burning recommendation would be to have piles sit for a minimum of one dry season to have as much of the residual moisture in the wood expelled (CSFS 2015).

The different types of slash piles used in Northwestern Ontario are variable based on a site's species composition and the contractor preforming the work. The majority of piles seen on the landscape are separate roadside piles which are frequently very tall and may take up a ground area of greater than 5 m in diameter. However, companies contracted to Domtar on the forests around Dryden are currently doing long wind row pilings. This is when there is a relatively short and narrow pile that extends for hundreds of metres down a block road. This type of piling is extremely effective for conifer debris, as it more readily takes a flame, meaning a burner may simply walk along a pile lighting as the go rather than standing in one spot building a fire and moving on.

3.0 METHODS

This literature review has been conducted using resources found online and in printed texts. The sources used have been retrieved from the Lakehead University Library as well as the Omni database. Google Scholar was also utilized for identifying new databases and publications that have undergone a peer review process. Other governmental documents and websites were also reviewed for critical information. A break down of the specific literature sources by source type can be seen in Figure 7 (raw data available in Appendix 6).

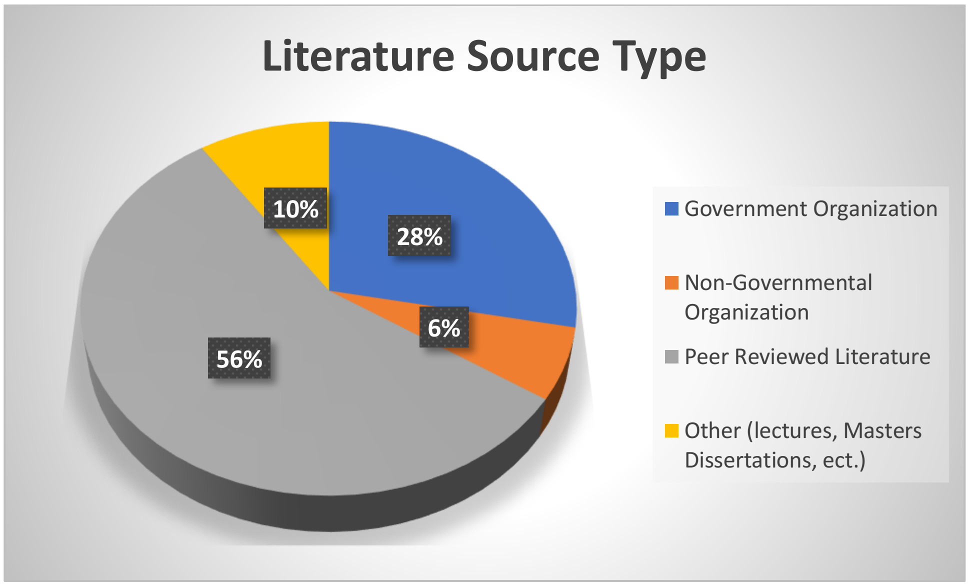

Figure 7. Literature break down by source type.

The specific search parameters that have been used are “Jack pine budworm-effects on wildfire”, “Jackpine budworm-increases in fuel loading”, “Salvage Harvest”, “slash pile burn” and “Fire smart recommendations for remote indigenous communities”. These search parameters provided a large compilation of resources. The publications collected have been chosen based on current and have been assessed for bias.

The Ontario GeoHub was accessed to retrieve public data produced by Land Information Ontario (LIO). Forest insect disturbance event maps were reviewed from 2017 until 2020 as 2017 was the first year the disturbance was mapped, 2020 was chosen as a stop point because wildfires in the area prevented insect disturbance mapping in 2021. Fire disturbance area maps of the area around Pikangikum were reviewed from 2017 to 2021 in order to assess whether any trends presented in the literature review appear.

Salvage logging practices were assessed to determine the viability of JPB affected trees for use as Biomass, pulp wood or saw logs. The possible reduction in fuel loading after salvage logging was also assessed in this review process.

4.0 RESULTS

Through the literature review process, it has been shown that Pikangikum has been negatively affected by the Jack Pine Budworm outbreak on the Whitefeather Forest in the form of increased fire risk. Unfortunately, due to the cyclical nature of JPB outbreaks it is a disturbance that can be expected to continuously re-occur around the community. Fires can be effectively controlled and managed at smaller sizes and lower intensities, but the conditions produced by the JPB often support rapid fire growth. Therefore, the only option to reduce the effects of an outbreak, is to manage the forests to prevent the accumulation of these fuels.

