UNIVERSITY TRANSPORTATION RESEARCH CENTER
Region II

Project 17-7-88-B

IMPACT ASSESSMENT OF THE REGULATION OF HEAVY TRUCK OPERATIONS

Final Report

September 1994

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EXECUTIVE SUMMARY

Study Objectives. The main objective of this project was to evaluate the impact of the New York State divisible-load permit system for heavy trucks in terms of benefits and costs to society. The costs result primarily from increased pavement damage; the benefits accrue to the trucking industry (primary economic benefits) and also to New York State's economy (secondary economic benefits). The present study is a follow-up of an earlier investigation (1987, Meyburg, Richardson, Schuler, et al.) that was commissioned by the New York State Permanent Advisory Committee on Truck Weights to investigate benefits of the divisible-load permit system. Research objectives for this project have been expanded and modified, based on findings from the surveys. Seasonal benefits and costs for several levels of departure from the federal weight regime were evaluated in order to assess the "optimum" weight limit under a simplified weight system, based on ratios of the federal limits.

Background. Since 1985, New York State has allowed a fleet of approximately 12,800 power units to operate above the federal limits on gross vehicle weight and axle loads. A permit system comprising eleven permit categories was instituted, corresponding to different truck configurations (number of axles), weight limits (either a ratio of federal limits or fixed limits), and geographic area of operation (statewide or downstate). The New York State Permanent Advisory Committee on Truck Weights commissioned the 1987 study referenced above, followed by this study, to evaluate the economic benefits and costs of this divisible-load permit system.

However, questions about truck weight regulations are not unique to New York State. Many state legislatures and transportation departments are concerned about the costs of increasing weight limits. Economic benefits of alternative weight policies are, in general, poorly understood. Despite the issues at stake, there have been few published studies addressing these concerns. To our knowledge, the predecessor to this study (Meyburg, Richardson, Schuler, et al., 1987) was the first one to be based on actual field data.

Methodology. In order to collect the information necessary to assess pavement damage and primary economic benefits, a 7.1% sample representing 916 vehicles was drawn from the New York State Department of Transportation permit application file. Operators of the trucks sampled were then surveyed three times over a one-year period in order to try to capture seasonal variations; one survey was conducted in the summer of 1990, another one in the winter of 1991, and the last one in the fall of 1991. No survey was conducted in the spring and it was assumed that vehicle usage information collected for the fall was representative of spring usage as well. Each survey questionnaire asked the operator of a specific truck to provide information for a randomly selected day of the week about mileage driven on three different road classes; driving and waiting times; changes

in axle loadings; and general information about the truck itself and the trucking company operating it. The response rates for the summer, winter, and fall surveys were 33.1%, 36.7%, and 28.9%, respectively. These response rates underscore the difficulty of collecting primary information about truck usage. After extensive checks of the nature of the respondents against several criteria, including known characteristics of the entire divisible-load permit fleet, the research team considers that these response rates are sufficient to estimate the order of magnitude of both the costs and benefits described above. The methodology used is detailed in Chapter 3.

Pavement Damage. Estimates of pavement damage were calculated from the data collected, using the ASSHTO formula (which gives equivalent single-axle loading based on a fourth power law). Damage to other parts of the infrastructure, such as bridges, could not be estimated because it was not possible to keep track of the bridge crossings by the vehicles surveyed. The impact of weather on pavement deterioration was not considered.

Extrapolating the pavement damage from the sample results to the whole fleet of permitted vehicles yields the following estimates of annual increases (above 100% of federal limits) in pavement damage (in millions of 1987 dollars per year):

125% of federal limits:	\$19 million
135% of federal limits:	\$28 million
145% of federal limits:	\$35 million

It is important to note that these results assume full compliance with the corresponding weight limits. Pavement damage estimates are discussed in Chapter 4.

Primary Benefits. Primary economic benefits, (i.e. the savings to the transportation industry due to reduced transportation costs under limits higher than the federal limits), are evaluated for 125%, 135%, and 145% of the federal limits. The methodology employed assumes that the load transported by each truck on the survey day under the divisible-load permit system would, under the federal regime, be transported by the same truck, along the same route, but with more trips, if necessary, so that federal weight limits would be respected. In addition, the load distribution on each axle that was reported in the surveys was maintained, but scaled down from the data reported in the survey, in order to estimate the number of trips that would be required at lower weight limits. It should be noted that a number of small operators surveyed indicated that they did not have scales to weigh their trucks. Therefore, their loads may be misrepresented. Average statewide labor and operating costs were used for the calculations.

Extrapolations of sample results to the whole fleet of permit vehicles give annual estimates of primary economic benefits (in 1987 dollars) of:

125% of federal limits:	\$551 million
135% of federal limits:	\$653 million
145% of federal limits:	\$708 million

The operating cost savings were greatest for the "Construction (including Ready-Mix Concrete) Industry", "For-Hire Transportation", "Mining & Quarrying", and "Utilities & Sanitation". Much of the variation in seasonal costs and benefits reflect seasonal economic activities. Superimposed on this seasonal variation are the effects of the national and regional economic recessions. Nevertheless, strong seasonal patterns of usage for some industries do emerge. Therefore, consideration of alternative regulatory treatment for some industries may be warranted.

