# Firewood Pathway Analysis for Canada

Prepared for:

Forest Pest Working Group -
Canadian Council of Forest Ministers

Prepared by:

Jennifer Gagné[1], Maria Al Zayat[1], and David Nisbet[1],

[1]Invasive Species Centre
1219 Queen Street East
Sault Ste. Marie, Ontario
P6A 2E5

Date: March 31, 2017
Revised: June 13, 2017

# Table of Contents

# Introduction

Forest invasive species threaten natural and semi-natural ecosystems and can lead to large economic losses of both "market and non-market" values (Pimentel et al. 2001; Aukema et al. 2011). Fortunately, not all species that arrive in a new country become established, fewer become invasive, and fewer still reach widespread establishment (Williamson and Fritter 1996). However, those that do become invasive can have profound effects on the economy and natural ecosystem as they further establish and spread through natural dispersal and pathways.

The firewood pathway—the means of moving forest pests from their natural habitat to new areas—is not usually the primary factor in new introductions, but plays a large role in the spread of invasive species that have arrived by way of other means (CFIA, 2011; Environment Canada, 2013).

Emerald ash borer (*Agrilus planipennis,* EAB) and other wood-boring insects likely arrived by way of infested solid wood packaging materials, and firewood has been a significant vector to their spread (USDA-APHIS 2011). Ash tree mortality caused by EAB is projected to cost Canadian communities over $890 million in removal and replacement costs. Within the United States, projections for costs incurred for EAB management increase into the billions (McKenney et al. 2012, Kovacs et al. 2010).

The rapid expansion of EAB has been associated with the movement of firewood by recreational campers (Haack et al. 2002, 2010; Kovacs et al. 2010). The Asian longhorned beetle (*Anoplophora glabripennis,* ALHB), a generalist of many hardwood species, was first discovered in Chicago when a citizen noticed the beetle emerging from local firewood (Poland et al. 1998). If the Asian longhorned beetle became established in North America, 1.2 billion trees would be at risk (Nowak et al. 2001).

In order to respond to the risk associated with the firewood movement, National Plant Protection Organizations (NPPOs) have implemented phytosanitary measures[1] to certify that wood is pest-free. Within North America, treated firewood may include wood that is heat-treated, kiln-sterilized, debarked or chipped to a degree accepted by regulators to kill pests (CFIA 2011). Fumigation with methyl bromide is no longer an acceptable wood treatment method within Canada since it increases deterioration of the ozone layer (CFIA, 2011).

However, despite phytosanitary measures at the international and national levels, untreated firewood continues to move domestically within Canada and threatens both urban and natural forests.

[1] According to the FAO, phytosanitary measures are "any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests" (FAO 1990, 1993).

In January 2017, the Invasive Species Centre (ISC) made a proposal to the Canadian Council of Forest Ministers (CCFM) – Forest Pest Working Group to create a pathway analysis of the domestic movement of firewood within Canada. The proposal included both commercial and recreational movement of the commodity, existing risk management, gaps in the existing management strategies, and recommendations.

The Province of Manitoba supervised initial work including a survey of Provincial, Territorial and National organizations' assessments and mitigation regarding firewood. The ISC continued this work to include surveys and interviews with other stakeholders, including public and private campgrounds, firewood producers and vendors, and U.S. counterparts.

The following report is in line with the National Forest Pest Strategy and provides background to:

- provide advice to forest managers to develop management tools, methods and decision-support tools; and
- implement domestic regulatory controls regarding forest invasive species.

Furthermore, the report attempts to document all of the work currently underway in Canada by various stakeholders, and also aims to identify the best approaches to manage risk going forward (NRCan, 2015).

**Section 1** categorizes the **risk** associated with the firewood pathway by exploring existing risk assessments, research surrounding domestic movement and procurement processes. **Section 2** reviews current risk **mitigation** associated with the firewood pathway within Canada and the United States. **Section 3** highlights the **gaps** in firewood pathway risk management and communication, and provides **recommendations** to close these gaps through a coordinated approach to address potential outreach, regulatory and voluntary measures associated with firewood movement within Canada.

## Characterizing the risk

The process of analyzing risk typically involves four stages: risk initiation, assessment, management and documentation (FAO, 2005). Risk communication may be an additional stage or considered part of risk management (CFIA, 2011).

The risk initiation stage involves either identification of a pest or pathway that may require phytosanitary measures or identification of existing phytosanitary measures that need to be reviewed or updated. The pest risk assessment area (PRA)—the area that may be at risk due to introduction or spread of the pest to this area—is also defined at this stage (FAO, 2005) along with a review of existing pest risk assessments in other PRAs.

The risk assessment stage describes the pest or pathway, characterizes the potential for the establishment and spread of pests, and assesses the potential environmental and economic

consequences were the pest to establish in the PRA. Although the majority of risk assessments assess risk posed by an individual pest, pathways such as the firewood movement pathway can also be assessed as a potential vector for the spread of multiple pests (FAO, 2005). In Canada, the initiation and assessment stage are documented together (CFIA, 2011).

At the end of the assessment stage, a level of risk is identified. If the risk level is identified as unacceptable, a risk management plan is typically developed to address potential impacts (FAO, 2005). Risk management at the international level is primarily the development of regulatory or phytosanitary measures, but may also include outreach (risk communication) or voluntary measures. Risk documentation is fairly self-explanatory and involves recording the results of the preceding stages, uncertainties and a clear rationale of management recommendations (FAO, 2005). The following section describes the second stage of the risk analysis process: risk assessment.

## Existing risk assessments

### *USDA – APHIS: Risk Assessment of the Movement of Firewood within the United States* (USDA, 2011)

According to the USDA – APHIS, firewood is frequently moving and is likely to carry wood insects and diseases. Firewood is a notorious and well-documented pathway for the movement of invasive forest insects and pathogens. It is often processed from dead or dying trees and as such is more likely to harbour pests. Surveys conducted in the United States have revealed that firewood is moved readily within all 50 states, across expansive distances, and—despite regulations—even through pest quarantines.

The potential cost of pest spread via firewood is in the billions of dollars even for single pests. Projected costs for emerald ash borer damage to ash trees is $10.7 billion for 2009–2019 (Kovacs et al. 2009), and the potential damage from the Asian longhorned beetle is $669 billion, were the insect to spread across the country (APHIS 2007). Furthermore, the value of the paper and lumber industry in the United States is $262 billion a year (US DOE 2000). If forest pests are increasingly introduced through firewood into areas where trees are harvested, this could greatly impact these industries.

Recommendations include a review of the existing regulatory framework for firewood movement at the state and federal levels and the coordination of strategies to address risk management. Due to the potential for firewood to introduce pests to new areas far from their origin, reducing long-distance movement was prioritized (USDA-APHIS, 2011).

### *CFIA - Firewood from all sources: Commodity Risk Assessment* (CFIA, 2011).

The CFIA's risk assessment of firewood movement addressed two issues in response to the U.S. heat treatment requirements for imports of firewood:

1. To assess the risk associated with pest spread by way of the firewood pathway; and
2. To review alternative phytosanitary treatments to respond to the USDA-APHIS' more stringent phytosanitary requirements for importing Canadian firewood into the United States.

Similar to the USDA-APHIS assessment, the CFIA named the main risk characteristic associated with firewood as the low-grade value of the wood, often associated with pest infestation or infection. Additionally, the presence of bark typically associated with firewood increases the probability of pest presence and survival.

In response to the USDA's requirement that all firewood imported from Canada must be heat-treated to an internal core temperature of 71°C for a minimum of 75 minutes, the CFIA identified that there was considerable uncertainty around the standard. The CFIA then recommended the adoption of a standard for all of North America of 60°C for 60 minutes, which would kill *most* life stages of insects and pathogens. The USDA later accepted this standard for imports from Canada (USDA-APHIS, 2017).

## International Import of Firewood

The increase in international trade of wood products or wood packaging has led to greater introductions of non-native forest insects and diseases (Mack et al., 2000). Non-native pests can have impacts on the natural environment as they attack hosts that did not evolve with them.

The risk of moving pests into Canada by way of firewood has been partially mitigated by heat-treatment and debarking requirements. Furthermore, firewood is not frequently imported into Canada.

For example, in 2011, a total of 235 metric tons of firewood (approximately 65 cords) were imported into Canada that year. This represented only 19 imports all from the United States, except one import of mesquite firewood (considered low-risk) from Cortes, Honduras (CBSA, 2011) as shown in Figure 1 below.

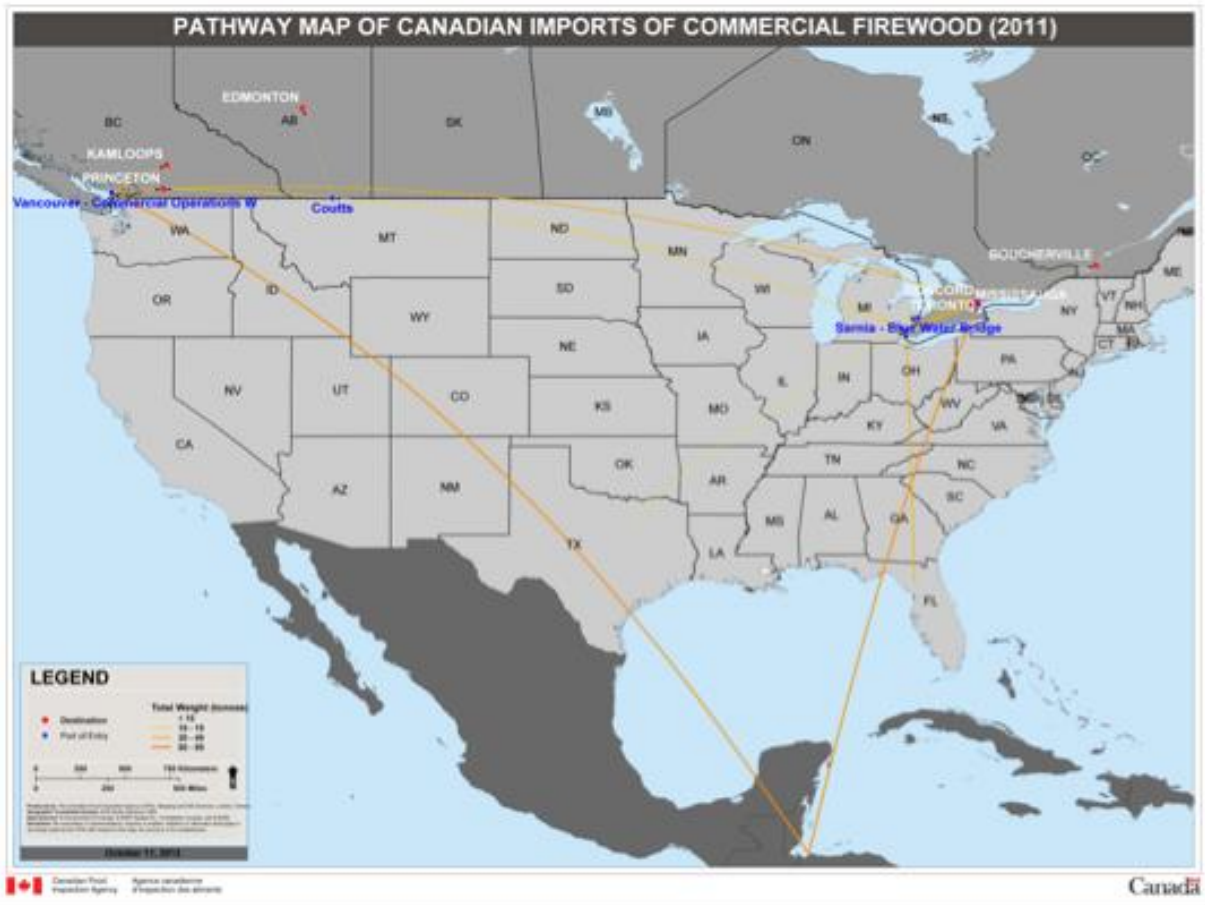


**Figure 1. Pathway map of Canadian commercial firewood imports in 2011.** Data source: Canadian Border Service Agency, Electronic Data Interchange system.

