

## TRANSPORTATION OF RAW FOREST PRODUCTS IN NORTHERN ONTARIO BY TRUCKS



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### **Abstract**

This paper describes key issues concerning the transportation of raw forest products in Northern Ontario, Canada. The issues are related to the need to minimize the cost of transporting raw forest products. The specific topics include the technology of logging trucks, the management of logging trucks on local roads, and strategies for reducing the cost of transporting raw forest products. Logging trucks are typically 8-axle single trailer trucks consisting of 3-axle tractor and 5-axle semitrailer equipped with two liftable axles. The strategies required to reduce the cost of transporting raw forest products include improvements to the network of roads used to transport raw forest products and improvements in the logging truck technology.

**Keywords:** Logging trucks, Road user benefits, Weights and dimensions, Transportation costs, Reduced load period.

### **Résumé**

Cet article décrit les principales questions liées au transport des produits forestiers bruts dans le nord de l'Ontario au Canada, et notamment le besoin de réduire le coût de transport de ces produits. Les sujets spécifiques traitent de la technologie des camions de bois ronds, leur gestion sur les routes locales, et les stratégies de réduction des coûts de transport. Ces camions ont généralement 8 essieux, et se composent d'un tracteur à 3 essieux et d'une semi-remorque à 5 essieux dont deux relevables. Parmi les moyens de réduction des coûts de transport des produits forestiers bruts on cite les améliorations du réseau routier utilisé et celles de la technologie des poids lourds de bois ronds.

**Mots-clés :** Camions de bois ronds, bénéfices des usagers de la route, poids et dimensions, coûts de transport, réduction de la durée de chargement.

## **1. Introduction**

After automobile manufacturing, the forest industry is the single largest contributor to the balance of trade in Ontario. The forest industry in the Province of Ontario generates about \$19 billion in sales, including exports of \$8.5 billion. Ontario harvests about 25 million cubic metres of wood fibre annually from clearing about 210 000 hectares of forest lands (Millard, 2005). The paper describes the transportation of this harvest by specialized heavy trucks from the forest to the processing plants.

Most of the Ontario forest industry is located in Northern Ontario where it is typically the major industry. Northern Ontario is the part of the Province of Ontario which lies north of Lake Huron, the French River, and Lake Nipissing. Compared to Southern Ontario, Northern Ontario is sparsely populated, contains less than 7 percent of the population, and has more than 50 percent of all provincial highways.

Raw forest products are transported from the forest to the processing mills by trucks using Forest Access Roads and provincial highways. The cost of transporting raw forest products, in terms of total production costs, is a significant component of the overall lumber costs. Nix (1996) reported that the total trucking costs (inbound from the forest to the mill and outbound from the mill to the customer) are in the range of about 9 to 23 percent of the sale price depending on the size of the lumber. Consequently, transportation costs play an important role in the competitiveness of the Ontario Forest Industry. For pulp and paper products, the cost of transporting raw forest products to the mills is smaller in the percentage terms because of higher pulp and paper production costs.

To minimize transportation costs of raw forest products, and thus to support the viable forest industry in Northern Ontario, it is necessary to address the truck technology as well the road network that provides the connection between the forest and the processing plants. Trucks transporting raw forest products, particularly logs, to the processing mills are called logging trucks. The road network consists of public highways and an extensive network of forest access roads. Ontario has about 100,000 km of forest access roads which are typically built and maintained by the industry. However, when they are located on public land, the public has the right to use them.

The objective of the paper is to summarize key issues concerning the transportation of raw forest products in Northern Ontario considering the need to minimize the cost of transporting raw forest products. The specific topics include: (i) Technology of logging trucks, (ii) Management of logging trucks on roads, and (iii) Strategies for minimizing the cost of transporting raw forest products.

## **2. Technology of Logging Trucks**

The trend regarding the type of trucks used for the transportation of raw forest products (mainly logs) in Northern Ontario is toward the use of logging trucks consisting of a three-axle tractor and a five-axle semitrailer. The first two axles on the semitrailer are liftable axles (Figure 1). Over 90 percent of logging trucks in Northern Ontario are of this type. A very small percentage of logging trucks may still use a four-axle semitrailer.



**Figure 1** – Empty Logging Truck Consisting of a 3-Axle Tractor with a 5-Axle Semitrailer. The First Two Axles on the Semitrailer are Lifted.