4.1 JACK PINE BUDWORM AND FUEL LOADING

A study focussing on the effect Spruce Budworm (Choristoneura fumiferana) had on the fuel loading suggested that the insects begin to increase the fuel load of a site three to nine years after the stand is affected. This increase in fuel load is expected to increase the likelihood of a large fire in the outbreak area. The Spruce budworm has a very similar life cycle, and feeding damage to the closely related Jack Pine Budworm and as such a similar pattern may be expected. This prompted the examination of the Jack Pine Budworm and wildfire maps between Red Lake and Pikangikum from 2017 to 2021. This range was chosen as it was the first year this outbreak had been mapped though defoliation was present in the summers of 2015 and 2016 (OMNRF 2016).

The maps provided in appendices 1 through 5 show the progression of the Jack Pine Budworm outbreak overlaid on the two worst fire seasons in the 5 years examined. It can be noticed that in 2019 there are three large sections of the outbreak that were burned from the previous years outbreak area. Red 014, 039 and 040 grew to 3,835 ha, 43,308 ha and 30,213 ha in areas which had been defoliated the previous year and which can be seen in appendices 1 and 2. This is consistent with the effect spruce budworm had on fuel loading and is further supported through map examinations. This is because the outbreak reaches the north shore of Nunguesser Lake in 2018, this area expands until 2020. The JPB data from 2021 was not collected, this is likely a result of fire response receiving higher priority that season. However, in the 2021 season

Red 068 started on the north shore of Nungesser Lake in the timber that had been affected since 2018 and consumed 26,674 ha of timber which had received defoliation in prior summers and it can be observed in appendices 3 through 5.

4.2 SALVAGE HARVEST AND PIKANGIKUM FIRST NATION

The residents of Pikangikum have a longstanding relationship with the forest surrounding their community. With the development of their “Keeping the Land” land use strategy allowed for the community to have further control of the use of their forests as well as opened the doors for the development of new businesses within the community. Recently, the community has started a small business that has began milling and production of hand made furniture with timber from the Whitefeather Forest.

The pine effected near the community could supply the mill with the timber required for production while reducing the fuel loads in areas which have not had a recent fire. This is because when an outbreak is caught in the early stages or trees haven’t reach mortality the timber should be viable for maximum lumber production as it may take multiple years of defoliation to cause mortality. Though current outbreak maps are unavailable there were mapped occurrences with road access or potential winter road access as recent as 2020 as seen in Figure 8.

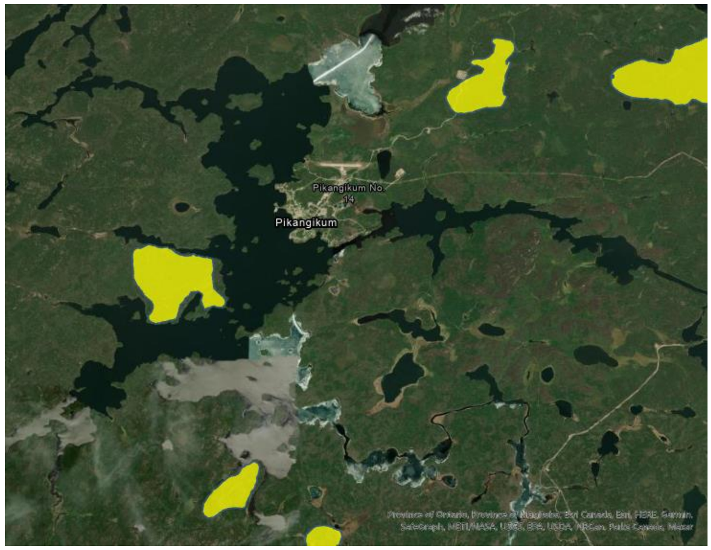

Figure 8. 2022 Jack Pine Budworm outbreak map with yellow polygons marking potential salvage harvest locations.

However, if the trees have reached mortality decay will set in. The rate and extent of decay is dependent on multiple factors and may be examined after felling. Usable timber can be diverted to the sawmill though the presence of decay should prompt the prioritize of milling and storage salvage lumber over “healthy” timber.

Staining though not a structural defect often occurs in jack pine which have contact with an *Ophiostomatales* fungi (Andersen 2009). The presence of which may cause the wood grain to have a blue to black staining, this defect may lower the value of lumber for the purpose of construction. However, the community sawmill doesn’t focus on production of construction grade lumber, rather the creation of value-added furniture. This stained wood may be a desirable visual aesthetic for the hand made furniture. The natural staining can create a striking visual effect and the community maybe able to take advantage of the unique product like many others in the furniture industry have done with the fungal spalting in Maple or Birch.