Commercial imports into Canada are tracked and inspected by the Canadian Border Service Agency (CBSA) and require phytosanitary treatment. By having enforced borders, strict heat-treatment protocols, certificate requirements, and limited imports, the risk associated with moving firewood into Canada is much lower than the domestic movement within Canada. Unfortunately, domestic movement is difficult to address and has not been well documented (Koch et al. 2012).

Although Europe, Australia and other countries have requirements in place for importing wood products, they tend to be country- or pest-specific. No phytosanitary requirements or risk assessments specific to firewood were found, and the European Union particularly did not identify firewood as a risk worthy of individual phytosanitary measures or assessment (EPPO 2015).

## Domestic movement of firewood

Recreational travel as a threat to invasive species spread has frequently been overlooked (Koch et al. 2014). Generally, recreational travel is limited to short distances (<100km per trip), with approximately 10% of campers traveling longer distances >500km[2]. Haack et al. (2010) revealed that 23% of firewood pieces surrendered at Michigan's Mackinac Bridge between the Upper and Lower Peninsula contained live borers, and 41% had signs of previous wood-borer infestation. Additionally, Jacobi et al. (2012) found that live insect pests emerged from over half of the wood purchased from vendors outside of the southern Rocky Mountains. If it is assumed that ~20% of firewood carried by campers is infested, then the risk associated with moving firewood is well justified[3] and can lead to significant satellite infestations, well beyond natural dispersal (Koch et al. 2012).

Insects and diseases can live in firewood for approximately 1-3 years and up to 5 years (Jacobi et al. 2012). Moving firewood that is not properly treated, regardless of whether it is seasoned or not, can move insects and diseases long distances and cause major environmental and economic damage where they arrive (Haack et al. 2010, Tobin et al. 2010, National Firewood Task Force [NFTF] 2010, Jacobi et al. 2011, Jacobi et al. 2012). Whereas trade tends to move infested materials to major urban centres, movement by campers expands the risk to natural forested areas, typically found near campgrounds (Poland & McCullough. 2006, Koch et al. 2012).

Restrictions of firewood movement exist in Canada and the United States. The United States has firewood restrictions in almost all states (TNC, 2017). In Canada, all domestic movement restrictions are related to regulated pest areas. However, within regulated pest areas, all firewood (or all hardwood or conifer firewood) tends to be regulated since it is difficult for inspectors and the public to recognize tree species once wood is processed (Haack et al. 2010).

Although data on domestic movement of firewood within Canada is lacking (Koch et al. 2012), recently papers have mapped recreational travel as a proxy for the firewood pathway (Jacobi et al. 2011, Yemshanov et al. 2015, Yemshanov et al. 2015b). Yemshanov et al. (2015b) mapped the pathway (origin (home) to destination (campground)) in three U.S States and three Canadian provinces as shown in Figure 2 below.

[2] Based on results of campers visiting National Parks in the United States (Koch et al., 2012).
[3] Koch et al. (2010) addressed the point that despite the high amount of infested wood, new infestations are dependent on the ability of the pest to establish in the new area.

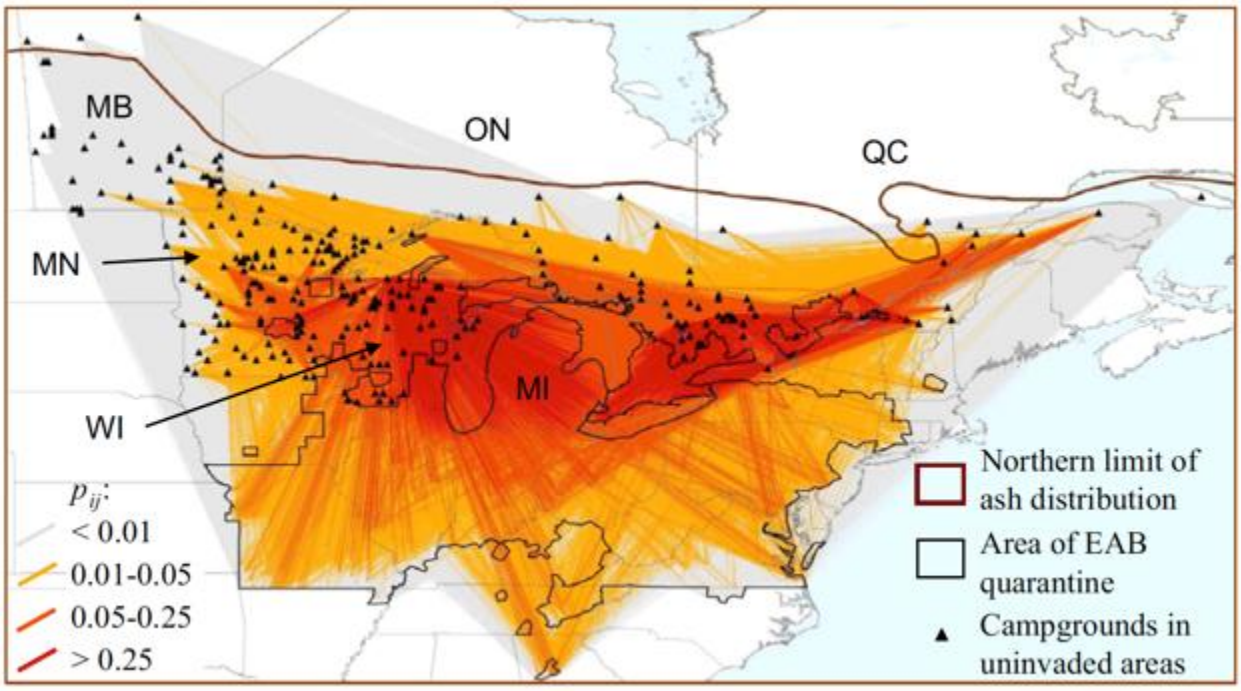


**Figure 2. Origin-destination vectors of potential emerald ash borer (EAB) spread with campers travelling from areas under EAB quarantine** to campgrounds in uninvaded areas in three US states (Michigan, Minnesota and Wisconsin) and three Canadian provinces (Ontario, Quebec and Manitoba). (Yemshanov et al. 2015b)

The research was conducted to assess optimal locations for surveillance of EAB, but it also shows the extent to which campers and firewood move from quarantined areas (origin) to generally non-infested areas (campgrounds) (Yemshanov et al. 2015b).

Given there are no internal border stations within Canada, it is difficult to enforce domestic regulations (CFIA). The CFIA provides movement certificates to facilities that move wood products outside of regulated areas that conform to movement restrictions. There is no central database for movement certificates, however, and the number of movement certificates is minimal and only provided if sourced from a regulated area.

## Procurement processes of major firewood distributors

(e.g. provincial parks, big box stores)

In Canada, firewood is sold by a large number of vendors from big box stores to gas stations and campgrounds to independent vendors. Firewood is harvested on public land through a permit process or on private property (e.g. personal woodlots) (Koch et al. 2012). Although it would be most cost-effective to sell firewood close to where it is harvested and avoid transportation costs, firewood tends to frequently move long distances because local demand can exceed supply (Jacobi et al. 2012).

Quantifying total firewood sales for recreation or home heating[4] is challenging since firewood is distributed in large quantities at a national level or by small distributors on private land (Jacobi et al. 2012). Due to the difficulty in contacting all vendors and distributors, the lack of cooperation from small companies, and privacy clauses, the collection was limited to two large companies that supply to big box stores. Information for provincial and private parks was also collected.

### Large-scale producers and big box stores

The big box stores Canadian Tire, Home Depot, Walmart, Metro, and Home Hardware carried Firemaster or X-traflame firewood. Both companies only produce heat-treated firewood[5]. SBC Firemaster uses mountain pine beetle-killed pine from British Columbia and heats the wood to a core temperature of 56°C for 30 minutes, as required for exporting softwood to the United States. Alternatively, Charbonneau Floral (Xtraflame) harvests hardwood, mainly maple, birch and beech from the Appalachian Mountains and heat treats wood to a core temperature of at least 60°C for 60 minutes (71.1°C for 75 minutes based on discussion with the company). See Table 1 below for a description of the companies.

**Table 1. Top Firewood Producers selling to Big Box Stores in Canada**

| Firewood Producer | Harvest location | Species | Vendors | Heat Treatment | Kiln location and standard | Kiln certification |
|---|---|---|---|---|---|---|
| **SBC Firemaster** | Mountain pine beetle-killed wood in BC | Pine | Canadian Tire, Home Depot, etc. across Canada excluding Atlantic Canada | 56°C for 30 minutes | Princeton, BC | FPInnovations |
| **Charbonneau Floral (Xtraflame)** | Appalachian Forests | Maple, birch, beech (no ash) | Walmart, Canadian Tire, Metro, Home Hardware; Loblaws - Across Canada | 60°C for 60 minutes | St.. Clair, New Brunswick | University of New Brunswick |

The kilns certified for SBC Firemaster[6] and Charbonneau Floral are inspected by FPInnovations and the University of New Brunswick, respectively. See Certification for more information regarding kiln certification.

[4] According to Stats Can (2011), 6% of Canadians use wood to heat their houses, with the majority coming from Nova Scotia and New Brunswick at 26% and 23%, respectively. Statistics Canada, Environment Accounts and Statistics Division. http://www.statcan.gc.ca/pub/11-526-s/2013002/t002-eng.htm

[5] Based on conversations with both companies.

[6] The CEO of SBC Firemaster offered to be part of any stakeholder groups moving towards heat-treatment certification in Canada.

Since the big box stores did not provide full lists of the firewood products sold across Canada, it is difficult to know what other firewood products are sold in these stores. However, heat-treated firewood appears to be readily available at big box stores. The demand for heat-treated firewood may be due to the request for wood that is certified pest-free and that looks tidier.

Essentially, it is a more predictable product, which reduces legal liability associated with non-compliance (TNC, 2017b). Furthermore, by purchasing heat-treated firewood, big box stores can limit the number of suppliers, charge more for their products and allow wood to move freely through pest-quarantines to locations across Canada. The larger market access and higher market price is also a positive for the companies.

**Campgrounds**

As mentioned above, campgrounds are frequent destinations for firewood. Due to a number of issues including cost, quality or availability of firewood, campers may bring their own wood. The procurement processes of campgrounds can not only provide information about the pathway of procured wood (distance travelled), but also about the quality of firewood – a major factor affecting camper satisfaction and the likelihood that they will purchase or use firewood that the campgrounds provide.

***Public Campgrounds***

Parks Canada, the provinces, conservation authorities and municipalities manage public campgrounds in Canada. Figure 3 below shows public campgrounds in Canada. Note that this information was not received directly from the source, so there may be some degree of error in the created map.

