

LEGISLATIVE REFERENCE LIBRARY
SD389 .F676 1990
Forest road traffic study, 1988-19
3 0307 00061 7855

This document is made available electronically by the Minnesota Legislative Reference Library as part of an ongoing digital archiving project. <http://www.leg.state.mn.us/lrl/lrl.asp>
(Funding for document digitization was provided, in part, by a grant from the Minnesota Historical & Cultural Heritage Program.)

900146

FOREST ROAD TRAFFIC STUDY

1988 - 1989



REPORT TO THE MINNESOTA LEGISLATURE

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

DIVISION OF FORESTRY, ST. PAUL, MINNESOTA

SD
389
.F676
1990

LEGISLATIVE REFERENCE LIBRARY
100 N. 5TH ST. ST. PAUL, MN 55101
651-224-2600

FOREST ROAD TRAFFIC STUDY

1988 - 1989

REPORT TO THE MINNESOTA LEGISLATURE

Submitted To

The Minnesota Senate Finance Committee

The Minnesota Senate Transportation Committee

The Minnesota House Appropriations Committee

The Minnesota House Transportation Committee

In Accordance With Laws of Minnesota 1988, Chapter 686, Art. 4, Sec. 10

Prepared Through The Cooperation of

Department of Natural Resources, Division of Forestry

Minnesota Association County Land Commissioners

Department of Transportation, Office of Transportation Data Analysis

Department of Revenue, Petroleum Tax Office

FOREST ROAD TRAFFIC STUDY 1988 - 89

EXECUTIVE SUMMARY

The Department of Natural Resources (DNR) administers 2,063 miles of forest roads that provide access to much of the 4.5 million acres of forest land managed by the DNR. County land departments manage another 2.7 million acres of public lands served by 1933 miles of county forest access roads.

In 1982 the Legislative Commission on Minnesota Resources provided funds to prepare the State Forest Road Plan. This plan recognized the need for a stable source of funding to accompany the increased demand in use. The DNR and counties could not absorb the costs of maintaining and expanding the road system to improve access for forest management as well as to serve the increased recreational and resource demands.

To help pay for these roads, the legislature passed the Laws of Minnesota for 1988, Chapter 686, Article 4. Section 7, Subd. 1a, estimates that \$675,000 of the total annual unrefunded revenue from the gasoline fuel tax on all gasoline and special fuel received in, produced, or brought into this state, except gasoline and special fuel used for aviation purposes, is derived from operation of motor vehicles operated on state forest roads and county forest access roads. Of this sum, it is estimated that \$400,000 is annually derived from motor vehicles operated on state forest roads and \$275,000 is annually derived from motor vehicles operated on county forest access roads in the state. Sections 10 and 11 required the commissioners of transportation, natural resources, and revenue, and the counties having forest roads to determine the percentage of revenue received from the unrefunded gasoline and special fuel tax that is derived from gasoline and special fuel for the operation of motor vehicles on state forest roads and county forest access roads on an annual basis. As required by the law this report is submitted to the transportation committees of the senate and house of representatives and to the house appropriations and senate finance committees as well as the legislative library.

At the time the law was passed there was little data to support this level of appropriations other than estimates made from analyzing timber sales, recreational activities and hunting counts. DNR and the counties decided to conduct separate studies of their own roads. Both parties would cooperate in designing and carrying out the studies to avoid double counting and to produce comparable results. The study period was 1 May 1988 through 30 April 1989.

The DNR study indicated that light vehicles traveled 15,394,824 miles on state forest roads. Logging trucks traveled another 420,900 miles. The combined fuel consumption of these vehicles on state forest roads was 1,367,082 gallons (0.0605 percent of the state state total), which generated \$273,416.40 in unrefunded gas tax.

The county study estimated that light vehicles and logging trucks, combined, traveled 14,525,175 miles on county forest access roads. The fuel consumption of all vehicles on county forest access roads was 1,252,170 gallons (0.0555 percent of the state total), which generated \$250,434.05 in unrefunded gas tax.

The combination of the results of the DNR Division of Forestry and the county traffic studies indicates that 2,619,252 gallons of fuel are consumed annually on Minnesota's state and county forest roads which generates \$ 523,850.45 annually in unrefunded gas tax. This represents 0.1160 percent of the unrefunded gasoline and special fuels tax which is collected each year.