## 2.1 Logging Trucks

The use of three-axle tractors with five-axle semitrailers of the type shown in Figure 1 has several advantages:

- The trucks are configured to take the full advantage of allowable Ontario vehicle weights and dimensions. A typical 5-axle logging truck operates at the Gross Vehicle Weight (GVW) of about 61,000 kg (Nix, 1996). (Following the common practice used in the technical literature intended for wider audience in Canada, axle and truck weights in this report are given in kg rather than in Newtons or kN).
- The trucks can move 8-foot (2.4 m), 16-foot (4.8 m), or tree-length logs. This type of flexibility is increasingly important to reduce the amount of rejected or wasted forest fibre. It facilitates the harvesting of all tree species on the same wood lot and their transportation to different processing facilities as may be required (e.g., sawmills, paper mills, and veneer mills). Figure 2 shows a logging truck carrying five bundles of 8-foot logs destined to a sawmill.
- The liftable axles in the middle of the configuration can be raised to negotiate difficult terrain on rough forest access roads with a substandard vertical and horizontal alignment. Without raising the axles that are in the middle of the configuration, large (vertical) bumps and sharp (horizontal) turns can damage the chassis. Alternatively, forest access roads would have to be constructed to higher geometric standards, or the trucks would have to be shorter.
- The existence of the liftable axles on the trailer allows load to be transferred to the tractor's drive axles. This permits or improves operations over slippery ground where additional traction is required (Nix, 1996).

## 2.2 Seasonal Load Allowance and Restrictions in Ontario

All Canadian highway agencies, the majority of Canadian municipal agencies, 19 U.S. States, and many northern European countries restrict heavy vehicle loading during the spring thaw period (C-SHRP, 2000). Load restrictions are applied to minimize pavement damage when the structural capacity of the pavement is reduced due to thaw and high moisture conditions of the subgrade and granular layers. The regulations concerning seasonal load allowance and restrictions in Ontario include an additional axle load allowance during a freeze-up period and a reduction of allowable axle loads during a reduced load period.



**Figure 2** – Logging Truck, Loaded With 8-Foot (2.4 m) logs.

### ***Additional Allowance During Freeze-Up Period***

An additional allowance of 10 percent of the allowable axle weights (and GVW) is given to vehicles used exclusively for the transportation of raw forest products during the designated freeze-up period. The allowance applies to all highways, not only to highways which are subject to reduced load periods (HTA, 1990). The raw forest product allowance during freeze-up is intended to allow for the additional moisture content in the wood that gets trapped and freezes during the winter months. The typical length of the freeze-up period is from late December to early March.

The 10 percent increase in the allowable axle weights results in increased productivity and the industry takes the advantage of the allowance. In addition, the period of the additional allowance during the freeze-up is followed shortly, on some of the highways, by the reduced load period.

### ***Reduction of Allowable Axle Loads During Reduced Load Period***

The reduced load period, or spring-load reduction period, is sometimes referred to as a half-load period because the maximum allowable weight of a single axle with dual tires is reduced by one half – from 10,000 kg to 5,000 kg. The reduction in allowable axle loads applies only to designated highways. Typically, for highways in Northern Ontario, the length of the reduced load period lasts for 3 months in the southern part (from March 1 to May 31) and for 4 months in the northern part (e.g., March 1 to June 30).

The load reduction during the reduced load period does not prevent the passage of unloaded, or partially loaded logging trucks because the steering axle weight of these trucks does not typically exceed 5,000 kg, and the weight of the payload-carrying axles (considering the flat-bed design of the trucks, shown in Figure 2), is typically less than 2,000 kg.

The actual reduction in the payload during the reduced load period is typically more than one half as suggested by data presented in Table 1. Consequently, more than two trips may be required to transport the same payload during the reduced weight load period compared to the unreduced period. For this reason, the operation of logging trucks is typically suspended during reduced load periods.

**Table 1 – Typical Reduction in Payload During Reduced Load Periods for Logging Trucks.**

Axle type	Allowable axle weight, kg		Typical weight of unloaded axle, kg	Typical full payload, kg		Typical payload reduction during reduced load period, %, 7
	Without reduction	Reduced load period		Without reduction	Reduced load period	
1	2	3	4	5	6	7
Steering axle <sup>1)</sup>	9,000	5,000	4,750	250	250	None
Single axle <sup>2)</sup>	10,000	5,000	2,000	8,000	3,000	63
Double axle	15,400 to 19,100	10,000	4,000	11,400 to 15,100	6,000	47 to 60
Triple axle	19,500 to 28,600	15,000	5,500	14,000 to 23,100	9,500	40 to 59

<sup>1)</sup> Steering axle with single tires.