As expected intuitively, the primary economic benefits of the permit system substantially exceed its costs, although not all costs could be quantified in this study. As an example, differential impacts on traffic safety in NYS are not included, although the use of permitted vehicles is shown to reduce the volume of truck traffic and, therefore, the exposure to accidents involving trucks. However, the question remains whether or not there is an increased frequency of accidents involving permitted vehicles. Unfortunately, NYS accident data do not contain information about the load (weight) status of vehicles involved in accidents.

Within the limited perspective of direct economic costs and benefits, the proper way to optimize the level of user-benefits, net of pavement costs, is to set the permit limit where marginal benefits equal incremental pavement damage costs (net marginal benefits approach zero). As shown at the end of Chapter 5, these results suggest that a weight limit at 145% of the federal limits is close to the optimum, and lower weight limits reduce the net benefits to society.

<u>Secondary Benefits.</u> Finally, the analysis of secondary economic impacts illustrates how the cost decreases in trucking, resulting from the divisible-load permit system, will work their way through the economy, primarily because in the long run, nearly every sector of the State's economy utilizes the goods and services provided by the initial beneficiaries of trucking cost savings (construction, mining and quarrying, for hire transportation, and sanitation and utilities). Thus, these cost decreases have a beneficial impact, ultimately, on nearly everyone in NYS, including manufacturing, finance and services. While available economic data are not adequate to report precise estimates of the level of increase in values of output, earnings, and employment in various sectors of the economy as a result of trucking cost decreases, the illustrations presented herein suggest that these benefits are significant and pervasive throughout the State's economy in the long run. Secondary economic benefits are examined in Chapter 6.

<u>Policy Implications.</u> Results of this study strongly support the continuation of the NYS divisible-load permit system. It was determined that the system in existence at the time of the surveys was complex and, therefore, difficult to understand and to comply with.

Certain assumptions had to be made about the degree of compliance in order to develop meaningful benefit and cost calculations. Recent changes in permit legislation and administration, which are to some degree based on preliminary results developed early in this study, have contributed to reducing these problems.

Policy implications are detailed in Chapter 9.

ACKNOWLEDGMENTS

The authors wish to acknowledge gratefully the valuable support given to us by several staff members of the New York State Department of Transportation. We would like to single out three individuals, in particular, who provided exceptional assistance to us through the duration of this project.

We are thankful to our project monitor, **Mr. Steve Slavick,** who showed great patience and understanding with the time-consuming task of working with survey data and all its pitfalls. He was a constructive and professional monitor through all phases of this project.

Mr. Albert Karoly's assistance in manipulating the Permit Application File data base in order to develop a scientifically sound sample for the permit vehicle usage surveys was absolutely invaluable to the success of this project. His competence in handling the sizable data base and his patience and good humor in responding to our numerous specific requests for data in various formats is very much appreciated by the Cornell University research staff.

Mr. Ray DeRocco was instrumental in helping us understand better the intricacies of the Divisible-Load Permit System. He was always ready with information and advice.

Of course, we are also grateful to the permit vehicle operators who responded to our request for confidential information in the three surveys. We recognize that the completion of the questionnaires was a time-consuming and difficult task. Their willingness to put in this extra effort was crucial in making the research project a success.

Finally, we also acknowledge the contributions to the early part of this project by graduate research assistant **Mr. Darshan Patil.**

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Chapter 4

CHAPTER 1. BACKGROUND AND OBJECTIVES OF RESEARCH PROJECT

The state-of-the-art of impact analysis for different vehicle loads and weights is still rather modest. Very little is known to help the continuing controversy, as to what the public sector should allow in terms of maximum axle loads and gross vehicle weights on the nation's highways. By the same token, the economic benefits to the private and the public sectors are equally poorly understood. Naturally, most of these benefits will occur in the private sector. Hence, primarily for reasons of competitive advantage, benefits are unlikely to be disclosed very readily.

The number of detailed studies investigating these impacts is very limited. Specifically, studies that investigate the actual usage of vehicles with specific loads and gross vehicle weights are virtually absent. To our knowledge, a predecessor to this study (Meyburg, Richardson, Schuler, et al., 1987) was the first such study to conduct an extensive survey to determine actual vehicle usage under varying load conditions and across the NYS network. The study area and the data base then and now was the New York State Divisible-Load Permit System.

New York State (NYS) has been operating this permit system since 1985, allowing a fleet of about 12,800 power units to exceed the federally mandated statutes on Gross Vehicle Weight (GVW) and axle load limitations by means of "grandfathering" vehicles in operation prior to the establishment of the federal statutes. Through a permit system, NYS allows these vehicles to operate with loads in excess of the federal limits.

For some time, NYS, and virtually every other state in the Union, has been keenly interested in determining the benefits and costs of allowing extra-heavy vehicles on their highways. The intuitively obvious benefits are those accruing to the vehicle operators who will be able to save on labor and vehicle operating costs due to the fact that freight can be transported with fewer trips than would otherwise be possible. The indirect benefits of these cost savings should flow back to the economy at large through what are called secondary economic benefits, e.g. business expansion because of lower costs, not only in freight rates, but also through the complex interactions that lower the costs of all transportation-intensive businesses supporting industries in NYS.

On the other hand, officials in the public sector have a legitimate concern about the costs that these extra-heavy loads impose on the State's infrastructure, i.e. pavements and bridges. In addition, concerns about vehicle safety of extra-heavy trucks and the psychological impact of extra-heavy vehicles enter the discussion.