INTRODUCTION

The Department of Natural Resources (DNR) administers 2,063 miles of forest roads that provide access to much of the 4.5 million acres of forest land managed by the DNR. County land departments manage another 2.7 million acres of public lands served by 1933 miles of county forest access roads. Maintenance of these forest roads has always been underfunded even though they are critical to resource management and economic opportunities such as tourism, recreation, and the intensification of timber and wildlife management.

In 1982 the Legislative Commission on Minnesota Resources provided funds to prepare the State Forest Road Plan. This plan recognized the need for a stable source of funding to accompany the increased demand in use. The DNR and counties could not absorb the costs of maintaining and expanding the road system to improve access for forest management as well as to serve the increased recreational and resource demands. The 1989 Governors Blue Ribbon Commission on Forestry and Forest Products also recommended increased funding of these roads.

To help pay for these roads, the legislature passed the Laws of Minnesota for 1988, Chapter 686, Article 4. Section 7, Subd. 1a estimates that \$675,000 of the total annual unrefunded revenue from the gasoline fuel tax on all gasoline and special fuel received in, produced, or brought into this state, except gasoline and special fuel used for aviation purposes, is derived from operation of motor vehicles operated on state forest roads and county forest access roads. Of this sum, it is estimated that \$400,000 is annually derived from motor vehicles operated on state forest roads and \$275,000 is annually derived from motor vehicles operated on county forest access roads in the state. Sections 10 and 11 required the commissioners of transportation, natural resources, and revenue, and the counties having forest roads to determine the percentage of revenue received from the unrefunded gasoline and special fuel tax that is derived from gasoline and special fuel for the operation of motor vehicles on state forest roads and county forest access roads on an annual basis. As required by the law this report is submitted to the transportation committees of the senate and house of representatives and to the house appropriations and senate finance committees as well as the legislative library.

At the time there was little data to support this level of appropriations other than estimates made from analyzing timber sales, recreational activities and hunting counts. The traffic study began in May 1988.

Representatives of the Minnesota Department of Transportation, Office of Transportation Data Analysis (Mn/DOT), counties, Department of Revenue (DOR) and DNR met to design the study. It was decided that DNR and the counties would conduct separate studies of their own roads. Both parties would cooperate in designing and carrying out the studies to avoid double counting and to produce comparable results.

These were the basic considerations in the design of the study:

- o identification of roads to be included in the study;
- o identification of use patterns and how best to categorize them;
- o methods for the study;
- o equipment available to do the study;
- o intensity required to provide a statistically sound report;
- o method of assigning random locations to carry out the study;
- o monitoring of the counting process;
- o processing of the data;
- o compatibility of the data with existing Mn/DOT methods;
- o a means to estimate the seasonal variability of the data with the equipment available;
- o personnel available to conduct the study.

STUDY SPECIFICS

Study Design

The study was designed through the cooperation of Office of Transportation Data Analysis of the Mn/DOT, DOR, DNR and the counties. It relied on the standard format used by most agencies in conducting traffic studies: that is, a limited number of permanently located (continuous) counters and a larger number of short-term roving counters. Information from the permanent counters is used to develop use curves, which can then be used to adjust the numbers obtained from the roving counters to a full-year basis.

Literature reviews of study designs indicated that the roads should be divided into categories according to expected use. Each use category should have about four permanent counter locations. The roving counters could be set at about 5-mile to 10-mile intervals and rotated on a 24-hour to 48-hour schedule.

Counting Periods

Most traffic studies by other agencies are carried out over short periods (24 to 48 hours) and adjusted to periodic or annual counts using data from permanent counters. Forest roads have more sporadic use than most public roads. It was agreed that a different monitoring scheme should be used. The sampling scheme selected for this study was a series of roving counters that moved each week and four or five continuous counters in each of the use categories. The counters were to be read on alternate days (three times per week). This method requires some averaging of counts to work with the standard equations, since 1-hour, 12-hour, and 24-hour counts are normally used by Mn/DOT. Extending the monitoring period to one week was designed to reduce the variability of the data.

DNR

State forest roads are widely dispersed, and the sampling density was felt to be too low with roving counters at 5-mile intervals. So DNR doubled the intensity to one sample every 2.5 miles for the roving counters, but left the permanent counters at four or five per use category. DNR also felt that the logging truck traffic should be estimated separately since 60 percent of this traffic is typically winter traffic, which was difficult to measure with the available equipment. The logging traffic study is discussed later in this report. Logging activity was noted in the remarks when the counters were read. These notes were then used to reduce the actual counts to corrected counts before entry into the data base.

Counties

The counties set roving counters at 5-mile intervals and used four permanent counters for every use category. The logging truck traffic was left in the county study because the counties decided that it would be too difficult to track it by any other means.