<sup>2)</sup> Payload carrying single axle. Not applicable to 8-axle logging truck shown in Figures 1 and 2.

### 2.3 Width of Trucks Carrying Raw Forest Products

The maximum allowable width of highway vehicles is 2.8 m for tractors (rear vision mirrors and lamps may extend in whole or in part beyond either side of the vehicle) and 2.6 m for a load on the vehicle (HTA, 2000). However, for loads of raw forest products, the maximum allowable total load width is 2.7 m at point of origin and 2.8 m at any time during transit (Figure 3). In addition, the load covering mechanism may further extend the width of the vehicle on either side by more than 102 millimetres.



**Figure 3 – Width of Load Exceeds the Allowable Width.**

The extra width of trucks carrying raw forest products should be considered when establishing geometric design requirements for highways used extensively for the transportation of raw forest products as well as for tourist routes. Figure 3 indicates that the width of the load may noticeably exceed the width of the trailer. The width of the trailer shown in Figure 3 is probably 2.6 m, the maximum allowable width.

### **3. Management of Logging Trucks on Secondary Highways in Northern Ontario**

There are many challenges facing transportation agencies managing highway networks where logging trucks represent a significant proportion of commercial vehicles. Typically, in Northern Ontario, these networks consist of secondary highways with the Annual Average Daily Traffic (AADT) volumes in the range of 100 to 900 vehicles, and the proportion of commercial vehicles ranging from 10 to 30 percent. Often, up to 80 percent of all commercial vehicles are logging trucks. The specific challenges outlined herein include the estimation of the volume of logging trucks using the road network, compliance and enforcement of vehicle weight regulations, and benefits of highway improvements to the forest industry.

#### **3.1 Estimation of the Volume of Logging Trucks**

Because the logging trucks often represent the main commercial usage on secondary highways in Northern Ontario, it is important to know their volume for the judicious management of the highway network. In the case of logging trucks operating on secondary highways, the traditional approach of estimating traffic volumes using traffic data collection in the field is unreliable for two reasons.

Firstly, the use of Automatic Traffic Recorders (ATR) that detect vehicle presence through the use of pneumatic tubes cannot reliably distinguish between related truck types, for example between 8-axle single trailer trucks (which are typically logging trucks) and 8-axle multi-trailer trucks (which are typically B-trains and not logging trucks). Even well maintained and calibrated Automatic Vehicle Classifiers (AVC) and Weigh-in-Motion (WIM) systems have difficulties properly classifying logging trucks with two liftable axles (Figure 1). In addition, the installation and operation of AVC and WIM equipment on gravel and surface-treated pavements (surface-treatment consists of the application of liquid bitumen, typically emulsion, onto an aggregate layer, followed immediately by the application of the cover aggregate) at remote locations is problematic and can be very expensive.

Secondly, the traffic counts of logging trucks carried out on secondary highways in the field reflect only the conditions during the traffic data collection period and not necessarily the typical or average conditions throughout the pavement design period. For example, if a large wood lot is harvested during the time of a traffic survey, the number of logging trucks recorded during the survey, when factored-up for the whole year (to obtain AADT volumes), or factored-up for the duration of the pavement design period of many years, can provide egregious results.

For this reason, a model has been developed that can be used to estimate the amount of the forest biomass that will need to be transported over the highway network year after year. The model is based on the premise that the forest resources will be managed in a sustainable manner, and that the need for wood fibre to manufacture goods (particularly lumber) and to generate energy will continue indefinitely. The procedure used to estimate the biomass and the associated transportation needs is summarized in Table 2.