NYS established a forum to discuss and investigate these matters. This "Permanent Advisory Committee on Truck Weights" has existed since the establishment of the divisible-load permit system in NYS. (Its successor committee is known as the "Motor Truck Advisory Council".) It continues to be called upon by the State Legislature for advice on whether the system should be continued in its original form, abolished, or modified. Most recently, the issue was whether the permit system should be opened up to those who have so far been excluded from it. The rationale was that the permit system has created unfair advantages for long-time heavy haulers that had their vehicles "grandfathered" under the NYS permit system, while shutting out newer entrepreneurs and expanding businesses. Implicit in this recent discussion is the assumption that these permits actually represent substantial economic benefits to the permit holders.

In 1987, the "Permanent Advisory-Committee on Truck Weights" commissioned two studies to investigate the actual benefits and the infrastructure costs, respectively, of the permit system.

A Cornell University research team (Meyburg, Richardson, Schuler et al., 1987) conducted the study on the economic benefit side. The present study is, in part, a follow-up of that earlier investigation, however, with considerably expanded objectives. First, the research reported in this document is based on data reflecting actual permit vehicle usage across three of the four seasons, in order to determine any seasonal variations.

Second, and maybe even more importantly, it used the same data base to estimate both the economic benefits (cost savings) to the operators **and** the infrastructure costs (pavement damage) that the public sector incurs. It should be noted that not all costs were allocated in this research. Specifically, the categories of bridge damage and compliance costs were not part of the scope of this investigation.

Third, a comparative analysis (sensitivity analysis) of the consequences of varying permissible maximum weight limits was performed. This analysis derived benefits and costs from actual usage data, recorded in the usage surveys, for weight limits of 125%, 135%, and 145% of the maximum Federal limits. The analysis assumed that the axle load distribution recorded in the surveys was simply scaled down from the permit limits in such a way that all trucks were in compliance with the weight limits.

We are aware that NYSDOT uses a rule of thumb which assumes that the front axle of a vehicle carries 70% of the average of the other axles. However, since in this study we have actual operator-reported axle loadings, we chose to use this survey information.

The effects of reducing the limits from 145% to 135% and 125% of federal statutes were investigated because the NYS Legislature has expressed strong interest in obtaining information on the consequences of lowering the weight limits.

To our knowledge, this is the first time that such a study has been conducted, based on actual vehicle usage (i.e. vehicles loadings and mileage traveled across three classes of roads). This approach allowed the investigators to estimate the benefits and the costs on the basis of the same information. Hence, the results are comparable and meaningful for use in formulating policy recommendations.

CHAPTER 2. DESCRIPTION OF THE DATA COLLECTION METHODOLOGY

This chapter summarizes the data collection methodology. After describing the sample selection process, it introduces the survey instrument (a copy of which is shown in Appendix A), and it provides a brief account of how the mail-back surveys were administered.

2.1 Sample Selection

A crucial, and the most time- and manpower-intensive part of this research project was the acquisition of original data about the actual usage patterns of the NYS divisible-load permit vehicle fleet. In order to be able to detect any seasonal variations in vehicle usage patterns, three surveys were scheduled, covering summer 1990, fall 1991 and winter 1991 operations. No separate survey was conducted for the spring because of budget constraints, under the assumption that overall fall and spring usage may be comparable.

The main objective of these surveys was to obtain:

- Industry information on permit truck use in terms of type of equipment used, loads hauled, mileage covered, nature of routes and types of road.
- Information on the purposes for which the vehicles are used and on the nature of the operators using them,
- Information and comments about the operators' experiences with and attitudes toward the divisible-load permit system.

In order to collect the desired data, a stratified random sample of permit vehicles was drawn from the NYSDOT Permit Application File (PAF). The PAF was screened carefully to avoid duplicate entries and to combine multiple permits so that in drawing a random sample of all vehicles, each vehicle could only be selected once. The final population of permit vehicles from which our sample was drawn, consisted of 12,822 vehicles (power units.)

In order to ensure statewide representation of operators and vehicles, the permit vehicle population was stratified by the county in which the vehicles were registered. In addition, the population was stratified by operator size (number of permitted vehicles registered by a single operator) to ensure that operators of all size classes were included in the data base. Finally, the sample was stratified by day of the week in order to avoid any bias due to potentially different weekday activity levels.

The final sample drawn was a 7.1% sample of all trucks in each stratum, representing 916 vehicles. The reason for this sample size was that it provided a large enough sample to generate a reliable statistical base, yet it remained manageable enough with respect to project resource constraints. The same sample was used for all three surveys, with only minor adjustments necessary, for example, when it was learned between surveys that a specific permit vehicle had been permanently withdrawn from operation.

2.2. Survey Instrument (Questionnaire)

An elaborate questionnaire was developed for the purpose of obtaining the data identified in section 2.1. In this effort, the research team took advantage of previous experiences with truck usage survey instrument design (Meyburg, Richardson, Schuler, et al., 1987) so that a refined questionnaire could be generated. A copy of the questionnaire ("Permit Vehicle Usage Survey") and the associated pre-publicity, endorsement, reminder, and thank-you letters can be found in Appendix A of this report.