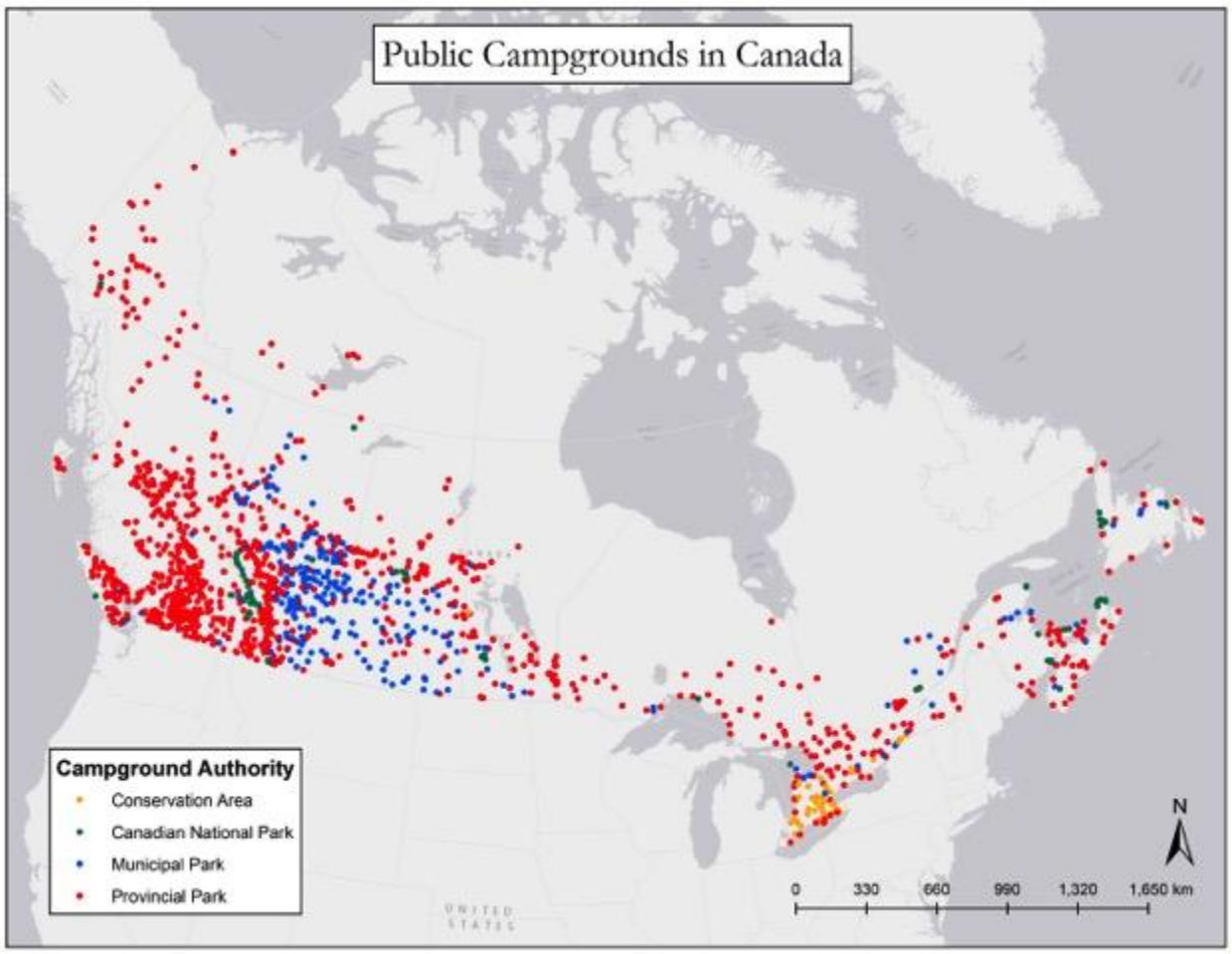


**Figure 3. Public Campgrounds in Canada**
Data source: http://www.uscampgrounds.info/takeit.html

The CFIA's website notes that bringing firewood into national parks is not allowed (CFIA, 2016). However, the CFIA only restricts movement into national parks if the firewood originated from a regulated area for a specific pest and the pest is absent in the park in question (CFIA, 2017b). The CFIA does encourage parks to implement their own firewood restrictions, which vary greatly between parks.

Kouchibouguac National Park in New Brunswick implemented a firewood ban in 2011 after discovering a single adult Brown Spruce Longhorn Beetle (*Tetropium fuscum*) within the park (CCFM-FPWG, 2013; Parks Canada, 2017b). It is suspected that BSLB was transported from Nova Scotia to the park by way of infested firewood (CFIA, 2011b). The restrictions are communicated on the Parks Canada website and upon reservation and arrival (Parks Canada, 2017; Parks Canada, 2017b). Upon arrival, each car is stopped at the park gate and surrendered firewood is exchanged with firewood from the park. Confiscated firewood is burned daily to avoid reintroduction of BSLB (Parks Canada, 2017b).

Other national parks, including but not limited to Banff, Jasper and Riding Mountain, provide free firewood with the purchase of a Parks Canada-issued fire permit, which is required in order to have a campfire at the park campgrounds (Parks Canada, 2016b, 2016c, 2017b).

### *Provincial and Territorial Campgrounds*

Campground firewood procurement processes can vary greatly from province to province and even from park to park. Table 2 below describes the procurement processes of provincial and territorial campgrounds. Information for Quebec and Prince Edward Island was unavailable and British Columbia was limited.

**Table 2. Procurement Processes of Provincial and Territorial campgrounds**

| Park Province | Current Firewood Provider(s) | Species | Quantity/ year | Seasoned / Treated |
|---|---|---|---|---|
| **British Columbia** | From local providers, cut or hauled within or around the park (16-140km) | Pine and Spruce* | ~ 488[7] cords | All seasoned |
| **Alberta** | Local vendors or from firesmart/ road construction/campground clearing etc. | Mostly pine and poplar (softwood) | Unavailable | Not treated – no specific policy re: seasoning |
| **Saskatchewan** | Harvested from within the forest of the park (3) others (21) varies, majority from Provincial Forest land (permitted) | Mainly spruce, poplar and pine | 6000-7000 cords | Typically seasoned longer than 6-8 months. |
| **Manitoba** | Harvested through fuel wood concessions, mostly from local providers (10km-158km), or from Hydro clearing projects | Mixture | >1875 cords | Seasoned |
| **Ontario** | Suppliers are spread out - NE supplies SW and NE is supplied by Northern ON. No shipping occurs from S to N of ON | 100% hardwood | 16,200 $m^3$ | Seasoned |
| **Nova Scotia** | From local providers (5km to 77km), from within or near the park, or locally supplied by fire crew | Varies – softwood and hardwood | ~240 cords | Majority seasoned |

[7] At the time of this report, only partial data had been received from British Columbia.

| | | | | |
|---|---|---|---|---|
| **New Brunswick** | By a local supplier or provided from within the park (fallen trees). | Mix of softwood and hardwood | Unknown | Seasoned |
| **Newfoundland and Labrador** | Locally sourced from blowdowns within the park or from small local providers adjacent to park | Unknown | Unknown | Unknown |
| **Yukon** | Unknown | Spruce and pine | 877 cords | Seasoned minimum of 2 years or beetle-killed |
| **Northwest Territories** | From within the campground and from local producers | All wood species | Unknown | Seasoned in 3/4 regions |

*Based on one region reporting

As shown above, the majority of provincial parks identified their firewood as seasoned. Seasoned firewood typically burns better than unseasoned or "green" firewood since it is drier. Public surveys have revealed that a main reason for campers not buying firewood from the campgrounds and bringing their own is that the wood was green and didn't burn well (Tobin et al., 2010; TNC, 2016). Knowing this, the reason for poor burning firewood may be due to poor storage without coverage from precipitation or providing species with a low BTU (DEFINE) rather than lack of seasoned stock.

### *Private Campgrounds*

The Invasive Species Centre conducted a survey about firewood procurement, voluntary actions and outreach. A total of 292 private campgrounds within Canada[8] were contacted by email and invited to fill out the survey. Thirty-three private campgrounds responded to the survey (11% response rate), with at least one response from each province or territory excluding Northwest Territories and Newfoundland and Labrador. Due to the small sample size, analysis was limited.

[8] Emails were collected from http://www.camping-canada.com/campground_search_e.asp for campgrounds that are private, sell or provide firewood, and have tent sites.

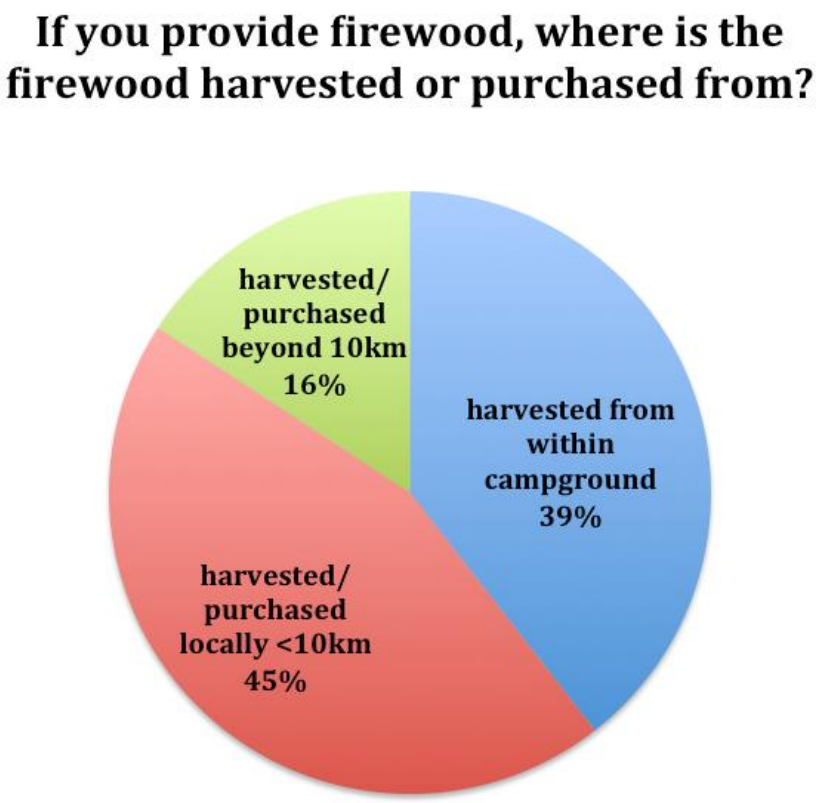


**Figure 4. Private campground survey question #3**

The majority of firewood was either harvested within the campground or purchased locally. Of the firewood in the campground, 91% was sold and 9% provided free of charge. 85% of wood was seasoned at least 6 months, 3% was not seasoned, 12% did not know, and none of the campgrounds provided heat-treated wood.

## Current risk mitigation

As mentioned above assessing the risk is only one component of risk analysis. Risk management provides concrete mitigation strategies to reduce risk. A number of interviews and surveys were held to collect information from provinces, territories and the United States about their active risk management strategies. Activities were separated into three categories: regulatory, voluntary and outreach.

### Risk mitigation in Canada

In 2016, a survey was sent to each province, the Northwest Territories, Yukon, the CFIA and the Canadian Council on Invasive Species (CCIS). A number of questions were posed

about current practices, their efficacy and cost-effectiveness, as well as a request for recommendations associated with firewood management.

**Regulatory**

The CFIA's *Requirements for the Importation and Domestic Movement of Firewood* (CFIA, 2010) is the only regulation or directive in Canada that directly addresses the domestic movement of firewood in Canada. The directive has the ability to further manage firewood movement in Canada, but is currently limited to restricting movement of firewood out of regulated pest areas for specific regulated pests. Specific "prohibition, treatment and certification options (are) described in, but not limited to, the following policy directives":

- D-03-08 (emerald ash borer);
- D-11-05 (Asian long-horned beetle);
- D-98-09 (gypsy moth);
- D-94-22 (pine shoot beetle);
- D-97-07 (Dutch elm disease); and
- D-97-10 (European larch canker) (CFIA, 2016b).