Trees felled to produce lumber that do not meet the decay standards should not go to waste, as the community has recently installed Biomass boilers. This addition to the community for the purposes of lowering the community's reliance on fossil fuels for heating the community. These "waste" trees can be chipped and burned to create the energy to heat various community structures. Being a significant portion of the forests directly adjacent to the community have been affected by either fire or insect disturbance it may be possible to do salvage harvests specifically for biomass production. Being harvest of fire kill alone could happen withing 3 km of town (Red 014), the incredibly short haul distances could support the financial viability of biomass production. It has also been noted that fire kill was a common source of firewood within Pikangikum so in addition to biomass production the community can benefit at the individual level from Red 014 through firewood collection.

Commercial salvage harvest of the southern portions of the Whitefeather Forest may be viable as harvest does occur on the North Road which crosses a portion of the Whitefeather Forest before re-entering the Red Lake Forest where the harvest occurs. In order for this harvest to be lucrative for the buyer it would likely require the same clear cut and slash pile burning treatment as the other blocks on the North Road due to the long-haul distance.

4.3 PRESCRIBED BURNING FOR CULTURAL VALUES

It was noted in Miller, Davidson-Hunt, and Peters's 2010 paper that the community has step away from traditional burning due to fire exclusion. Since then, food has become accessible year-round and the necessity for such a practice has passed. However, the community is deeply interested in maintaining traditions and as such would be interested in reinstituting it. In 2019, 2 large fires had their boarders within 6km of the community one of which (Red 014) occurred less than 3 km from the community. This fire has road access points in two locations as well as areas of exposed bed rock as seen in Figure 9. Which may make it a good location to practice traditional burning for berry production. The position of this fire was east of the community which offers a slight decrease in the risk of an escaped fire entering the community. This is because the prevailing winds in Canada are from the west. Which means with proper planning the fire should generally spread from west to east in the event of an escape.

Figure 9. Red 014 (2019) fire perimeter map of the area north of the Barens River.

The placement of the burn plots within the old burn may offer additional protection as there has been a recent reduction in fuel loading in the area and the new growth itself may slow fires progression due to the high moisture content (season dependent). With the inclusion of biomass and firewood production occurring in this area additional post fire waste will be removed from the site further reducing the fuel load in the area. Additionally, this fire stretched along the north shore of the Barens River which would provide a sufficient water source in the event if suppression were required as well as a decent fuel break.

The community of Pikangikum has two full time OMNR Fire Ranger crews entirely made of community members stationed in town. These crews may be involved in the suppression and burning of the blocks as they have advanced fire control training already. If the need for further resources were required, it would be possible to have crews stationed at the OMNR Forward Attack Base at BAK Lake which is a 25 km east of the community for quick response purposes. When properly planned and implemented the community may be able to create and maintain excellent berry habitat outside of their community while reviving a lost tradition of cultural burn.

4.4 SLASH PILE BURNING

If commercial harvest of the southern portions of the Whitefeather Forest were to occur the use of slash pile burning may be implemented as a land clearing opportunity which offers some benefits (Thorpe and Timmer 2004). Domtar has harvested in the area before (different licence) which shows there is opportunity for timber to be salvaged in the area. However, logging residue left in these sites may be out of reach for Pikangikum’s biomass plant, in which case the waste should be piled and burned to benefit ecosystem services.

Slash pile burning around the community is another option for fuel reduction in areas which have had mass mortality from the JPB outbreak and have had time to deteriorate. As advanced decay sets in most timber becomes unusable as biomass due to the high moisture content (Mansuy et al. 2018 and Anerud et al. 2021). Though this timber may still add to an areas fuel load in the form of snags, and downed woody debris. For this reason, it may still be beneficial for community Fire Smart commitments to remove the fuel load.

4.5 FIRE SMART VALUE

With an increase in vegetation management in the form of salvage logging, slash pile burning and biomass production the fuel loads surrounding the community should be reduced. These reductions can be maintained through continued forest and disturbance management. Which may make future JPB outbreaks less a fire hazard to the community.

Additionally, many indigenous groups have utilized fire for the creation of fuel breaks around their communities (Miller, Davidson-Hunt, and Peters 2010). By continuing to maintain burnt blocks within the Red 014 burn east of the community there could be a near contiguous fuel break from the from the Airport to the Barens River. The fuel break may not fully limit a fire spread but may reduce intensity of the fires approaching the community.

5.0 DISCUSSION

5.1 ECONOMICS

Many of the options for managing the JPB outbreak around Pikangikum can benefit the community on an economic level. In event the community were to institute a salvage harvest for biomass or lumber production, the community would have an increase in locally available jobs. This is because an endeavour like this would require a harvesting team, new haul drivers, additional plant employees, and a planning team. All of which are positions that could be held by community members and offer transferable skills for career advancement. Additionally, if salvage harvest were to occur in the southern portions of the Whitefeather Forest, the community members trained on the harvest team may be able to work as contractors for whatever large corporation were to purchase the timber. This allows for income to the community from both the purchasing of the timber as well as acting as contractors. The proximity of the harvest locations may also reduce the cost of delivery of biomass to replace diesel fuel for the benefit to the environment.