**Table 2** – Estimation of Transportation Needs Generated by the Forest Industry.

Condition	Note	Size of catchment area	
		Large	Small
Size of the catchment area in km <sup>2</sup>	1	10,000	225
Size of the catchment area in hectares	2	100,000	2,250
Estimated yield of marketable wood fibre in 40 years, m <sup>3</sup>	3	12,000,000	270,000
Annual amount of the total estimated marketable fibre per year, m <sup>3</sup>	4	400,000	9,000
Annual number of logging trucks required to transport wood fibre	5	3,636	82
Annual average daily volume of trucks required to transport the fibre, one way	6	10	0.2
Annual average daily volume of trucks required to transport the fibre adjusted for seasonal load restrictions, one way	7	13	0.3

Notes

- 1: Estimated forested area that is serviced by a highway or a highway segment. Different parts of the highway may have different catchment areas. The size of the large catchment area is assumed to be 100 km by 100 km; the size of the small catchment area is assumed to be 15 km by 15 km.
- 2: The conversion to hectares is needed because several industry indicators, such as wood fibre yields, growth rates, and forest plantation densities, are reported in hectares (Willcocks and Bell, 1995).
- 3: This is an average yield assuming that Ontario harvests 25 million cubic metres of wood fibre annually from clearing 210 000 hectares (Millard, 2005). It is expected that yield will increase in the future through the ongoing process of converting single entity Sustainable Forest Licenses (SFLs) to Shareholder SFLs to better utilize wood available from all tree species.
- 4: It is assumed that the sustainable regeneration rate is 30 years.
- 5: It is assumed that one logging truck can transport 110 m<sup>3</sup> of wood fibre per trip. This is based on the dimension of the truck load being 2.6 m wide, and about 3 m high, and 14 m long.
- 6: The calculation assumes that wood fibre is transported to the nearest mill. In practice, wood fibre from different tree species may need to be transported to different mills. However, ongoing changes in the Ontario Forest Management Planning process (Shareholder SFLs) will probably alleviate the need for additional transportation.
- 7: It is assumed that the seasonal load restrictions last for three months and that during this time the transportation of raw forest products is suspended.

According to the data presented in Table 2, the average annual daily number of logging trucks expected on routes serving large catchment areas, is expected to be about 10 fully loaded logging trucks per day, or about 13 trucks per day outside a load reduced period. The annual average daily number of logging trucks expected on routes serving small catchment areas is expected to be about 0.2 fully loaded logging trucks per day, or about 0.3 trucks per day outside a load reduced period.

### **3.2 Compliance and Enforcement of Vehicle Weight Regulations**

The impact of seasonal load restrictions on the forest industry depends also on the degree of compliance with regulations and on the level of enforcement. The influence of axle overloads, and the impact of the level of compliance and enforcement, is much more important during the reduced load period. Firstly, during the reduced load period the pavement structure is weakened by the spring-thaw moisture conditions and susceptible to damage due to overloads. Secondly, significant axle load overloads typically occur only during the reduced load period. Logging trucks are purpose-built and their GVW cannot be significantly increased (overloaded) outside the reduced load period because they are already transporting their maximum volume of logs possible (Figure 2).

According to findings by a Minnesota (2005) study, the level of compliance with spring load restrictions was estimated to be between 20 and 50 percent. Also, the enforcement of vehicle weight regulations is very demanding for remote locations on secondary highways— there are no permanent truck weighting facilities located on secondary roads.

### **3.3 Benefits of Highway Improvements to the Forest Industry**

Road improvements can provide a number of road user benefits to the forest industry. The road improvements that reduce road user costs contribute to the sustainability of the forest industry and increase the total amount of wood fibre that can be economically harvested. By reducing transportation costs, it may become economical to utilize also marginal wood fibre, for example for energy. The specific road user benefits include the benefits due to improvements in highway geometry and pavement smoothness, and benefits due to the removal of the reduced load period.

#### ***Benefits Due to Improvements in Highway Geometry and Pavement Smoothness***

Benefits due the improvements in highway geometry and pavement smoothness have been quantified by estimating the difference in road user costs incurred by users before and after upgrading using Priority Economic Analysis Tool PEAT (Cambridge, 2004). PEAT can be used to estimate road user benefits (in terms of travel time savings, vehicle operating costs, and accident costs) separately for passenger cars and commercial vehicles. However, it is difficult to distinguish if road user benefits associated with passenger cars are incurred by the travelling public in general or by the industry.

#### ***Benefits Due to the Removal of the Reduced Load Period***

Benefits due to the removal of the reduced load period include:

- Increase in the transportation productivity by transporting larger payloads during the reduced load period.
- Providing the option for implementing “just-in-time” delivery operations throughout the year. This may reduce or eliminating the need to stockpile logs leading to savings in storage costs.
- Savings due to the elimination of the need to use longer alternative routes during reduced load periods. However, because of the sparse network of secondary roads used to transport logs, alternative routes are typically not available.
- The possibility to transport large indivisible loads during the reduced load period. This possibility does not apply to the transportation of logs (logs constitute a divisible load). However, forest industry may benefit by the possibility to transport heavy equipment for the mills or for the construction of forest access roads throughout the year.