Based on a recent survey of provincial and territorial natural resources departments, all organizations were either aware of or concerned with the movement of invasive species within firewood. However, despite awareness, the risk of firewood movement wasn't perceived as high by British Columbia, New Brunswick, the Northwest Territories or Yukon. After further discussion, the reason for this was the cold climate in the territories, which isn't hospitable to many forest invasive species. In British Columbia, after further discussion it was revealed that the risk of movement within the province wasn't perceived as high, but that there was concern surrounding the introduction of new insects into the province.

A list of existing Canadian legislation that limits wood or firewood movement has been collected and summarized in Table 3 below.

**Table 3. Canadian legislation associated with restrictions of firewood or wood movement**

| Jurisdiction | Legislative Authority | Regulation / Directive | Description |
|---|---|---|---|
| **CANADA** | Plant Protection Act | Plant Protection Regulations / Phytosanitary Requirements for the Importation and Domestic Movement of Firewood | **Domestic**: Generally, the movement of firewood into national parks and from regulated pest areas to non-regulated areas in Canada is prohibited[9] |
| **Yukon** | Forest Resources Act | Forest Resources Regulation | Allows Forestry to control pest if necessary on any lands both private and public and First Nations; requires timber mark to transport timber through Yukon |
| **Alberta** | Forests Act | Timber Management Regulation and associated Directives 2011-01 and 2011-02; Agriculture Pests Act | Restricts import of coniferous logs or other coniferous forest products (incl. firewood) with bark into Alberta. Elm wood cannot be stored or transported unless en route to the closest elm wood disposal site |
| **Saskatchewan** | The Forest Resources Management Act | Minister's Order Restricting the Import, Transportation and Storage of Pine Logs and Pine Forest Products With Bark Attached; The Dutch Elm Disease Regulations, 2005; | Restricts import of pine logs with bark (incl. firewood) into Saskatchewan from B.C., Alberta and the U.S. (MPB designated as a pest). Restricts movement, storage and use of elm wood. |
| **Manitoba** | Forest Health Protection Act | Forest Health Protection Regulation | Restricts transport of pine wood with bark from Mountain Pine Beetle-infested areas in the U.S. and Canada into Manitoba. Restricts the transport and storage of elm wood and all firewood within Manitoba. |
| **Ontario** | Ontario Invasive Species Act (potential) | n/a | Potential to restrict the introduction or spread of pests or their carriers (e.g. firewood). |

[9] unless properly treated (dependent on pest-specific policies).

Enforcement differed between provinces, with a common linkage being public reporting of violations. Furthermore, in Saskatchewan, municipal inspectors may and have used the power of the Forest Resource Management Act to remove materials infected by Dutch Elm Disease, and the Alberta government works closely with Alberta Transportation to enforce border restrictions.

The Plant Protection Act and regulations currently limit domestic movement of firewood out of regulated pest areas, but do not otherwise regulate domestic movement of firewood, nor apply to native species such as the Mountain pine beetle (Smith et al. 2013).

The CFIA's role is to set quarantine borders to the limit of the pest's distribution and efficiently allocate funds to restrict movement to areas where the insect is not present. However, by expanding quarantine borders, movement of firewood and other potentially infested wood products are permitted to move freely within borders, potentially increasing the population density of existing quarantine pests, and the possibility of introduction or spread of non-quarantine pests or those that have yet to be discovered.

**Voluntary**

Voluntary strategies can be implemented quickly as they generally do not require the level of approval that is characteristic of regulations. Voluntary strategies described by the surveyed jurisdictions included:

- Firewood disposal bins
- Wood exchange/free firewood programs at campgrounds
- Firewood vendors lists on provincial websites
- Campgrounds restricting firewood

***Firewood Disposal Bins***

Firewood disposal bins provide individuals with firewood disposal options when traveling across international and provincial borders. Although the bins can be placed anywhere, they are currently at borders and along major highways or at Travel Information Centres, where they can be most effective. Figure 5 below shows the location of bins in Canada.

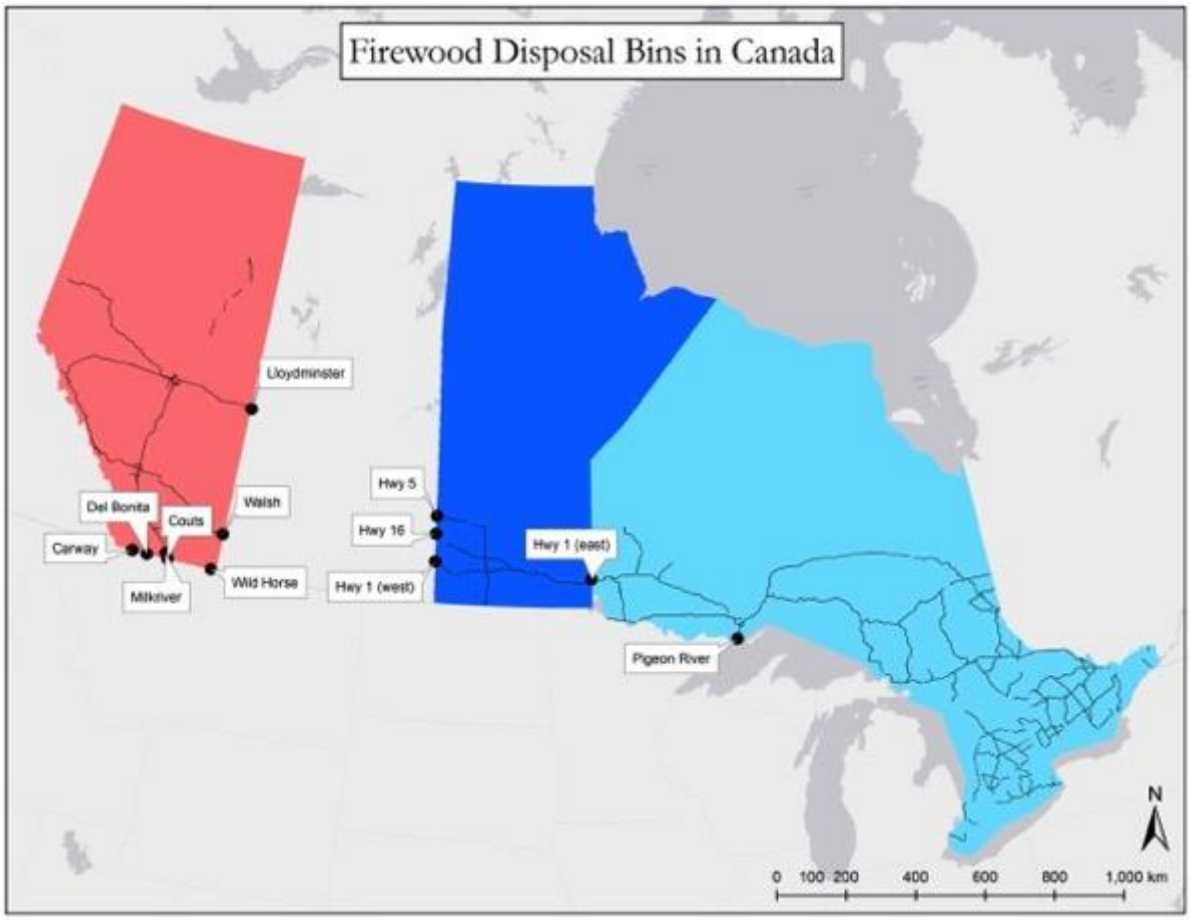


**Figure 5. Firewood disposal bin locations within Canada**. All located within Alberta, Manitoba and Ontario. Basemap: Esri Inc.; Roads data: Geobase, National Road Network (NRN); Bins: STOPDED 2017, Manitoba Government, 2017, CFIA, 2017c.

The locations of the bins are consistent across provinces in proximity to borders and major highways; however, the organization responsible for managing the bins differs for each province. Table 4 below describes the responsible organization and other factors related to the management of firewood collected.

**Table 4. Firewood Disposal bins in Canada**

| Jurisdiction – Responsible organization | # of bins | Signage | Quantity | insect damage | Bin Management |
|---|---|---|---|---|---|
| Alberta - Society to Prevent Dutch Elm Disease | 7 | yes | Not available | yes | Emptied 3x/season |
| Manitoba - Manitoba Conservation and Water Stewardship | 4 | yes | 200-300 pieces | yes | Emptied ~bi-weekly from May to October. Not monitored in the winter. |
| Ontario - Canadian Food Inspection Agency | 1 | yes | 3-4 face cords a year | yes | Emptied bi-weekly in the spring/summer, monthly in the fall, non-operational in the winter |

In Albert, the bins are managed by a not-for-profit organization called the Society to Prevent Dutch Elm Disease (STOPDED). The project started 30 years ago to deal with elm wood that would otherwise be confiscated by CBSA. According to STOPDED, the bins work very well at intercepting potentially infected or infested wood into Alberta.

In Manitoba, the bins are managed by the province and emptied frequently. According to the Manitoba government, bins are voluntary and require minimal additional funding for maintenance. In addition, they were reported as effective from an outreach point of view due to signage at highway exits and at bins.

In Ontario, the CFIA manages the bin located at the Pigeon River border crossing. This was an improvised setup created to address the lack of an international waste facility to deal with seized firewood in the area.

Disposal bins were emptied either bi-weekly or monthly (~3x/season) and no information was collected about the effectiveness of keeping living insects contained or whether disposal frequency was adequate to prevent spread.

All three parties reported insect damage on collected wood. Signs of past EAB infestation were found in the wood collected at Pigeon River; however, no live EAB adults or larvae were seen, which is consistent with the research at Mackinac Bridge in the United States[10] (Haack et al. 2010).

[10] Although no live EAB adults or larvae were found in the surrendered wood at Mackinac Bridge during the study period, 13% had signs of previous infestations (Haack et al. 2010).


**Figure 6. Firewood disposal bin and signage in Manitoba**
Source: Government of Manitoba

In terms, of distance travelled, almond wood from California, ash wood from Southern Ontario and mountain pine beetle–killed wood from the west had been collected in the Manitoba bins. After contacting the CFIA and tracing the wood back to its origins, it was confirmed that both wood bundles had been heat-treated to kill any live pests.

### *Firewood Vendor Website*

Nova Scotia has a list of registered firewood vendors on their website. In order to become registered, the vendor must abide by the Code of Ethics, which in addition to ensuring that the appropriate quantity is provided, the vendor name and contact are displayed and documented for the buyer. The program is voluntary and benefits the vendor with free advertising on the province's website. Currently 19 vendors in Nova Scotia are registered (Nova Scotia, 2017). The website has the potential to expand its code of ethics to include harvest location, which would help facilitate distance restrictions on firewood, whether regulatory or voluntary.

### *Firewood Programs in Provincial Parks*

According to the Quebec Department of Forests, Wildlife and Parks, SEPAQ[11] has a program to exchange firewood with campers who bring their own. Although the program was effective at limiting campers bringing their own wood, the firewood was left onsite for too long, essentially creating a higher risk than if the visitor had burned the wood during their

[11] The Société des établissements de plein air du Québec is an agency that manages nature reserves in Quebec.

stay. Although many attempts were made to contact someone from SEPAQ involved with the firewood exchange program, the ISC was not successful.

Another program related to campers and firewood movement is in Saskatchewan. According to the Saskatchewan Ministry of Environment, firewood is provided to campers for "free" as part of their camping fee. The program can reduce the number of campers who bring "inexpensive firewood" from home. Further examination is required to assess cost-effectiveness of the program.