The fuel load reductions, as well as the increases in fire breaks, and access may also be able to reduce the likelihood of forced large scale evacuations ultimately saving community members and other Canadian government money. The actual cost of the evacuations was not evaluated, though the value would be huge. This is a community of over 3000 individuals only accessible by plane meaning everyone needed fights, housing, food, and entertainment for more than a month out of a year.

5.2 SOCIAL IMPACT

Along with the economic benefits developing an integrated resource management strategy can have for the community, it could also provide opportunities for social development. This is because the old burns which occur near the community may be used to produce firewood and cultural burn plots. Both of which have been identified as past cultural practices in the community. Cultural burning is a lost tradition which had been practiced prior to fire management, for the development of fire breaks and food production. With the addition of burning blocks in proximity of the community, individuals may benefit from the fire breaks and higher blueberry yields while reviving a lost tradition. Ultimately acknowledging the communities understanding of the ecosystem and taking steps towards reconciliation. The addition of these burn plots and the fire smart benefits they bring also prevent social disruption in the community from fire evacuations. In the evacuations families are sent to various communities with different cultures and may end up away from loved ones for extended periods of time.

5.3 ENVIRONMENTAL IMPACT

With an increase in Biomass production the community may be able to reduce its reliance on fossil fuels for energy production, thus making the community more environmentally friendly. If the community moved to a primarily biomass system most of the energy would be coming from a renewable resource, which has incredibly short haul distances. These short haul distances reduce haul emissions over that of long hauling, which is how the diesel fuel is currently transported. So, there are greater emissions from transporting the non-renewable fossil fuel, that will then be burned in the community. It is recognized that fossil fuels do emit lower levels of particulate matter and carbon monoxide (CO) than biomass. However, these emissions come from a source which has adapted to require burning for renewal (boreal species), making biomass a more natural option while still having a lower carbon output than that of fossil fuels due to the renewable nature and carbon sequestration of forest resources.

6.0 CONCLUSION

Pikangikum First Nation may be able to benefit from the Jack Pine Budworm outbreak in multiple ways while reducing the fire risk around their community. The salvage harvest of the timber affected by JPB would be considered a form of vegetation management through Fire Smart programs and would provide an economic return to the community. While simultaneously providing additional Biomass for the community's boilers, which could further reduce the community's reliance on fossil fuels. For the non-viable timber in the area slash pile burning may be an option for fuel reduction as well. Additionally, by continuing to maintain burnt blocks within Red 014 burn east of the community there would be a near contiguous fuel break from the Airport to the Barens River. This fuel break may not fully limit a fires spread but it will reduce the intensity and provide easy access for ground crews which may also reduce the community's likelihood of mass evacuation.