Use Categories

DNR

The state forest roads were divided into five use categories:

1. Recreational roads were defined as those that served a developed recreation site, such as a campground, water access, or

trailhead, and the traffic was probably closely related to the use of these facilities.

2. Through roads connected two "public" roads. The use of these roads was closely related to the use of the adjoining public roads.
3. Class 5 roads are the roads with the lowest construction standards in the study (class 6 roads were excluded from the mileage and the study). They were assumed to have the most variable traffic use since the primary reasons to use them are closely tied to specific short-duration activities such as logging and hunting.
4. Southeast roads were those in the R. J. Dorer State Forest. They were neither recreational nor through roads. These roads were considered separately because the land forms and types of activity, such as trout fishing, turkey hunting and sight-seeing, are quite different from those in the rest of Minnesota.
5. Other roads were those that did not fit one of the categories already defined.

Counties

County forest access roads were divided into two use categories:

1. Category A roads were those that had two lanes (18 to 24 feet wide). It was assumed that these had the most use on the most regular basis.
2. Category B roads were the rest of the county forest access roads. These were single-lane roads that were traveled because of some specific activity.

The temporary and lowest-standard roads were excluded from the study because of the difficulty in measuring the traffic on them, and the perception that these would add little traffic to the total.

Equipment

Old pneumatic counters, retired from Mn/DOT service, were used for most of the roving short-term counting. From Mn/DOT information it appeared that at least

a 10 percent failure could be expected after about 48 hours with these counters for one reason or another. No adjustment was made for this expected failure rate because Mn/DOT felt that this was a normal problem with their counting program that would be worked out as the data were analyzed, as it is with the Mn/DOT studies. DNR and the counties ordered a number of buried-loop electronic counters and a couple of infrared counters to use in the permanent locations. Several new pneumatic counters were later purchased to replace broken Mn/DOT counters. Because of manufacturing delays, the electronic counters were delivered just after the fall frost in 1988. Several could not be installed until the spring of 1989. Readings from the pneumatic counters were collected until snow or mud made them unreliable.

Some of the counters functioned well throughout the study; others developed problems. Hoses and counters were stolen. Batteries continually failed. Some of the older counters developed mechanical or electrical problems and had to be sent in for repairs. A few counters were physically damaged by a variety of means; some were shot with guns or run over by vehicles. Substitution of other machines was limited by the number of machines available at the time. The impact of these problems on the study is not fully understood. The amount of traffic that was not counted is unknown, and there is too little time to repeat the study.

Permanent Counters

Locations

Permanent counters were distributed randomly within each use category. For each use category the mileage was totaled and divided by 4 to determine the spacing between the permanent counter locations. The location of the first station was determined by proceeding one-half of this mileage from the start of the listing for that use category. The second counter location was placed the full interval down the list. While this method biased the sample away from the first roads listed, and thus the administrative unit they were in, it also avoided over-sampling of this location. Upon examination of the geographic distribution of these counter locations on the state forest roads, it was decided to add one additional permanent counter location in the central region of the state in both the Class 5 and Other use categories.

Reading of Counters

Pneumatic counters at permanent locations were to be read three times per week (alternate days). Electronic counters at permanent sites would be read at least once, but preferably three times per week to insure continuous data records. The reading and placement of the counters were carried out by local DNR and county personnel who were familiar with the roads and the traffic patterns. Counters were placed at the locations specified in the lists. Notes were made at each reading of the number of active logging permits and any other special conditions or problems such as counter malfunction, ground conditions (such as mud) that might affect the count, vandalism, or special notes on the observed use in relation to the count.

Pneumatic counting was limited to the frost-free months as much as possible to reduce problems with the counting machines.

Weekend counting proved to be the biggest volume but also the biggest problem. Vandalism or counter malfunctions seemed most frequent then. The combination of three days between readings and increased public attention took its toll on the counting process.

Fire fighting, tree planting and other important tasks occasionally interrupted the monitoring schedule. These interruptions exacerbated the problem of counter malfunction. In a few instances, several readings were missed. These missed readings made analysis difficult.

Roving Counters

Locations

Each use category was considered separately for assignment of roving short-term counter locations. The roads within each use category were printed out. Total mileage was calculated to assign the counter locations.