***Private Campgrounds***

The majority of private campgrounds (64%) allowed campers to bring firewood to their property. Seven campgrounds reported that they place restrictions on what kinds of firewood enter the property. The restrictions included firewood: purchased or harvested within proximity to the park[12]; that is debarked; or free from pests.

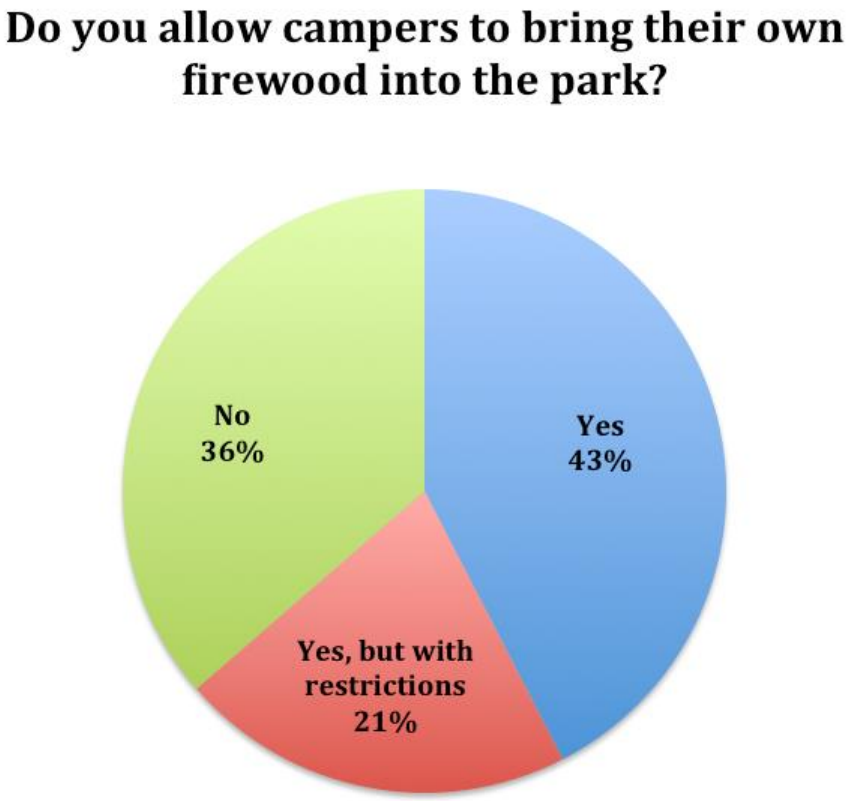


**Figure 7. Private campground survey question #7.**

Regardless of the restrictions, only one campground confiscated wood that was not compliant, though it was not specifically traditional firewood, but painted or chemically

[12] However, proximity was not defined.

treated wood. The campgrounds that did not allow campers to bring their own firewood reported that regardless of informing campers of their policies, campers continued to bring firewood into the park.

**Outreach**

The majority of the provinces and territories in Canada are involved in some form of outreach regarding invasive species and firewood movement (table 5). Additionally, both the CFIA and CCIS are leading national campaigns (table 5).

**Table 5. Outreach Measures by Jurisdiction**

| Jurisdiction | Outreach Activities |
|---|---|
| **Alberta** | Information signs at provincial borders, information pamphlets developed for the general public |
| **Saskatchewan** | Print and radio media releases; Highway Signage for both DED and Invasive species; pest fact sheets; school outreach programs; library lecture series. |
| **Manitoba** | Signs at major entry points and the entrance to some communities that are managed for DED warning against moving firewood. Provincial staff attend public events, create pamphlets, publish articles, surveys |
| **Quebec** | Outreach at events (once or twice per year) |
| **Nova Scotia** | Designing website, fact sheets and rack cards for public and governmental distribution. Presentations and displays, surveys |
| **Yukon** | Forest Health Presentation to communities and interested groups; MPB info available on forestry website |
| **CFIA** | "Don't Move Firewood" national campaign with targeted messages to Canadians encouraging their purchase and/or use of local firewood |
| **Parks Canada** | Brown Spruce Longhorn Beetle Campaign: educating the public and setting protocol including not moving firewood, which helps defend against the re-establishment of the beetle during eradication |
| **CCIS** | Researching and developing the first phase of a national public campaign for reducing the movement of firewood in Canada |

Outreach is generally considered to be effective since the general public appears to be more informed, though efficacy is not specifically measured. Current public outreach efforts that are passive may not be as effective as active engagement.

***Private Campgrounds – Outreach***

Generally, there was no difference in the number of private campgrounds that provided outreach and education regarding firewood movement, compared to those that did not. Of the private campgrounds surveyed, 48% informed their campers about the risk of moving firewood long distances either at the time of reservation, upon arrival or during their stay.

However, of the 15 campgrounds that did not currently provide information to campers, all campgrounds were willing to in the future.


**Figure 8. Private campground survey question #3:**

The fact that campgrounds were willing to expand their outreach is good news for future outreach campaigns.

### *Firewood Certification and Treatment Facilities*

Currently, there is no certification program for domestic firewood in Canada. However, the Canadian Heat Treated Wood Products Certification Program (HT Program) is administered by the CFIA. The CFIA sets the standards for facilities registered in the program to meet the phytosanitary requirements of foreign countries. It also sets out a process to verify facility conformance. Through this program, facilities can obtain heat-treatment or phytosanitary certificates ensuring that wood is properly treated (CFIA, 2015).

The Canadian Lumber Standards Accreditation Board (CLSAB) through the CFIA-CLSAB Agreement accredits grading agencies that monitor and audit kilns of facilities

registered in the HT Program. CFIA Third Party Auditors may also audit facilities for conformance. Audits are monthly for the first 3 years and bi-monthly thereafter (CFIA, 2015). Audits assess facilities for the development of proper chamber loading procedures and whether the chamber air flow will be sufficient to heat treat wood packaging products (CFIA, communications). Standards are in line with The Technical Heat Treatment Guidelines and Operating Conditions Manual (CFIA, 2008).

In conversations with the CLSAB, it was asked if the certification program could be expanded should regulations be in place requiring all firewood to be certified heat-treated. The response was that if the HT program expanded, the organization would need greater capacity since the CSLAB's primary responsibility and priority is structural lumber grading.

## Risk mitigation practices in other countries

### Regulatory

Many states in the U.S. have implemented regulations related to firewood. Figure 9 below shows the states that have statewide or state land (i.e. forest and parks) firewood regulations or policies.

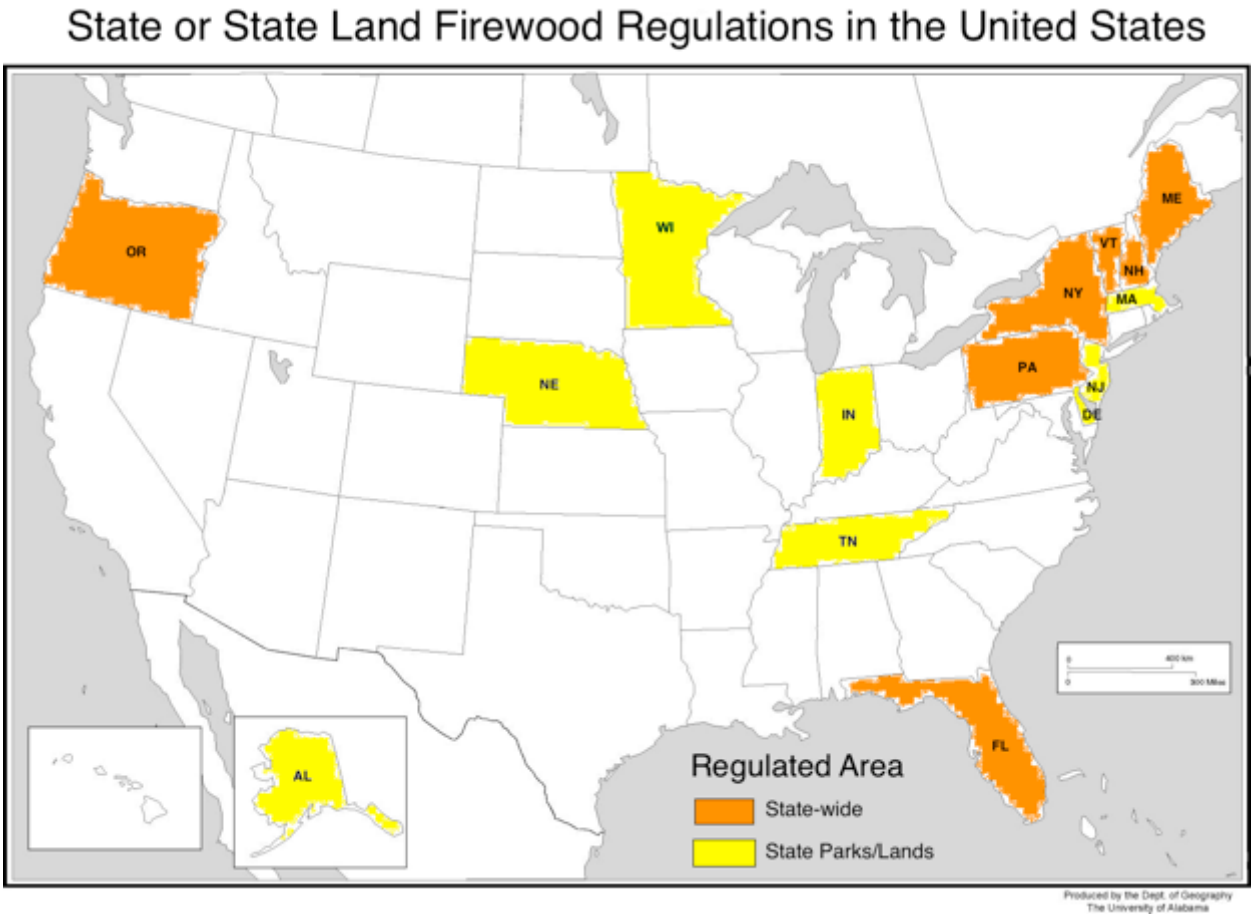

**Figure 9. State regulations restricting firewood movement in the United States.** Base map source: University of Alabama; Base map: The University of Alabama. Data source: TNC, 2017; State legislation (see Table 6 below)

In terms of state-wide firewood restrictions, Florida, Maine, New Hampshire, New York, Oregon, Pennsylvania and Vermont have active regulations as shown in Table 6 below.

**Table 6. State Firewood Regulations in the United States**

| Jurisdiction | Regulation / Order | Restrictions |
|---|---|---|
| **Florida** | Firewood Movement Rule, Rule No. 5B-65 | Movement of all commercial shipments of firewood into state prohibited (unless accompanied by master permit); movement within state restricted to 50 miles |
| **Maine** | Emergency Order Restricting Transportation of Firewood Into the State of Maine | Movement of all firewood into state prohibited unless heat-treated |
| **New Hampshire** | State of New Hampshire Exterior Firewood Quarantine | Movement of all firewood into state prohibited unless heat-treated or accompanied by compliance agreement |
| **New York** | 192.5 Firewood restrictions to protect trees and forests from invasive species | Movement of all firewood into state prohibited unless heat-treated; movement within state restricted to 50 miles |
| **Oregon** | 2015 ORS 570.720 Firewood sources | Movement of all firewood into state from outside of the Pacific Northwest (OR, WA, ID) prohibited unless heat-treated |
| **Pennsylvania** | Order of Quarantine, Firewood | Movement of all firewood into state prohibited unless heat-treated |
| **Vermont** | Rule Governing the Importation of Untreated Firewood into the State of Vermont | Movement of all firewood into state prohibited unless heat-treated or accompanied by a waiver |

In addition to the above, Wisconsin, Alaska, New Jersey, Massachusetts, Delaware, Nebraska, Tennessee, and Indiana have firewood-specific policies or regulations restricting firewood movement into state parks or state forests. Even more states have pest-specific restrictions related to emerald ash borer and other pest quarantines.