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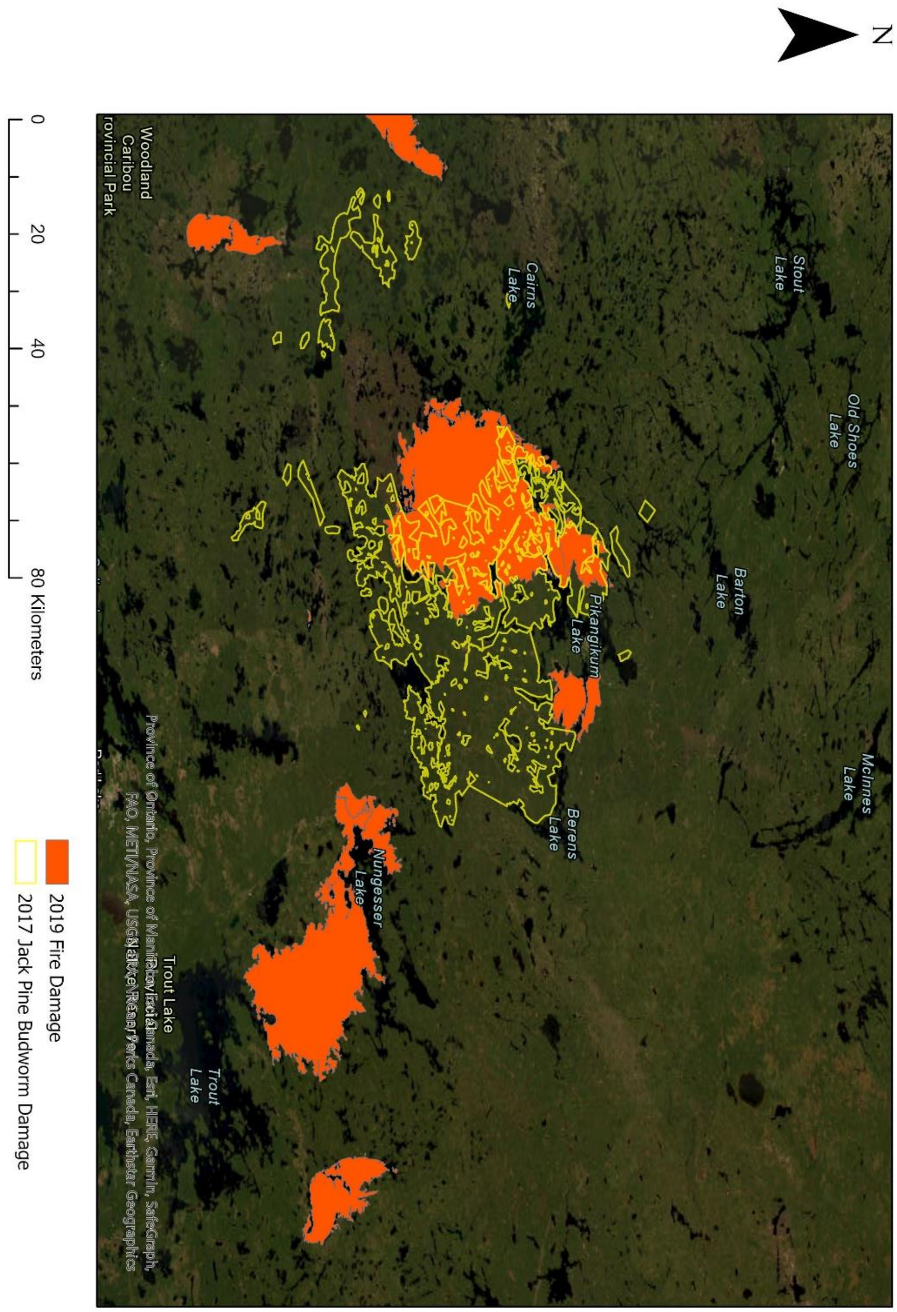