DNR

Roving counter locations were selected by starting 2.5 miles from the start of each use category list and assigning a counter location every 5 miles down the list. The first time a counter location fell exactly at the end of one road, the counter was assigned there. On the second

time a counter location fell at the end of a road, the counter was placed at the start of the next road. The third time, the counter was left at the end of the road, and so on. This first list of locations was used beginning in early May 1988.

A second list of locations was developed by starting at the top of the list and again going down the list in 5-mile increments. The object of the second list was to place a counter between each of the previous locations on the roving list. This list was used beginning in late July 1988.

County

Roving counters were distributed in the same manner as on DNR roads, except that only one list of locations was sent out at the start of the study. Consequently, counters were placed at 5-mile intervals, rather than every 2.5 miles.

Reading of Counters

Pneumatic counters were to be read three times a week (alternate days). The roving short-term counters were to be moved to a new location each week. The reading and placement of the counters was carried out by local DNR or county personnel, who were familiar with the roads and the traffic patterns. Notes were made at each reading of the number of active logging permits and other special conditions or problems.

Roving counts were limited to the frost-free months as much as possible to reduce problems with the counting machines.

Just as with permanent counters, vandalism or counter malfunctions seemed most frequent on weekends. Likewise, fire fighting, tree planting and other important tasks occasionally interfered with the monitoring schedule.

DATA ANALYSIS

The study collected a large volume of data that was entered into an RBASE data base. RBASE and LOTUS 1-2-3 were used by the Mn/DOT staff to analyze the data. It was not feasible to use the standard Mn/DOT program, which is normally used for processing continuously collected traffic counts. The actual hourly

counts required by the analysis program were not taken in this study because of the logistics, equipment, and lack of traffic. The so-called hourly counts in the forest road study were estimated by averaging the data for each time period at a specific counter location. The multiday counts from the permanent counters were to be converted into average-week-of-the-year counts, to provide use patterns for adjusting the short-term counts. This conversion of multiday counts proved more difficult than expected.

Analysis Methods

In processing the data, the first step was to standardize the count volumes. These were adjusted to 24-hour volumes, which represented the daily average for the week when they were taken. The data was then edited to eliminate any counts that appeared to be invalid due to machine problems or other reasons, as noted by the field staff. Especially important in the editing process were the comments by the field staff. A file was then created, which assigned a week of the year to each count using the date of counter placement. The data from the continuously counted stations was then graphed for each use category. These graphs were analyzed by road category and also across categories. At many of the stations there were long periods when data was not collected. It was concluded that because of the missing data and the widely varying patterns from station to station, the best approach was to develop broad seasonal patterns using the existing data. In these circumstances, it was not possible to estimate average annual daily traffic (AADT) from short-term counts. Consequently, broad-based seasonal adjustment factors were developed and applied to the short-term counts. The objective was to obtain an estimated AADT for each of the stations in the use categories. The AADTs from individual stations in each category were then added and averaged to get the AADT for each category. This average AADT was then multiplied by the number of miles of road in each category to arrive at daily vehicle miles. Daily vehicle miles were then multiplied by 365 to get the annual vehicle miles of travel for that category.

Data Validity

The data in this study fit together in a reasonable manner. The volumes recorded at the continuously operating stations were, for the most part, similar to the short-term data for the same use category over the same time. This indicates that the random selection of locations for both the continuous counting and the short-term counting was adequate. Frequently there were several weeks of data gathered at one of the short-term stations. In these cases Mn/DOT selected only one of these weeks to seasonally adjust to AADT. To maintain the randomness of the count locations, which was the foundation of the study, it was felt that multiple readings at one station could not be accepted.

Summary of Counter Data

After analysis of the data and expansion to an annual traffic basis, the following tables of results were compiled:

DNR

Road Category	Number of Stations	1988-89 AADT	Number of Miles	Daily VM	Annual VM
Recreational	28	32	184.9	5,916.8	2,159,632
Through	72	33	494.0	16,302.0	5,950,230
Southeast	30	7	120.2	841.4	307,111
Other	133	18	809.8	14,576.4	5,320,386
Class 5	45	10	454.1	4,541.0	1,657,465
TOTAL*	308		2063.0	42,177.6	15,394,824

*Logging truck traffic was reported separately.

Counties

Road Category	Number of Stations	1988-89 AADT	Number of Miles	Daily VM	Annual VM
Category A	119	15	853	12,795	4,670,175
Category B	128	25	1080	27,000	9,855,000
TOTAL*	247		1933	39,795	14,525,175

*Logging truck traffic was included in this study.