Distance restrictions exist in New York and Wisconsin. New York limits intra-state movement to 50 miles, whereas Wisconsin limits firewood entering state-owned land to a 25-mile radius. In addition to regulations, many states strongly recommend the local purchase and use of firewood. Moreover, many have outreach and education campaigns to promote the message.

New York was the first state to enact firewood regulations restricting the import of untreated firewood (USDA-APHIS 2010). Based on conversations with the New York DEC, writing and implementing a regulation is a difficult task. The general timeline was as follows:

- 2003: Began communicating need for a regulation;

- 2006: The Commission asked for the first briefing and situation analysis. Approval and funding to proceed with firewood analysis;
- 2008: Developed and finalized First Express terms. Permission to pursue legislation. Developed FAQs and started an intensive outreach campaign targeting the major parks and campers as well as local producers and fire energy enthusiasts;
- 2012: Rewrote the regulation.

***Enforcement***

Certificates are voluntary, but the DEC samples for compliance, and the Department of Agriculture and Markets regularly sends officers to certified establishments and requires them to report on compliance.

Although fines are minimal, seizure of products has resulted in losses of over 10 thousand dollars. A limited number of roadside checks and a few violations that were publicized provide the coverage needed to show businesses and the public that the regulations are enforced. The distance rule has yet to be enforced, as certificate holders tend to stay well within the maximum distance.

There has however been some confusion around interpreting the firewood rule with other pest quarantines such as EAB or ALHB, etc.

## Voluntary

Wisconsin and other states have voluntary programs that would be good examples for Canada. They include:

- State park firewood improvements; and
- Online firewood vendor tool – Firewood Scout

***Wisconsin Firewood Quality and Availability***

In Wisconsin, it is illegal to bring firewood onto state lands from a radius greater than 25 miles. A survey of 800 campers who had used Wisconsin State Parks revealed that campers use calculated motivation when deciding to comply with firewood rules. The study revealed that quality, price and availability of firewood at campgrounds played a key role in determining whether campers would bring their own firewood. Peterson and Diss-Torrance (2014) coins the marketing involved in addressing the motivations as the **4 Ps – product, price, place and promotion**.

To respond to the first three Ps, Wisconsin DNR decided to make changes to the quality and availability of firewood within or in proximity to campgrounds, while keeping the price low. The following changes were implemented at state campgrounds:

- Shelters were provided to keep firewood dry and tidy;

- Firewood was provided in bundles, rather than loose;
- A policy was implemented that campgrounds either harvest firewood from within the park or sell certified heat-treated firewood;
- The price was kept at $5 per bundle[13]; and
- Firewood is now sold at all staffed campgrounds.

In addition, compliance and camper satisfaction is tracked by biannual surveys, which can not only ensure that the approach is sustainable and remains dynamic to address changing environments, but also creates a framework to measure efficacy.

***Firewood Scout***

Firewood Scout, (http://firewoodscout.org/) is an online firewood vendor locator tool searchable by address, park, or area. It identifies vendors within 10, 25 or 50 miles of their destination to ensure that they find, buy and burn firewood locally. The website also identifies vendors that provide heat-treated firewood.


**Figure 10. Firewood Scout – online tool to locate local firewood vendors.**

Vendors in the following states are searchable via Firewood Scout:

- Wisconsin
- Michigan
- Kentucky
- Tennessee
- North Carolina

[13] Despite keeping prices competitive even for certified heat-treated wood, the public still complained about the cost.

- New Hampshire
- Maine
- California

## Outreach

***The Nature Conservancy (TNC) – "Don't Move Firewood" Campaign***

The TNC's "Don't Move Firewood" campaign is a very successful project led by The Nature Conservancy in the United States. According to the program manager, Leigh Greenwood:

"The Nature Conservancy maintains the 'Don't Move Firewood' campaign, a continent-wide outreach effort educating both forestry professionals and the firewood-using public on the concepts, regulations, and best practices surrounding firewood as a pathway for the movement of forest pests.

'Don't Move Firewood' accomplishes its goal of slowing the spread of forest pests by coordinating the extensive efforts of dozens of partnering state, federal, provincial and local agencies and non-profits. While all partners are encouraged to customize and adapt their efforts to their local ecology, culture, and pest-specific situations, 'Don't Move Firewood' provides a consistent look, feel, message, and core concept that enhances acceptance of the message through a consistent brand presence.

Through the use of a central website, simple and positive messaging, and a large portfolio of outreach materials, 'Don't Move Firewood' educates tens of millions of members of the public about the threats of forest pests each year."

The campaign's outreach efforts are primarily based on expansive surveys. A few general statements derived from the surveys include:

1. The more outreach that people receive on abstaining from moving firewood, the less they move firewood, and they move it shorter distances when they do;
2. A brochure at a park's entrance or a label on wood packaging is most likely to catch attention;
3. "Buy it Where You Burn It" is the slogan that the public thinks is the most effective, but that message must be tailored to the situation;
4. Park Rangers were the most believable source of information about forest issues;
5. Outreach platform success is dependent on demographics, e.g. social media is not effective with older groups.

# GAP ANALYSIS AND RECOMMENDATIONS

## Existing gaps in risk mitigation

The following gaps have been identified through stakeholder interviews and research. For a full list of interviews and survey respondents, see Appendix I.

***Outreach***

- Various outreach campaigns across North America

***Voluntary***

- Need for best management practices for firewood producers, vendors and consumers
- Limited kiln capacity and distribution
- Insufficient disposal options for firewood at borders or along major highways
- Consumers do not know how to access certified vendors
- Limited supply of treated firewood for sale at campgrounds
- Low quality of firewood at campgrounds – incentive to bring own
- Need for a certification program with labeling and record-keeping requirements

***Regulatory***

- Federal regulations are at pest level rather than pathway
- Federal regulations focus on invasive species native to Canada, and do not address risk of moving native species (i.e. mountain pine beetle)
- Limited data on private "roadside" firewood vendors

## Recommendations

Because regulatory changes may take years to implement, voluntary and outreach measures are described first since they can be implemented immediately or in the near future. Further discussion will be needed to address regulatory strategies, which are complex and require significant stakeholder consultation. A number of the following recommendations are in line with the National Firewood Task Force Recommendations that address similar gaps within the United States (NFTF, 2013):

### Outreach

Outreach is an important component of the strategy as it communicates both the risk of moving untreated firewood and the risk management activities that are being implemented to mitigate the risk. The success of the proposed voluntary and regulatory strategies is dependent on the effectiveness of the communication strategy. The more that stakeholders are informed, the greater the opportunity for compliance.

1. **The Message: Consistent messaging and branding across Canada (or North America)**

   A number of stakeholders[14] identified a need for consistent messaging and branding across Canada. Although many departments and organizations are developing outreach materials, the messaging is not always consistent and some messages may be confusing to the public (Stakeholder Discussion Panel, 2013). Educational materials should be eye-catching, easy to understand and targeted to key groups.

   A survey conducted by The Nature Conservancy revealed that the message "Don't Move Firewood" was unclear and ineffective in changing behaviour. In contrast, "***Buy it where you burn it***" was considered clearer and more effective (TNC, 2016). Another message used in brochures by the Wisconsin Department of Natural Resources (DNR) is "***Protect trees where you live, live, play, or camp. Get firewood where you use it***." The latter message also adds value to protecting the beautiful places that are visited by campers and is inclusive of those who don't *buy* firewood, which in the context of the Wisconsin surveys represented 10% of the campers (8% who cut it themselves and 2% who get it from relatives/friends) (Peterson and Diss-Torrance, 2014).

   "Buy it where you burn it" has since been adopted by British Columbia (BC Parks, 2017) and by the CCIS. The CFIA on the other hand is using "Don't Move Firewood", which doesn't properly convey the risk or reasoning behind the rule. Moreover, it is important to use simple and clear messaging that is specifically tailored to groups,

[14] Includes provinces of Saskatchewan, Manitoba (National Firewood Survey, 2017), British Columbia (British Columbia, 2017), and other organizations including Parks Canada and the Canadian Council for Invasive Species.

with more detail available for vendors or other parties that need to know specifics about the rules or regulations. The Nature Conservancy has offered to share materials with Canada to further the North American approach to outreach.

2. **The Messenger: An organization that the public can trust**

   Peterson and Diss-Torrance (2014) showed that compliance with rules and regulations is dependent on calculated, social and normative motivations. The social motivations include the rapport, connectedness, trust with the regulator, and agreement with rule or regulation. Furthermore, the Nature Conservancy showed that in the United States on a national scale, park rangers were the most trusted source for communication of issues (TNC, 2016). "The messenger is often more important than the message" (TNC, 2017b).

   The Nature Conservancy was chosen to lead the "Don't Move Firewood" campaign since it was agreed that the message would be more accepted if delivered by an apolitical conservation organization (TNC, 2017b). The "Don't Move Firewood" campaign that is provided by The Nature Conservancy in the United States has been very effective. The campaign lead/manager, Leigh Greenwood, has expressed a readiness to work with Canada to develop similar materials and to provide advice and guidance. The coordinator/group could partner with the TNC campaign to deliver a continent-wide campaign.

3. **Website for outreach materials and tools**

   A single-source website for outreach materials and up-to-date descriptions of provincial, territorial, regulatory and voluntary measures could be developed. In addition, the website could provide a tool for individuals visiting parks and specify the distance restrictions regarding where firewood may be bought. The *Firewood Scout* website would be a good example of the tool. The Nature Conservancy's "Don't Move Firewood" may be able to house Canadian materials as well since the campaign is intended to be a continental one.

   In addition, the website could provide frequently asked questions (FAQs). Comments received in response to the CFIA's most recent "Don't Move Firewood" campaign revealed that a portion of the public did not understand the difference between moving firewood and logs, nor did some consider moving firewood to be a risk. The public could be educated by FAQs that address these and other concerns.

**Voluntary**

Voluntary strategies, similar to outreach strategies, can be quick to implement and effective. They rely on self-regulation, which is more cost-effective.

1. **Best Management Practices to be developed for firewood producers, vendors and consumers**

   When regulations are not in place, self-regulation may be the next best way to address compliance with rules. A number of stakeholders[15] identified the need for best management practices (BMPs) to provide how-to's for self-regulation or compliance. BMPs could be provided to target groups with educational material explaining why their compliance is important. NFTF (2010) provides examples of BMPs that could be developed for Canada.

2. **National firewood certification program for commercial firewood producers**

   Provincial organizations (Manitoba and Ontario, via National Survey 2017) and industry stakeholders (SBC Firemaster, 2017; Charbonneau Floral, 2017) recommended the creation of a certification program. The certification program would be voluntary and include labeling and record keeping. Labels would provide information about the location of harvest, vendor, quantity and treatment method. The Canadian Lumber and Standards Accreditation Board may be expanded to certify additional grading agencies to assess kilns for heat-treatment (CLSAB, 2017). In exchange for membership, facilities could receive free listings on provincial or national websites. The certification could be marketed as the environmental option, similar to forest certification companies. In addition, the program could be marketed to producers, retailers and the public.