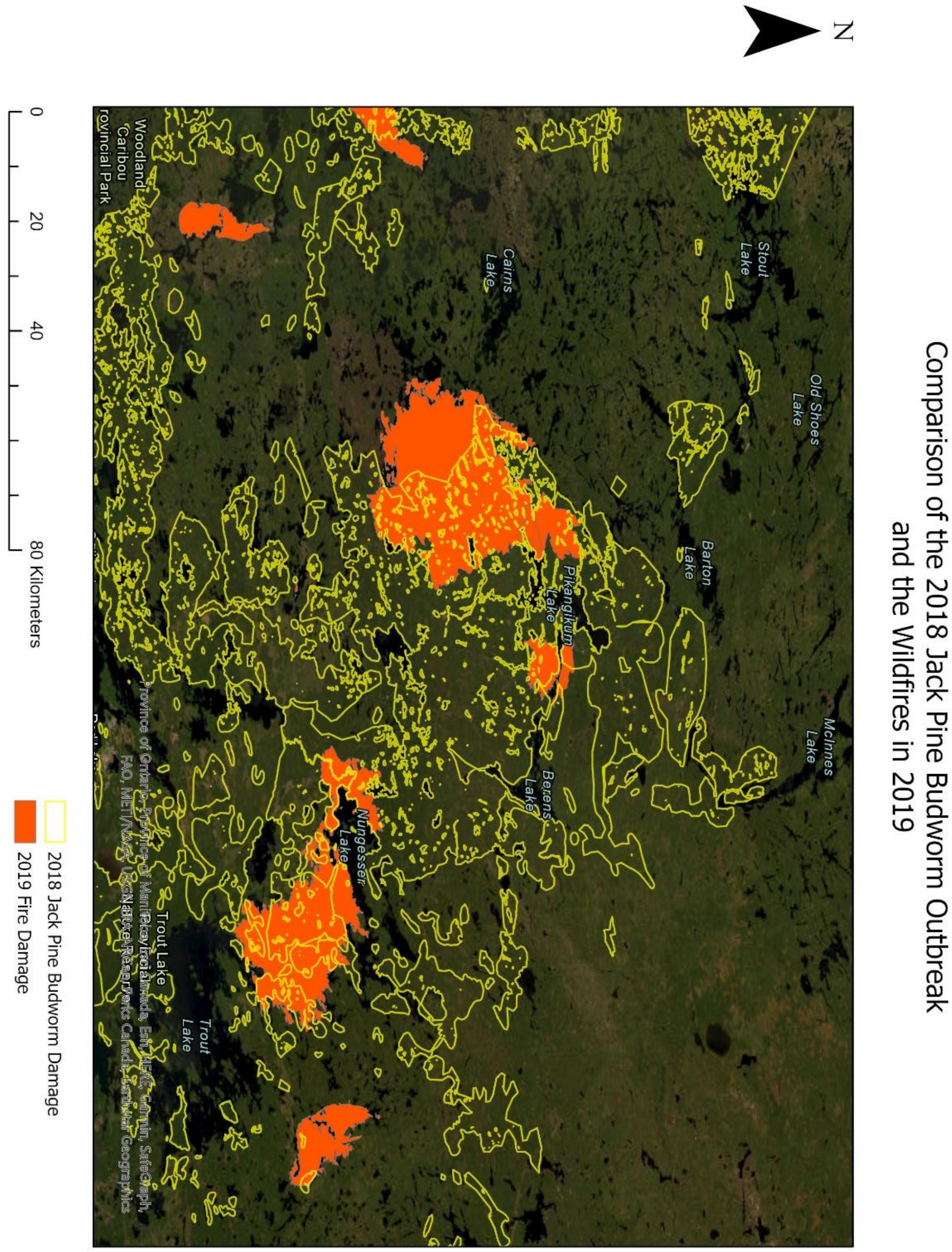
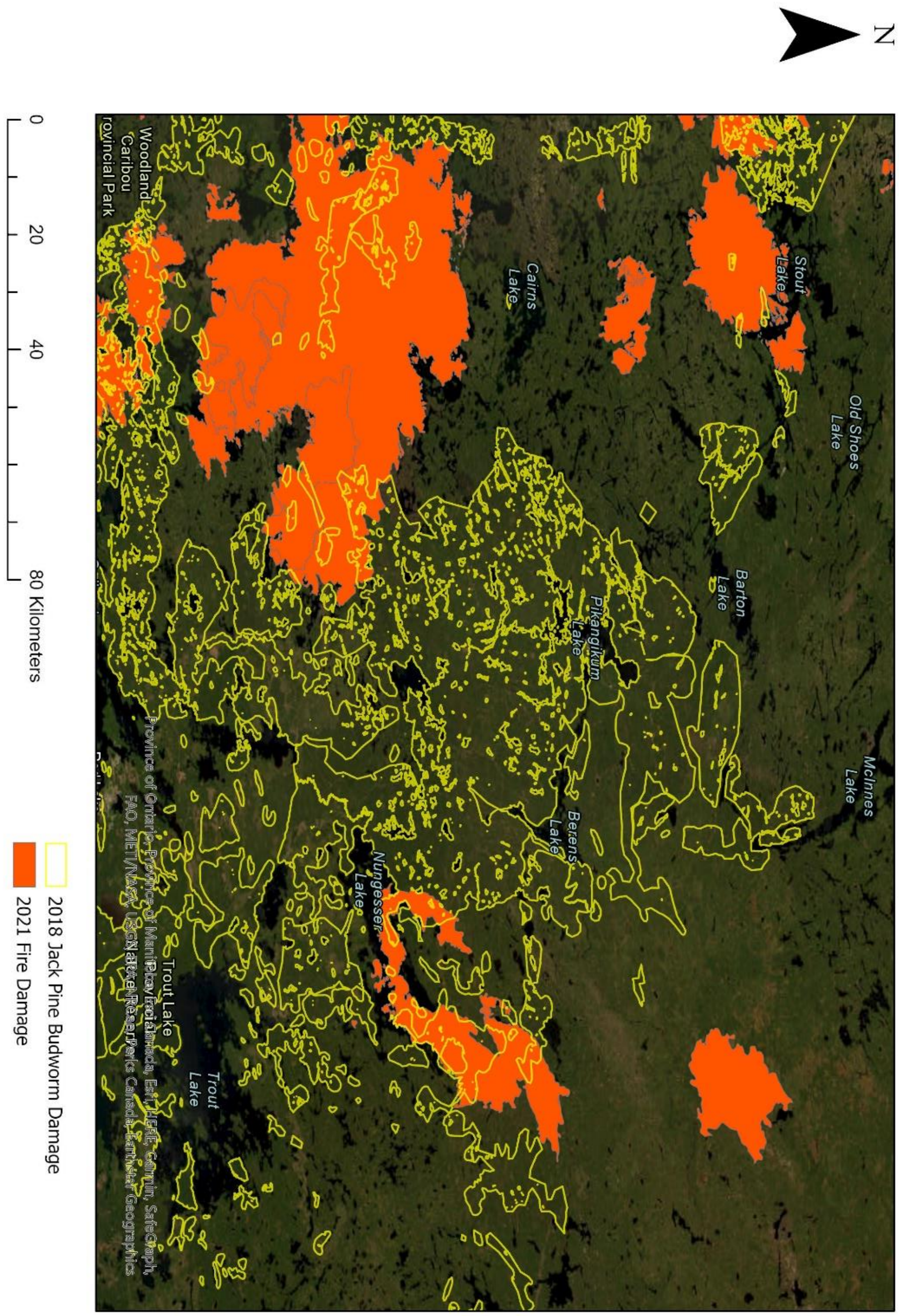
APPENDICIES