The main sections of the questionnaire pertain to the following information categories:

- Permit Vehicle Information
- Permit Vehicle Description
- Operator Characteristics
- Trip Log Forms.

For ease of use, the different sections of the questionnaire were color-coded.

2.3 Conduct of Usage Survey

The conduct of the permit vehicle usage surveys involved a number of steps. Since the main elements of the questionnaire had undergone extensive in-field testing in previous research efforts, the pilot survey was replaced by intensive in-house scrutiny and evaluation of the particular refinements and format changes developed for these specific surveys.

A substantial amount of time and effort was spent on developing an efficient format for the trip log forms in order to facilitate the recording of a potentially large number of trips in a concise and understandable manner. Nevertheless, some respondents misunderstood some questions (e.g. meanings of tare weight, time of return). Part of the explanation for these problems can probably be related to the fact that a variety of people with different backgrounds filled out the questionnaires, namely drivers and office staff.

In spite of our efforts, some categories of users are likely to be under-represented in the responses. This belief is based on some comments found in partially completed questionnaires or gathered through phone conversations. This problem would affect mainly refuse haulers and fuel deliveries. The reason for their under-representation lies in the nature of the information requested. Refuse and tanker vehicles typically make frequent stops with loads changing virtually continuously. Hence, it is unrealistic to expect drivers to record truck weights for all route segments.

Also, there exists a serious limitation in the original data base, the Permit Application File, in that it does not provide the industry affiliation of the operator. Hence, this information had to be assessed from the data collected through the surveys. As a result the industry affiliation selected by operators frequently did not match Standard Industrial Classifications (SIC). The investigators attempted to code the correct SIC by reconstructing individual classifications based on information provided by the respondents, such as load carried, fleet composition, and the operators' statement of industry affiliation.

An illustrative example of this problem is the proper classification of ready-mix concrete operators. Operators typically did not know whether to classify their industry as "construction" or "manufacturing". Another example is listing consistently the industry affiliation of sand and gravel haulers, who appear under either "mining", "quarrying" or under "construction".

The main survey was preceded by the mailing of a **pre-publicity letter** to the 660 truck operators representing the stratified random sample of 916 vehicles. Whenever possible, the letter and the subsequent mailings of questionnaires were addressed to individuals in the company who were listed as the contact persons in the Permit Application File. The reasoning was that such a contact person would likely be familiar with the divisible-load permit system and, hence, more understanding of our request for information. After all, an inspection of the survey instrument shows that a substantial amount of effort was required of operator personnel (drivers or office staff) to complete the questionnaire. In addition, the letter informed the operators about the mechanism by which they had been selected to receive one or more questionnaires, depending upon how many of their vehicles were selected in the random sample. The letter also served the purpose of assuring them of the confidentiality with which the data they provided would be handled. Finally, it was intended to solicit their cooperation.

The **mailing of the surveys** started a few days after the pre-publicity letters were sent out. The mailings were performed in five "waves", corresponding to the five specified survey days covering all weekdays of a specific week in August 1990, February 1991, and November 1991. The distribution across all weekdays was done randomly to prevent any bias due to systematic activity differences on particular weekdays. This staggered mailing procedure was necessary to make sure that the questionnaires did not arrive too early or too late on the respondent's desk.

The main mailings consisted of (i) a cover letter by the principal investigators, (ii) an endorsement letter by the Executive Director of the NYS Motor Truck Association, (iii) the questionnaire, and (iv) a postage-paid, self-addressed return envelope.

Two **reminder letters** were sent subsequently. The first one, sent to all operators in the sample, was a combination thank-you and reminder letter. It arrived shortly after the specified survey days to thank those who had completed their forms, and to instruct those who had missed the specified date to simply fill out the forms on the specified day of the week during the following week. The second reminder letter was sent only to those operators who had not responded after two to three weeks. A random sample of non-respondents also received a second questionnaire copy in case they had discarded or misplaced the first one.

Telephone support was provided at Cornell University throughout the duration of the survey to assist respondents with any problems or questions. Truck operators made ample use of this information line.

Finally, **thank-you letters** were sent to all respondents.

CHAPTER 3. ANALYSIS OF SURVEY RESULTS

This chapter provides a comprehensive overview of the information collected about the divisible-load permit vehicles operating in NYS during three surveys (summer 1990, winter 1991, and fall 1991). It presents seasonal comparisons of permit vehicles and fleet characteristics, as well as changes in seasonal truck usage. It also underscores some limitations of this study, which are partly due to the nature of the information collected. The chapter introduces the methodology used for the 125%, 135%, 145% weight limit scenarios, in comparison with the federal statutes on weight limits. An inclusive summary of the data collected is shown in Tables 3.1 through 3.18 and associated Figures. These can be found at the end of the chapter.

3.1 Comparison of Vehicle Population, Survey Sample, and Seasonal Survey Responses

As described in Chapter 2, a 7.1% sample, equivalent to 916 permit vehicles, was drawn from a population of permit vehicles of 12,822. The response rates (counting valid responses only) for the summer, winter, and fall/spring surveys were 33.1%, 36.7%, and 28.9%, respectively. One possible explanation for the drop-off in responses during the last survey (November 1991) may be that the operators in our sample were getting tired of responding to yet another survey, a phenomenon well known in surveys involving human respondents ("panel mortality"). Table 3.1 gives a summary of the responses to the surveys.