3. **Campgrounds provide quality and reasonably priced firewood**

   Surveys have identified that one reason that campers bring their own firewood is because of the poor quality or cost of firewood at campgrounds. Peterson and Diss-Torrance (2014) describe that the success of behaviour change relies on "value exchange". For instance, in exchange for public compliance and the understanding that motivation may be reliant on self-interest, campers should be given the option of quality and reasonably priced wood if they cannot bring their own (Peterson and Diss-Torrance 2014). A good model to review is the case of the Wisconsin DNR described above. Additionally, the Saskatchewan model of free firewood at campgrounds or the Quebec firewood exchange model could be assessed as options. Providing free firewood or encouraging use of local firewood could prevent campers from bringing their own firewood.

4. **Deploy more firewood disposal bins with adequate management across Canada**

[15] Province of Manitoba, CCIS (survey results) and Parks Canada (Parks Canada, 2017b).

Based on communication with Alberta, Manitoba and Ontario, it appears that firewood disposal bins are an effective tool for outreach and limit the wood that moves across national and provincial borders in Canada. Furthermore, they provide three different management models that could be applied to new disposal bins, i.e. management by a not-for-profit, the province, or the CFIA.

To start, two additional disposal bins could be placed in Newfoundland and Labrador and Prince Edward Island. The Newfoundland and Labrador government has requested that the CFIA install and manage the bins at the North Sydney Ferry Terminal (Government of Newfoundland and Labrador, 2017). The ferry terminal, which connects Nova Scotia and Newfoundland, is run by the federal Crown corporation Marine Atlantic.

The province of Prince Edward Island, on the other hand, asked the PEI Invasive Species Council if they could manage the bins at PEI entry points; the council, similar to the province of Newfoundland and Labrador, stated that they did not have the capacity to lead the programs.

Moving forward, it will be important to assess the effectiveness of disposal bins as more than an outreach tool, but as a voluntary measure to reduce spread. The effectiveness of disposal bins at reducing spread may be dependent on how well bins are sealed and the frequency of disposal. For example, disposal frequency varies between different park managers within Canada from disposal 3x/season to daily burning of surrendered firewood as in the case of Parks Canada's Kouchibouguac National Park (Parks Canada, 2017).

5. **Review options to increase kiln accessibility**

   One of the issues in implementing regulations or rules requiring the heat treatment of firewood is kiln accessibility (Stakeholder Discussion Panel, 2013). The opportunities for subsidizing new kilns, kiln sharing or creating cooperative kiln networks should be examined.

6. **Further identify and address knowledge gaps**

   Knowledge gaps may include greater need for research and science, surveys, and data on attitudes and practices of private distributors, roadside sellers, private campgrounds, etc.[16]

**Regulatory**

[16] Although this data was collected, the private campground survey only received 33 responses out of 292 due to being outside of camping season, and the strict timeline.

Provincial and Territorial organizations (Alberta, Saskatchewan, Manitoba, Ontario, Nova Scotia and Yukon) support various regulatory actions (National survey results, 2017). Support for firewood movement regulations may be the best option in theory, though enforcement of regulations in practice tends to be limited. Prior to implementing any regulations, it is more important to implement the outreach and voluntary actions, meet with stakeholders to assess regulatory options, and conduct surveys to assess the likelihood of compliance. Once ready, options for regulatory strategies could include:

1. **Build a collaborative national approach to regulatory controls**

   The CFIA alone does not appear to have the capacity to implement and enforce national regulations. Therefore, it is important to review options for a collaborative approach. A permanent national firewood working group could be established to help foster Memorandums of Understanding (MOUs) and agreements across provincial boundaries, and to develop harmonized programs/public outreach and track progress on implementing recommendations.

2. **Investigate options to expand firewood restrictions in public parks**

   Provincial and territorial parks can apply the model implemented by the Wisconsin DNR to limit non-local or untreated wood entering the park. Outreach and the use of surveys to track efficacy and compliance should be part of the rule.

3. **Evaluate options for regulation(s) for inter- or intra-provincial movement of firewood**

   There are regulations in Canada that limit firewood movement, but only within areas regulated for specific pests and diseases (CFIA 2011). Regulations that limit the movement of untreated firewood into or within a province could be developed. However, it is important to review options and identify who the regulations are meant to target. For example, regulations even through enforcement may miss individuals and rather heavily regulate companies (Yemshanov, 2017). That being said, individuals may be better targeted through outreach and voluntary strategies, whereas regulations—assuming that they are properly enforced—could lead to greater compliance among vendors and producers.

# References

Aukema, J.E., Leung, B., Kovacs, K., Chivers, C., Britton, K.O., Englin, J. et al. (2011). Economic impacts of non-native forest insects in the continental United States. *PLoS ONE,* 6(9): e24587.

BC Parks (2017). Personal communication by email with Jennifer Grant, Protected Areas Ecologist, British Columbia Parks. March 2017.

Cappaert, D., McCullough, D.G., Poland, T.M. and Siegert, N.W. (2005). Emerald ash borer in North America: a research and regulatory challenge. Am Entomol 51: 152–165.

CBSA (2011). Canadian Border Service Agency, Electronic Data System. Firewood Imports from the United States, unpublished data.

CCFM-FPWG (2013). Canadian Council of Forest Ministers Forest Pest Working Group. Pest Risk Analysis: Risk Assessment of the Threat of Brown Spruce Longhorn Beetle to Nova Scotia Forests.

CFIA (2008). Canadian Food Inspection Agency. The Technical Heat Treatment Guidelines and Operating Conditions Manual: PI-07 4th Revision. Retrieved from http://www.clsab.ca/uploads/file/PI_07_Technical_Heat_Treatment_Guidelines_and_Operating_Conditions_Manual_2008_12_02_with_Option_G.pdf

CFIA (2010). Canadian Food Inspection Agency. D-01-12: Phytosanitary Requirements for the Importation and Domestic Movement of Firewood. Retreived from: http://www.inspection.gc.ca/plants/plant-pests-invasive-species/directives/forestry/d-01-12/eng/1323828428558/1323828505539

CFIA (2011). Canadian Food Inspection Agency. Firewood from all-sources: Commodity Risk Assessment. Plant Health Risk Assessment Unit Plant Health Science Division, Ottawa, Ontario.

CFIA (2011b). Canadian Food Inspection Agency. Brown Spruce Longhorn Beetle Confirmed in New Brunswick. Retrieved from: http://www.inspection.gc.ca/plants/plant-pests-invasive-species/insects/brown-spruce-longhorn-beetle/notice-to-industry-2014-07-17-/eng/1404941283317/1404941284614

CFIA (2014). Canadian Food Inspection Agency. RMD-13-01: Regulated Areas for Emerald Ash Borer (EAB) (*Agrilus planipennis* Fairmaire) March 2014 (1st revision). Retrieved from: http://www.inspection.gc.ca/plants/plant-pests-invasive-species/directives/risk-management/emerald-ash-borer/eng/1368741925939/1368741926892

CFIA (2015). Canadian Food Inspection Agency. D-13-01: Canadian Heat Treated Wood Products Certification Program (HT Program). Retrieved from: http://www.inspection.gc.ca/plants/plant-pests-invasive-species/directives/date/d-13-01/eng/1438703782830/1438711462283

CFIA (2016). Canadian Food Inspection Agency. Firewood. Retrieved from: http://www.inspection.gc.ca/plants/forestry/firewood/eng/1330963478693/1330963579986

CFIA (2016b). Canadian Food Inspection Agency. Plant Protection Policy Directives. Retrieved from: http://www.inspection.gc.ca/plants/plant-pests-invasive-species/directives/eng/1304570539802/1304570628492

CFIA (2017). Canadian Food Inspection Agency. Areas Regulated for the Emerald Ash Borer. Retrieved from: http://www.inspection.gc.ca/plants/plant-pests-invasive-species/insects/emerald-ash-borer/areas-regulated/eng/1347625322705/1367860339942

CFIA (2017b). Personal communication by email and phone with Naima Ait Oumejjout, Canadian Food Inspection Agency. January – June 2017.

CFIA (2017c). Personal communication by email with Bryan Lock, Inspector, Canadian Food Inspection Agency.

Charbonneau Floral (2017). Personal communication by email and phone with Jennifer Charbonneau and Marcel Gazaille, respectively. January-March 2017.

CSLAB (2017). Personal phone communication with the Canadian Lumber Standards Accreditation Board General Manager. March 10, 2017.

Department of Forests, Parks, and Recreation (2016). Rule Governing the Importation of Untreated Firewood into the State of Vermont. http://fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Forest_Health/Library/Vermont%20Rule_Importation%20of%20Untreated%20Firewood.pdf

Environment Canada (2013). How do alien species get in Canada? Retrieved from: http://www.ec.gc.ca/eee-ias/default.asp?lang=En&n=b28651e6-1

EPPO (2015). European Plant Protection Organization. EPPO Technical Document No. 1071, EPPO Study on wood commodities other than round wood, sawn wood and manufactured items. EPPO, Paris.

FAO (1990). Food and Agriculture Organization. Glossary of Phytosanitary Terms, FAO Plant Protection Bulletin, 38 (1): 5-23.

FAO (2005). Food and Agriculture Organization. Pest Risk Analysis For Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms. FAO Corporate Document Repository. Retrieved from: http://www.fao.org/docrep/008/y5874e/y5874e00.htm

Forest Pest Management Forum (2005). Proceedings of the Forest Pest Management Forum 2005, Ottawa, Ontario. Retrieved from: http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/32722.pdf

Government of Newfoundland and Labrador (2017). Personal phone and email communication with Dan Lavigne and Geoff Bailey. Department of Tourism, Culture, Industry and Innovation. March 2017.

Government of Saskatchewan (2005). The Dutch Elm Disease Regulations. Retrieved from: http://www.qp.gov.sk.ca/documents/english/regulations/regulations/f19-1r5.pdf

Haack, R.A., Petrice T.R., Wiedenhoft, A.C. (2010). Incidence of bark- and wood-boring insects in firewood: a survey at Michigan's Mackinac Bridge. *J. Econ. Entomol*. 103, 1682-1692.

Illinois Department of Agriculture. (2015). Illinois to Drop Internal EAB Quarantine. Retrieved from: http://www.iml.org/file.cfm?key=9368

IPPC (2007). International Plant Protection Convention. Framework for Pest Risk Analysis. Rome, IPPC, FAO.

Jacobi, W.R., Goodrich, B.A. and Cleaver, C.M. (2011). Firewood transport by national and state park campers: a risk for native or exotic tree pest movement. Arboriculture & Urban Forestry 37(3), 126–138.

Jacobi, W.R., Hardin, J.G., Goodrich, B.A. and Cleaver, C.M. (2012). Retail firewood can transport live tree pests. Journal of Economic Entomology 105: 1645-1658.

Koch, F.H., Yemshanov, D., Magarey, R.D. and Smith, W.D. (2012). Dispersal of invasive forest insects via recreational firewood: a quantitative analysis. Journal of Economic Entomology 105(2), 438–450.

Koch, F.H., Yemshanov, D., Haack, R.A. and Magarey, R.D. (2014). Using a Network Model to Assess Risk of Forest Pest Spread via Recreational Travel. PLoS ONE 9(7): e102105. doi:10.1371/journal.pone.0102105

Kovacs, K.F., Haight, R.G., McCullough, D.G., Mercader, R.J., Siegert, N.W. and Liebhold, A.M. (2009). Cost of potential emerald ash borer damage in U.S. communities, 2009–2019. Ecological Economics.

Kovacs, K.F., Haight, R.G., McCullough, D.G., Mercader, R.J., Siegert, N.W. and Liebhold, A.M. (2010). Cost of potential emerald ash borer damage in U.S. communities, 2009–2019. Ecological Economics 69, 569–578.