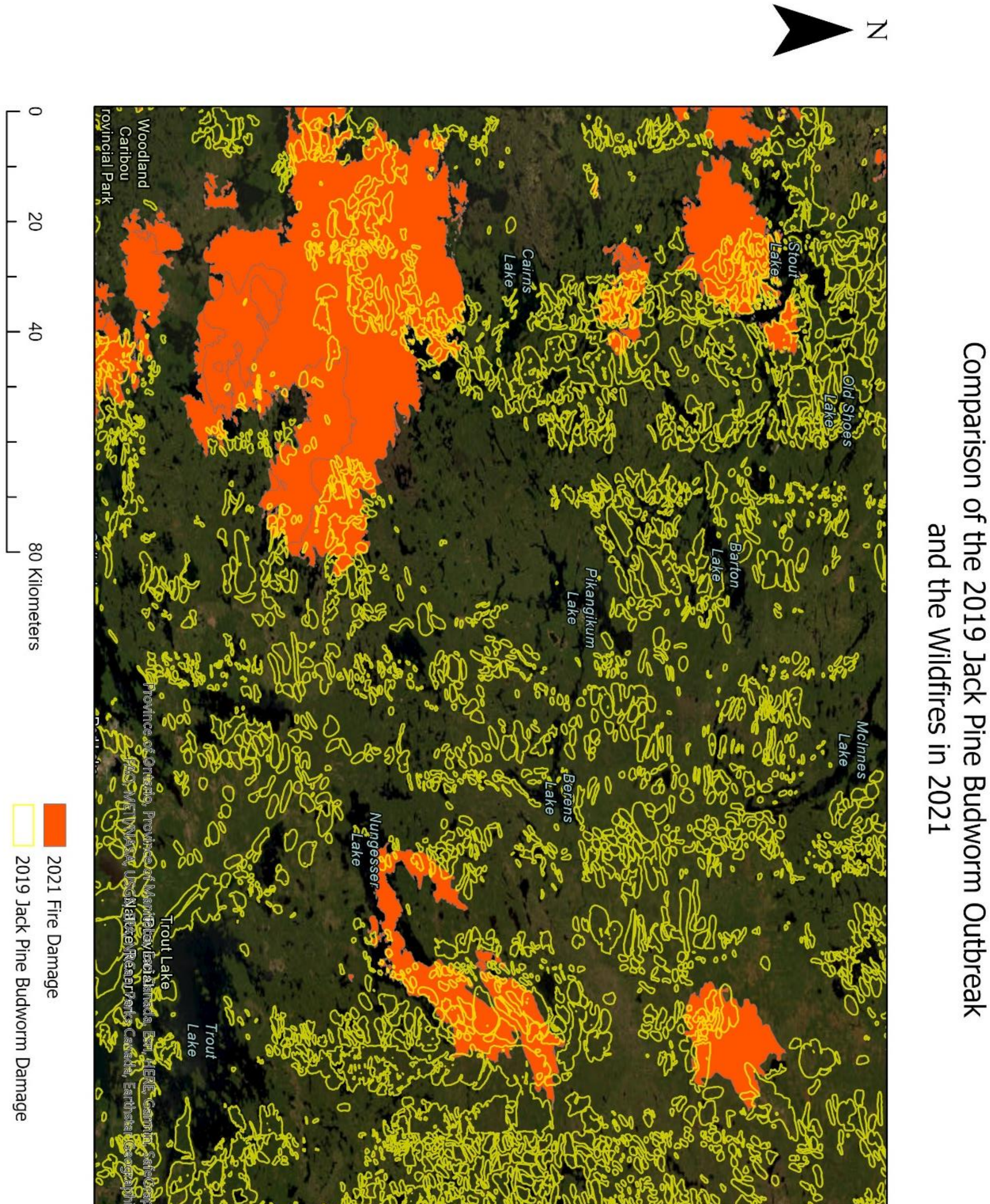
Appendix 1. Map of the 2017 JPB outbreak over laid on 2019 Wildland Fires.