Since survey returns represent far less than the complete sample, it is essential that some effort be made to establish whether the characteristics of the survey respondents was representative of the original population from which the sample was drawn to try to detect whether a systematic bias was introduced by non-responses.

The survey team investigated a number of criteria to detect the presence of any such bias in the responses to the three surveys.

The check for representativeness was based on three parameters: "Make of Truck", "Fleet Age", and "Operator Permit Vehicle Fleet Size". In each instance, a comparison was made between the values of these variables in the PAF Population (i.e. total permit vehicle population), the sample, and in the responses for the three surveys. Tables and Figures 3.2, 3.3, and 3.9 show that, overall, the survey results match very well the characteristics of the sample and of the population of permit vehicles. A few interesting deviations can be noted, however. In the characteristic "Fleet Age" we observe an over-representation of newer vehicles in the "1985 and newer" category that is consistent across all three surveys. An explanation of this phenomenon may be that operators of these vehicles have transferred their permits to the newer vehicles, fully recognizing the value of the permits. They have a keen interest in the continuation of the divisible-load permit program. Hence, they are more likely to respond to a survey investigating the use of permit vehicles.

Another observation is that operators of larger fleets are more likely to respond to this kind of survey than smaller operators. This can be observed, again, consistently across the three surveys. One possible explanation is that large operators are more likely to have clerical staff in the office who have the time, inclination, and/or orders from the "boss" to help fill out the questionnaire. For smaller operations, we gained the impression through various telephone contacts and through the comments returned with the questionnaires that either the owner/operator or the spouse was faced with the task of filling out the survey forms. This could constitute a considerable burden for them. Hence, several of the smaller operators may have decided against taking on this added task.

Finally, we checked the response rates for each day of the week. The reader will recall that the sample was distributed equally across the five working days in the survey week. We found a reasonably good spread of responses across all five days, around the 20% mark.

Since a very similar survey of the NYS Permit Vehicle Fleet was conducted in the summer of 1987 (Meyburg, Richardson, Schuler, et al.), those results are presented (in parentheses) alongside the 1990 results in several of the tables and figures, summarizing the survey results. The obvious match between the two sets of results adds further credence to the validity of the survey and its results.

3.2 Seasonal Comparison of Permit Vehicle and Fleet Characteristics

As stated in Chapter 1, a major objective of this research was to establish whether seasonal differences exist in permit vehicle use and, hence, in terms of economic benefits and infrastructure damage. Chapter 4 and 5 provide detailed analyses of our findings in this regard.

In this section, vehicle and fleet characteristics are compared across the three surveys (with the results from the summer 1987 survey provided for comparison). The following characteristics were used for this comparison:

- Axle Configuration
- Number of Axles
- Vehicle Type
- Body Type
- Permit Vehicle Tare Weights.

The results of these seasonal comparisons are presented in Tables 3.4 through 3.8 and in the graphs associated with these tables. The results for all five characteristics show remarkable consistency across the seasons. Some variation is to be expected, particularly given the relatively small absolute number of vehicles in the surveys. This will result in a somewhat exaggerated percentage change, when only a few vehicles are involved in each category. A noteworthy exception to this pattern is the fact that the winter 1991 survey shows a significant shift towards the use of lighter vehicles. A more than four-fold increase in the use of vehicles with tare weight between 10,000 and 20,000 lbs. was observed.

3.3 Seasonal Comparison of Primary Business and Fleet Usage and Activity

The "Primary Business" of operators responding to the surveys shows a remarkable consistency across seasons (Table 3.10 and associated graphs). This result states that business type played virtually no role in the propensity of operators to respond to the survey requests. Please note, though, that this consistency pertains to business type only. This fact constitutes a desirable basis for making meaningful seasonal comparisons in actual vehicle usage.

These seasonal variations in actual vehicle usage by "Primary Business" are shown in Table 3.11 (and associated graphs). The numbers shown in that table and the graphs represent those proportions of permit vehicles, owned by "Primary Business" category, that were actually on the road during the relevant survey days. (This means that each percentage could theoretically be 100 % if all permitted vehicles had been active.) A similar picture also develops from the inspection of Table 3.12 (and associated graphs) that shows the permit vehicle status in the survey days across the seasons. The effect of winter operations are very obvious across all major permit vehicle operators, except "Utilities (incl. Sanitation)". However, the dramatic decline in vehicle use for the winter 1991 and, to a lesser degree, for the fall 1991, could represent the combined effect of seasonal usage variations as reinforced by the deepening economic recession during the time of the surveys. This issue is discussed more fully in Chapter 5 in the "Primary Economic Impact Analysis".

Table 3.13 presents trip mileage and duration statistics for the permitted vehicles that made loaded trips on the survey day. For these vehicles, on average, trips are longer in the winter, followed by summer and fall in this order. Trip duration follows the same pattern with apparently even longer durations for the winter which may be related to weather conditions. The observation of shorter trips in the summer, compared to the winter, may be the result of activity in the "construction" and "mining and quarrying" where trips tend to be short. However, the observation of smaller trip lengths in the fall than in the winter is somewhat more surprising.