Fuel Consumed by Vehicles on Forest Roads

DNR

The vehicles covered by this portion of the study are primarily pickup trucks and some passenger vehicles. These light vehicles were assumed to consume fuel at a rate of 12 miles per gallon due to stop-and-go driving and the surface conditions of forest roads. By dividing the total annual vehicle miles by 12, the amount of fuel consumed is calculated to be 1,282,902 gallons for light vehicles.

Counties

Light vehicles and heavy trucks together are covered by this portion of the study. For this reason, vehicles were assumed to consume fuel at a rate of 11.6 miles per gallon. By dividing the total annual vehicle miles by 11.6, the amount of fuel consumed is calculated to be 1,252,170 gallons for all vehicles.

LOGGING TRUCK TRAFFIC STUDY

Traffic generated by logging trucks was removed from the DNR traffic counter study because it was felt that there was a different pattern of use by these vehicles. Approximately 60 percent of the logging traffic occurs during the winter, when the pneumatic counters do not work very well. Logging truck traffic is sporadic, corresponding with sales lasting from one week to three years. The logging truck traffic noted in the remarks for each of the counter locations was subtracted before the light traffic component was computed. There was no attempt to remove any of the logging support vehicles from the measured count because no good estimate of this traffic was available. The logging truck traffic was calculated by using the DNR scale and sales reports as described below.

Timber Volume and Haul Distance

All DNR timber scaling reports (including Sold on Appraised Volume timber, but excluding firewood, boughs and noncommercial thinnings) for the period 1 May 1988 through 30 April 1989 were aggregated to determine the amount of wood cut and hauled from state lands. This aggregation was stratified by: (1) administrative region and (2) type of sale. This stratification allowed the current volume data to conform to the same standards as the data from our three-year (FY 85 to FY 88) study of timber hauling (draft report dated 29 February 1988, previously supplied to Mn/DOT). This study developed the mean distance of haul on forest roads. A copy of the basic information tables from this report are attached as Appendix A.

Load Size and Distance

The volume scaled on each type of sale in each administrative region was divided by the mean number of cords per truckload (trucks varied from 6 to 10 cords in size) to determine the estimated number of logging truck trips during the study period. This number of "loads" was doubled to determine the number of round-trip miles of forest road travel by logging trucks.

Log Truck Fuel Use

Total mileage was divided by 5 miles per gallon to determine the gallons of fuel consumed by logging trucks on forest roads. (The 5 mpg figure was taken from "Transportation Methods and Costs for Sawlogs, Pulpwood Bolts, and Longwood", Technical Note B44, February 1981, Division of Land and Forest Resources, Tennessee Valley Authority, Norris, TN.)

Summary of Logging Truck Mileage

The following table is a summary of the logging traffic generated from state timber sales during the study period. A full listing of the supporting data is included in Appendix 2.

<u>Volume</u> <u>(Cords) Harvested</u>	<u>Truck Loads</u> <u>Hauled</u>	<u>Miles</u> <u>Traveled</u>	<u>Gallons of Fuel</u> <u>Consumed</u>
652,310.6	75,387.3	420,900.0	84,180.0

REVENUE DERIVED FROM ALL TRAFFIC ON FOREST ROADS

DNR

The sum of the light vehicle (1,282,902 gallons) and logging truck (84,180 gallons) fuel consumption is 1,367,082 gallons, which is 0.0605 percent of the state total. The present fuel tax rate for all motor fuels covered by this study is \$0.20 per gallon. The total consumption in gallons was multiplied by 20 cents per gallon to determine the state fuel tax revenue generated from the use of forest roads for travel by light vehicles and logging trucks hauling state timber. The study shows a total revenue of \$273,416.40 is attributable to travel on state forest roads annually.

Counties

The traffic on county forest access roads annually consumes 1,252,170 gallons of motor vehicle fuel, or 0.0555 percent of the state fuel consumption. Total revenue of \$250,434.05 is attributable to travel on county forest access roads annually.

Combined Fuel Consumption

The combination of the results of the DNR Division of Forestry and the county traffic studies indicates that 2,619,252 gallons of fuel are consumed annually on Minnesota's state and county forest roads which generates \$ 523,850.45 annually in unrefunded gas tax. This represents 0.1160 percent of the unrefunded gasoline and special fuels tax which is collected each year.

Opportunities for Further Study

This study was implemented on short notice with a minimum of equipment and staff training. As a result, important information was lacking. In the future, data gathered at the continuous counter locations will make more accurate estimates of road use possible. Further study is also warranted to incorporate more of the random counts into the final figures. To do this, a system of weighted averages will need to be developed.