Maine Forest Service (2010). Emergency Order Restricting Transportation of Firewood Into the State of Maine. Department of Agriculture, Conservation and Forestry. Retrieved from: http://www.maine.gov/dacf/mfs/forest_health/invasive_threats/firewood_out_of_state_ban.shtml

Leal, I., Allen, E., Humble, L., Sela, S., and Uzunovic, A. (2010). Phytosanitary risks associated with the global movement of forest products: A commodity-based approach. Natural Resources Canada. Canadian Forest Service Pacific Forestry Centre Information Report BC-X-419

Mack R.N., Simberloff, D., Lonsdale, W.M., Evans, H., Clout, M. and Bazzaz, F.A. (2000) Biotic invasions: causes, epidemiology, global consequences, and control. Ecological Applications 10: 689–710.

Manitoba Laws (2015). C.C.S.M.c. F151 The Forest Health Protection Act. Retrieved from: http://web2.gov.mb.ca/laws/statutes/ccsm/f151e.php

Manitoba Government (2017). Personal communication by email with Kyla Maslaniek, Fiona Ross, Jason Kelly and Jason Watts. February–March 2017.

McCullough, D.G., Poland, T.M., Cappaert, D.L., Clark, E.L., Fraser, I., Mastro, V., Smith, S. and Pell, C. (2007). Effects of chipping, grinding, and heat on survival of emerald ash borer, Agrilus planipennis (Coleoptera: Buprestidae), in chips. Journal of Economic Entomology 100:1304–1315.

McKenney, D.W., Pedlar, J., Yemshanov, D., Lyons, D.B., Campbell,K.L., & Lawerence, K. (2012). Estimates of the potential cost of emerald ash borer (Agrilus planipennis fairmaire) in Canadian municipalities. *Arboriculture & Urban Forestry,* 38(3), 81-91.

TNC (2016). The Nature Conservancy. Webinar: Public Attitudes About Forest Pests. Presentation by Leigh Greenwood.

TNC (2017). The Nature Conservancy. “Don’t Move Firewood” campaign. Retrieved at: https://www.dontmovefirewood.org/

TNC (2017b). Personal communication by phone and email with Leigh Greenwood, The Nature Conservancy. January–March 2017.

National Firewood Survey (2017). Responses to questions related to the firewood pathway. Includes input from provincial and territorial natural resource departments, the Canadian Food Inspection Agency and the Canadian Council on Invasive Species.

Nova Scotia (2017). List of Registered Firewood Vendors. Government of Nova Scotia. Retrieved from: http://novascotia.ca/sns/access/individuals/consumer-awareness/consumer-purchases/vendor-list.asp

Nowak, D.J., Pasek, J.E., Sequeira, R.A., Crane, D.E. and Mastro, V.C. (2001). Potential effect of Anoplophora glabripennis (Coleoptera: Cerambycidae) on urban trees in the United States. Journal of Economic Entomology 94: 116–122

NRCan (2015). National Resources Canada. National Forest Pest Strategy. Retrieved from: http://www.nrcan.gc.ca/forests/fire-insects-disturbances/pest-management/13409

NFTF (2010). National Firewood Task Force Recommendations.

New York Department of State Division of Administrative Rules (2017). 6 CRR-NY 192.5 Official Compilation of Codes, Rules and Regulations of the State of New York. Department of Environmental Conservation; Lands and Forests; Forest Insect and Disease Control. Retrieved from: https://govt.westlaw.com/nycrr/Document/I21efc065c22211ddb7c8fb397c5bd26b?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)&bhcp=1

Oregon Laws (2015). 2015 ORS 570.720 Firewood sources. Retrieved from: https://www.oregonlaws.org/ors/570.720

Parks Canada (2016). Kouchibouguac National Park: Firewood Importation Ban. Retrieved from: https://www.pc.gc.ca/en/pn-np/nb/kouchibouguac/info/conservation/longicorne-longhorn.

Parks Canada (2016b). Banff National Park of Canada. Retrieved from: http://www.pc.gc.ca/qrt/Banff-EN.pdf

Parks Canada (2016c). Riding Mountain National Park of Canada. Retrieved from: http://www.pc.gc.ca/qrt/RidingMountain-EN.pdf

Parks Canada (2017). Jasper National Park of Canada. Retrieved from: http://www.pc.gc.ca/qrt/Jasper-EN.pdf

Parks Canada (2017b). Personal communication by phone with Patrick Nantel, Ecosystem Scientist, Parks Canada. June 12, 2017.

Peterson, K. and Diss-Torrance, A. (2014). Motivations for rule compliance in support of forest health: Replication and extension. Journal of Environmental Management 139 (2014) 135e145.

Pimentel, D., McNair, S., Janecka, J., Wightman, J., Simmonds, C., O'Connell, C., Wong, E., Russel, L., Zern, J., Aquino, T. and Tsomondo, T. (2001) Economic and environmental threats of alien plant, animal, and microbe invasions. *Agriculture, Ecosystems and Environment*, 84, 1–20.

Poland, T.M., Haack, R.A. and Petrice, T.R. (1998). Chicago joins New York in battle with the Asian longhorned beetle. Newsl. Mich. Entomol. Soc. 43: 15–17.

Poland, T.M., Haack, R.A., Petrice, T.R., Miller, D.L., Bauer, L.S. and Gao, R. (2006). Field evaluations of systemic insecticides for control of Anoplophora glabripennis (Coleoptera: Cerambycidae) in China. Journal of Economic Entomology 99(2):383-392.

Province of Alberta (1973). Forest Act: Timber Management Regulation (Alberta Regulation 60/1973 with amendments up to and including Alberta Regulation 62/2013). Retrieved from: http://www.qp.alberta.ca/documents/Regs/1973_060.pdf

Putman, H. A. (2010). Firewood Movement Regulations: Firewood Movement Rule, Rule No. 5B-65. Florida Department of Agriculture and Consumer Service. Retrieved from: http://www.freshfromflorida.com/Divisions-Offices/Plant-Industry/Business-Services/Registrations-and-Certifications/Firewood-Regulations

Redding, C. R. (2010). Notices – Department of Agriculture: Order of Quarantine; Firewood [40 Pa.B. 441]. The Pennsylvania Bulletin. Retrieved from: http://www.pabulletin.com/secure/data/vol40/40-3/108.html

SBC Firemaster (2017). Personal Communication by phone and email with Gabriella Zilahi-Balogh, CFIA on behalf of Paul Patton, General Manager, SBC Firemaster Ltd.

Smith, A.L., Bazely, D.R. and Yan, N. (2013). Are legislative frameworks in Canada and Ontario up to the task of addressing invasive alien species? Biological Invasions: 16(7): 1325–1344.

Stakeholder Discussion Panel (2013). Session IX: Firewood as a Pathway: working collaboratively to help mitigate the spread of native and introduced forest pests; Forest Pest Management Forum, Ottawa, Ontario. Invited stakeholders included: federal departments (CFIA, CFS, Parks Canada), provincial partners (Quebec, Manitoba, Ontario) and private stakeholders (campground associations, commercial firewood producers, associations, cities, First Nations, etc.).

State of New Hampshire (2013). Firewood Exterior Quarantine, Joint Quarantine No.2, Amendment No.2. Retrieved from: http://www.agriculture.nh.gov/publications-forms/documents/exterior-firewood-quarantine.pdf

STOPDED (2017). Personal email communication with Stop Dutch Elm Disease Executive Director, Janet Feddes-Calpas, January–February 2017.

The Forest Health Protection Act (C.C.S.M. c. F151) (2009). Forest Health Protection Regulation M.R. 87/2009. Retrieved from: http://web2.gov.mb.ca/laws/regs/current/_pdf-regs.php?reg=87/2009

Tobin, P. C., Diss-Torrance, A., Blackburn, L.M. and Brown, B. D. (2010). What does "local" firewood buy you? Managing the risk of invasive species introduction. J. Econ. Entomol. 103: 1569-1576.

USDA-APHIS (2007). Asian longhorned beetle: questions and answers. United States Department of Agriculture – Animal and Plant Health Inspection Service.

USDA-APHIS (2010). Industry alert: the U.S. Department of Agriculture (USDA) seeks comments on National Firewood Task Force (NFTF) recommendations. United States Department of Agriculture – Animal and Plant Health Inspection Service.

USDA-APHIS (2011). Risk Assessment of the Movement of Firewood Within the United States. United States Department of Agriculture – Animal and Plant Health Inspection Service. Retrieved from: https://www.aphis.usda.gov/import_export/plants/plant_imports/firewood/firewood_pathway_assessment.pdf

USDA-APHIS (2017). FEDERAL ORDER, All Imported Firewood from Canada and Spruce Logs from Nova Scotia, Canada. United States Department of Agriculture – Animal and Plant Health Inspection Service. Retrieved from: https://www.aphis.usda.gov/import_export/plants/plant_imports/federal_order/downloads/2011/DA-2011-28.pdf

US DOE (2000). United States Department of Energy. Forest products industry analysis brief.

Yemshanov, D., Koch, F.H., Ducey, M. and Haack, R.A. (2015). Towards Reliable Mapping of Biosecurity Risk: Incorporating Uncertainty and Decision Makers' Risk Aversion. Biosecurity Surveillance: Quantitative Approaches: 12, 217-237.

Yemshanov, D., Haight, R.G., Koch, F.H., Lu, B., Venette, R., Lyons, D.B., Scarr, T. and Ryall, K. (2015b). Optimal allocation of invasive species surveillance with the maximum expected coverage concept. Diversity and Distributions: 21, 1349–1359.

Yukon Government (2016). Legislation: Acts and Regulations. http://www.gov.yk.ca/legislation/legislation/page_f.html

Yemshanov, D. (2017). Personal phone communication with Denys Yemshanov, Canadian Forest Service, Natural Resources Canada. March 27, 2017.

**Appendix I -** Personal communication and survey respondents

- BC: Tim Ebata, Jennifer Grant
- AB: Caroline Whitehouse, Vicky Bosse, Caroline Crell, Graham P Legaarden, Megan Evans
- SK: Rory McIntosh
- MB: Kyla Maslaniek, Fiona Ross, Jason Kelly, Jason Watts
- ON: Richard Wilson, Brendan Shepherd
- QC: Pierre Therrien
- NB: Drew Carleton, Jane Caverhill
- NS: Dustin Oikle, Gina Penny, Alan White, Williams Barry, Chris MacIntyre, James C. Scott, Jordan Post, Peter Colp, Kirk Webster, Dolores A MacDonald, Tom Prest, Deanna Nauss, Mark Vanderhoeden, Terry Moore
- NL: Dan Lavigne, Geoff Bailey
- YK: Rob Legare, Carrie Mierau, Barry Troke
- NWT: Jakub Olesinski, John Cournoyea, Jennifer Thistle, Marc Schmitz
- United States: Leigh Greenwood, Jerry A. Carlson, Andrea Diss-Torrance
- CFIA: Marcel Dawson, Andrea Saunders, Naima Ait Oumejjout, Gabriella Zilahi-Balogh, Holly Armstrong, Julia Ruhl, Barbara Robinson, Cara Grant, Troy Kimoto, Bryan Lock, Jason Watts
- CFS: Taylor Scarr, Denys Yemshanov
- Parks Canada: Patrick Nantel
- CCIS: Gail Wallin, Barry Gibbs
- STOPDED (AB): Janet Feddes-Calpas
- Lowe's: Raphael Macias
- Canadian Tire: Jeff Rolfe and Kate Kelly
- Xtraflame: Marcel Gazaille, Jennifer Charbonneau
- Great Britain: Nick Mainprize