The heaviest loads are carried in the summer, as illustrated by Table 3.14, and this results also in the largest E.S.A.L.s for this season. However, trucks tend to be heavier in the winter than in the fall. Overall though, since more permitted trucks are on the road daily on average in the fall than in the winter (48% versus 28%), aggregated pavement damages are higher in the fall than in the winter (see Chap. 4). More data about the number of miles traveled on each road class is shown on Table 4.6.

3.4 Implications for Economic and Pavement Damage Impact Analyses

Conjectures can be made about the causes of these variations in permit vehicle usage and survey response rates, but these variations are not necessarily an impediment to the overall objectives of this research project. Since it is the main purpose of this study to establish and compare the benefits (cost savings) and infrastructure damage attributable to the existence of the

"NYS Divisible-Load Permit System", and since the estimates for both benefits and costs are based on the same data base, i.e. actual usage of permit vehicles, it is the relative relationship between the two that is of overriding concern, and not necessarily the absolute dollar values for each, which can only be grossly estimated from this analysis.

3.5 Assumptions about the 145%, 135%, and 125% Weight Limit Scenarios

Before presenting the details of the actual procedure used in determining the economic benefits and the pavement damage costs of different weight limit scenarios, it is important to state explicitly a number of assumptions and relevant observations.

It was assumed that the relative vehicle weight (load) distribution across axles remained the same for all weight-limit scenarios. The weight distribution was scaled down from the actual distribution, in order to bring the truck weight in compliance with the selected weight limit, with at least one axle being at the weight limit. The load that could not be accommodated under the reduced weight limit was assumed to be transported by the same truck during additional trips, assuming the same weight distribution.

This assumption seems reasonable for commodities and vehicle types that allow the relatively even distribution of the load across all axles, whether the vehicle is fully or partially loaded. This assumption is likely to be valid for bulk loads (e.g. sand, gravel, ready-mix concrete), but it is clearly inappropriate for specific vehicle types and loads that are unevenly distributed, such as garbage trucks and tanker trucks, which experience loading and unloading, respectively, in a highly uneven manner.

The result of this assumption is that the pavement damage computations shown in this report are likely to be lower bounds. Highly uneven distribution of loads could lead to substantial overload on a specific axle or axles for these types of vehicles. Unfortunately, there is no reliable information available to substantiate this concern. Only anecdotal evidence was obtained that uneven (overloaded) axle loads on garbage trucks during the early phases of their collection rounds have been ticketed by law enforcement teams with mobile weight scales. Again, this information does not provide us with hard evidence as to what degree any violations occur and whether these are vehicle-type specific, load-type specific, etc.

The seasonal survey answers did not contain many garbage trucks and tankers. This could be due to the fact that the operators found it difficult, if not impossible to respond to the type of detailed questions asked in the surveys, or alternatively, because only relatively few of these types of vehicles were in the Divisible-Load Permit System fleet. Since the Permit Application File does not contain information on industry affiliation of permit vehicles, it is not possible to determine the actual proportion of these types of vehicles in the overall permit fleet. And hence, we cannot state whether they are properly represented in the survey responses. Based on comments and telephone calls received , we suspect that these categories are under-represented.

3.6 Observations about Weight Limit Compliance

Another assumption has to be made with respect to operator compliance with the permit load limits. Given the fact that the survey results suggested some violations under the permit system, it is reasonable to assume that violations are likely to occur under revised sets of permits and weight limits as well. In fact, it is likely that the number and gravity of weight limit violations would increase as load limits are reduced. But there exists no meaningful basis for estimating compliance under different weight limit scenarios.

The result of this inability to project potential non-compliance with load limits is an underestimation of the actual pavement damage caused by the different load limits considered, since our computations assume full compliance with the various weight limit scenarios. Of course, there also exists a corresponding underestimate of primary and secondary economic benefits as a consequence of this compliance assumption.

For this reason, net benefits were calculated as the benefits-minus-costs differences between full compliance with 145% and 100% of the federal limits, instead of taking the difference between the permit system, which includes load limit non-compliance, and the federal system, where the effect of load limit violations could not be estimated. Given the limitations of these surveys, we feel this is the best assessment that could be made.

Statistical information about non-compliance is presented in Tables 3.15 through 3.18 (with associated figures). It is important to emphasize that the information underlying these tables and figures was reported voluntarily which implies that the operators most likely were unaware of this non-compliance.

From Table 3.15 we see that more weight was transported by permit vehicles in the summer of 1990 than in the summer of 1987. Figure 3.15.1 also clearly illustrates this point. Moreover, holders of permits 7 and 7A did not seem to have adapted to the reduction in permitted GVW. Figure 3.15.2 shows that this group of vehicles carried as much weight in 1990 as it did in 1987. We can even notice a break in the empirical distribution for 1990: the upper 20% of trips for the 1990 survey were used to carry significantly more weight than in 1987. This observation supports the contention that, since no weight reduction was observed following the lowering of limits in 1990, the only reasonable method for estimating the "optimal" weight limit for the permit system, based on the 125%, 135%, and 145% weight limits, was to calculate the incremental costs and benefits based upon full compliance with the revised load limits.

Table 3.16 shows consistency for the distribution of permitted weight limit categories between surveys. One problem was the fairly sizable percentage of trucks for which the permit held was not known. Assuming that this unknown category is identical to the rest of the sample in terms of permit composition, it is possible to estimate the distribution of permitted weight limits for the entire population, given the configuration of the vehicles on the survey day.