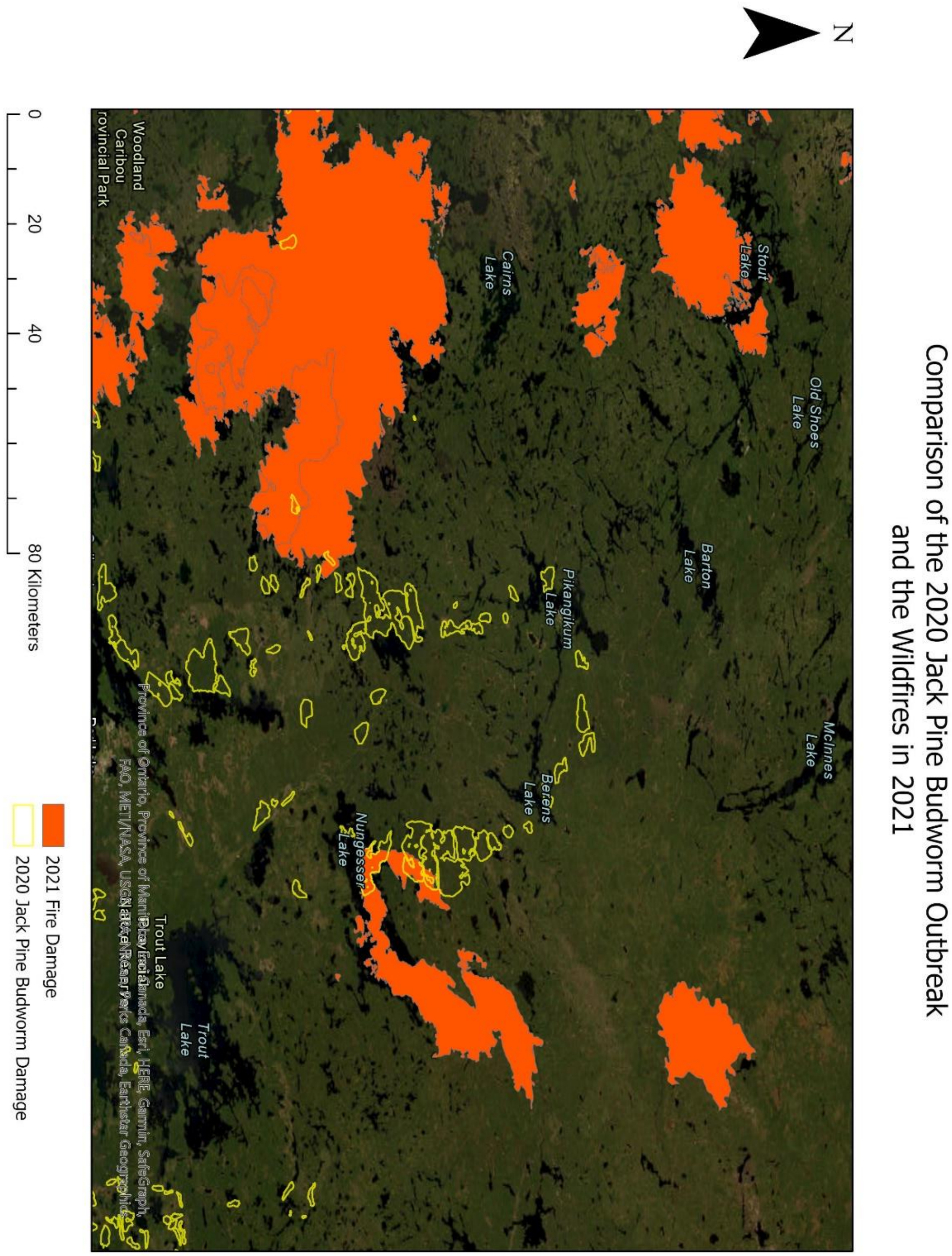
Appendix 2. Map of the 2018 JPB outbreak over laid on 2019 Wildland Fires.



Appendix 3. Map of the 2018 JPB outbreak over lain on 2021 Wildland Fires.



Appendix 4. Map of the 2019 JPB outbreak over lain on 2021 Wildland Fires.



Appendix 5. Map of the 2020 JPB outbreak over lain on 2021 Wildland Fires.

Document #	Government Organization	Non-Governmental Organization	Peer Reviewed Literature	Other (lectures, Masters Dissertations, ect.)
1				1
2			1	
3		1		
4				1
5	1			
6			1	
7			1	
8		1		
9			1	
10			1	
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22	1			
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24			1	
25			1	
26	1			
27			1	
28			1	
29			1	
30			1	
31				1
32			1	
Totals	**9**	**2**	**18**	**3**

Appendix 6. Raw data for literature review sources.