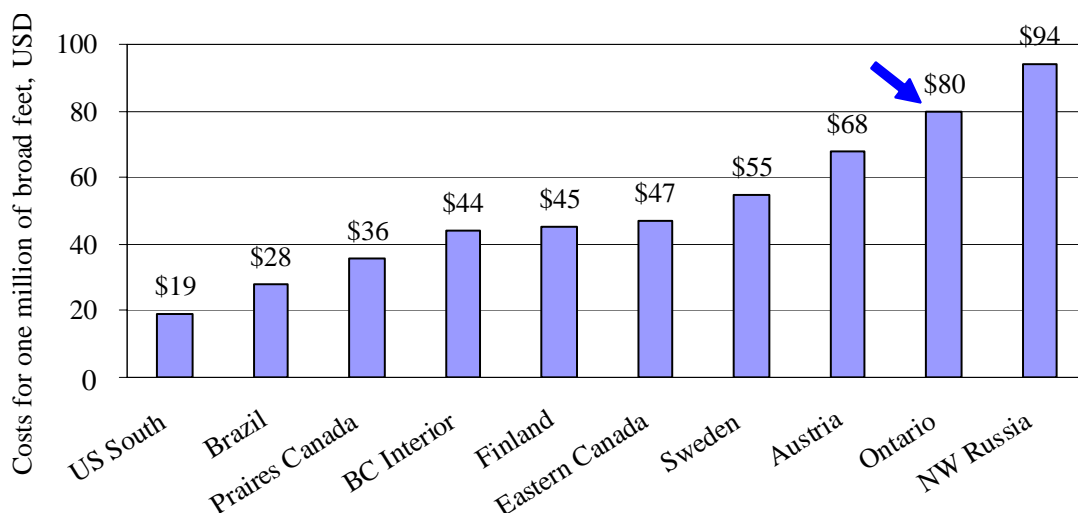


- The removal of the reduced load period, and the associated improvements in the pavement structure, have the potential to attract new business to the corridor served by the upgraded highway.

The quantification of benefits to the forest industry due to the removal of the reduced load period is difficult because of the uncertainty associated with the estimation of the latent demand for the transportation of raw forest products during the reduced load period. Overall, highway improvements can enhance the competitiveness of the forest industry in Northern Ontario. However, unless there are significant technological advances in forest product processing technology, the road improvements alone will probably not result in the creation of new forest product processing facilities.

#### 4. Cost of Transporting Forest Products

According to the report by the Minister’s Council on Forest Sector Competitiveness, transportation costs play an important role in the competitiveness of the Ontario forest industry. According to data presented in Figure 4, supplied by the forest industry (Millard, 2005), Ontario raw forest product transportation costs are about 80 percent higher than the comparable costs in Eastern Canada.



**Figure 4** – Comparison of Transportation Costs (Including Road Costs) in Different Jurisdictions

The transportation costs in Figure 4 are reported in US dollars per one million board feet. One board foot is the nominal quantity of lumber derived from a piece of rough lumber one inch (25.4 mm) thick, one foot (304.8 mm) wide, and one foot long).

To reduce the cost of transporting raw forest products in Ontario, it is necessary to pursue a two-prong approach:

- Improving network of roads used to transport raw forest products, and
- Improving logging truck technology.

### ***Road Improvements***

The benefits to the forest industry stemming from the improvements to the secondary highway network were outlined in Section 3.3. Regarding the improvements to the Forest Access Roads that are built and maintained by the forest industry, the Minister's Council on Forest Sector Competitiveness (MNR, 2005) recommended subsidies to the forest industry for maintaining primary forest access roads.

### ***Improvements to the Technology of Logging Trucks***

The improvements to the technology of logging trucks include:

- The use of central tire inflation systems. The use of the central tire inflation systems can lead to the changes or the elimination of the reduced load period, to the potential increase of allowable vehicle weights and dimensions, and to less costly pavement structures.
- The use of the self-steering load-carrying axles. The introduction of the self-steering load-carrying axles may lead to the elimination of liftable axles and to the increased axle weights. The elimination of liftable axles would be also beneficial in reducing pavement damage.

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