Table 3.17 and 3.18 provide useful information about the extent and level of load non-compliance. At first glance, a striking difference appears between the two summers, with a large jump in the frequency and severity of non-compliance. However, substantial consistency can be observed between the last three surveys (conducted in 1990 and 1991), both for the statistics at the truck level and also at the trip level. Therefore, we may conclude that the operator response to the revised limits did not change within the 1990-91 period. It should be noted that an arbitrary "grace weight" of 500 lbs. was subtracted from the gross vehicle weights for all seasons to account for uncertainties in measuring weights, reporting axle spacing, etc.

Practically, the information needed to factor in estimates of non-compliance in calculating benefits and costs for the permit system is not maintained systematically by the State's regulatory or police agencies and it is not readily obtained. While some operators may knowingly overload their vehicles, most of the non-compliance may be inadvertent, since the operators reported it voluntarily.

TABLE 3.1: SUMMARY OF RESPONSES TO THE SURVEYS

TABLE 3.1.1: TRUCKS OPERATED WITH A DIVISIBLE-LOAD PERMIT

CATEGORY		NUMBER OF TRUCKS FOR EACH SURVEY		
		SUMMER 1990	WINTER 1991	FALL 1991
Trucks that made loaded trips on public roads on survey day for which full information was provided:		135	64	82
Trucks on the road on survey day for which mileage was provided but other essential information was missing:	Missing gross vehicle weight:	+10	+7	+8
	Axle loading inconsistencies:	+1	+2	+2
	Not enough information to infer axle loading:	+7	+1	+2
Trucks that made loaded trips on public road on survey day for which mileage was provided:		153	74	94
Trucks for which mileage was incomplete or missing:		+9	+6	+5
Trucks that made loaded trips on public roads on survey day:		162	80	99
Trucks that made loaded trips off road on survey day:		+4	+2	+2
Trucks that made only empty trips on survey day:		+2	+2	+1
Uncertain cases:		+0	+0	+1
Trucks that made trips on survey day :		168	84	103
Trucks that did not travel on survey day:		+97	+204	+104
Uncertain cases:		+0	+1	+0
Trucks still operated with a divisible-load permit on survey day:		265	289	207

TABLE 3.1.2: TRUCKS NO LONGER OPERATED WITH A DIVISIBLE-LOAD PERMIT

REASON	NUMBER OF TRUCKS FOR EACH SURVEY		
	SUMMER 1990	WINTER 1991	FALL 1991
Truck sold:	16	20	17
Permit not renewed or truck not registered:	+8	+11	+17
Permit transfered:	+5	+4	+3
Other reason:	+9	+12	+21
Trucks no longer operated with a divisible-load permit:	38	47	58

TABLE 3.1.3: GRAND SUMMARY OF RESPONSES TO THE SURVEYS

CATEGORY	NUMBER OF TRUCKS FOR EACH SURVEY		
	SUMMER 1990	WINTER 1991	FALL 1991
Trucks still operated with a divisible-load permit on survey day:	265	289	207
Trucks no longer operated with a divisible-load permit:	38	47	58
TOTAL NUMBER OF VALID ANSWERS RECEIVED:	303	336	265

TABLE 3.2: MAKE OF TRUCKS

MAKE	PAF POPULATION	SAMPLE	SUMMER 1990	WINTER 1991	FALL 1991
MACK	49.3%	49.6%	51.1%	46.8%	49.5%
INTERNATIONAL	10.9%	11.8%	9.4%	11.2%	10.3%
FORD	10.3%	11.0%	8.6%	12.0%	8.8%
AUTOCAR	6.7%	6.3%	6.4%	6.7%	5.2%
WHITE	4.4%	3.9%	5.3%	5.2%	6.2%
GMC	4.0%	4.0%	4.9%	4.1%	3.6%
BROCKWAY	3.7%	3.9%	3.4%	4.5%	6.2%
OTHER	10.7%	9.5%	10.9%	9.4%	10.3%

FIGURE 3.2.1: POPULATION COMPOSITION

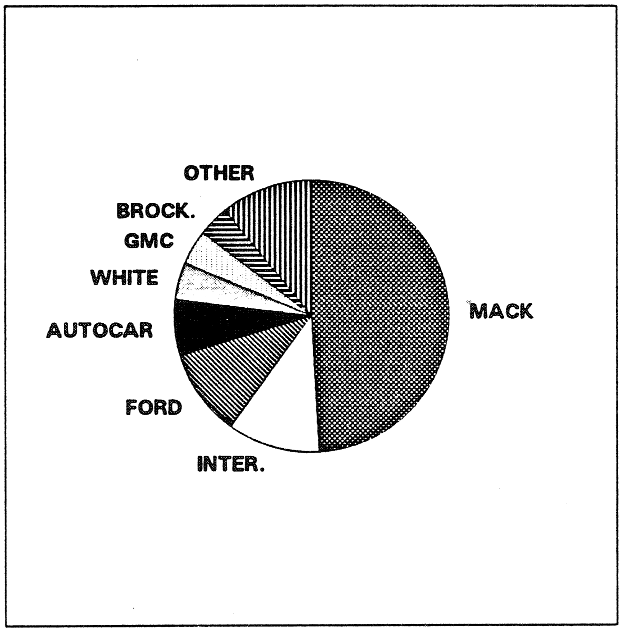


FIGURE 3.2.2: TRUCK MAKE - SUMMER 1990

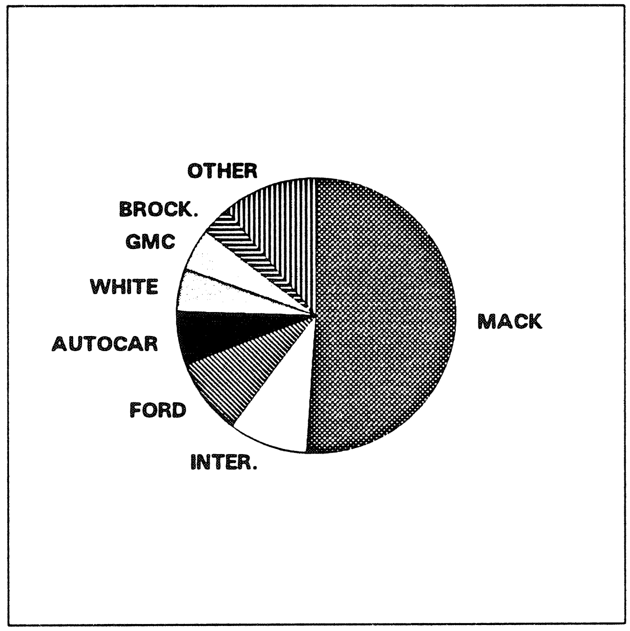


FIGURE 3.2.3: TRUCK MAKE - WINTER 1991

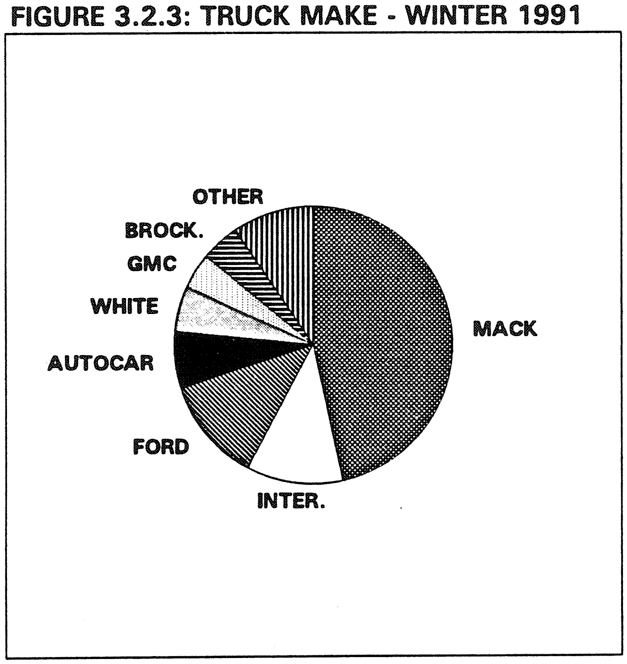


FIGURE 3.2.4: TRUCK MAKE - FALL 1991

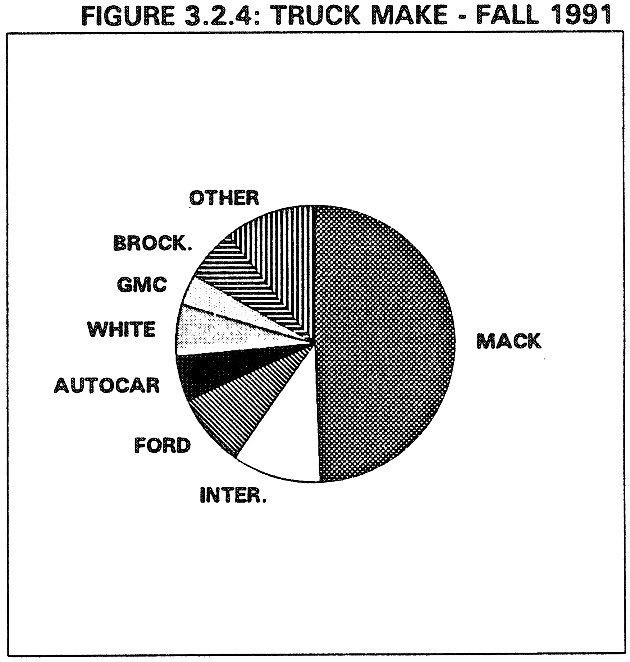


TABLE 3.3: FLEET AGE

YEAR OF MANUFACTURE	PAF POPULATION	SAMPLE	SUMMER 199	WINTER 1991	FALL 1991
<1960	0.2%	0.8%	0.8%	0.0%	0.0%
1960 to 1964	1.9%	1.7%	0.8%	1.5%	1.0%
1965 to 1969	9.1%	7.6%	4.5%	5.6%	5.2%
1970 to 1974	27.6%	27.3%	20.3%	19.9%	18.0%
1975 to 1979	25.4%	27.2%	20.3%	22.1%	23.2%
1980 to 1984	20.2%	19.5%	19.2%	19.9%	17.5%
1985 to 1989	15.2%	16.0%	33.5%	30.3%	34.5%
1990 to present	0.0%	0.0%	0.8%	0.7%	0.5%

FIGURE 3.3.1: CUMULATIVE DISTRIBUTION OF TRUCK AGE

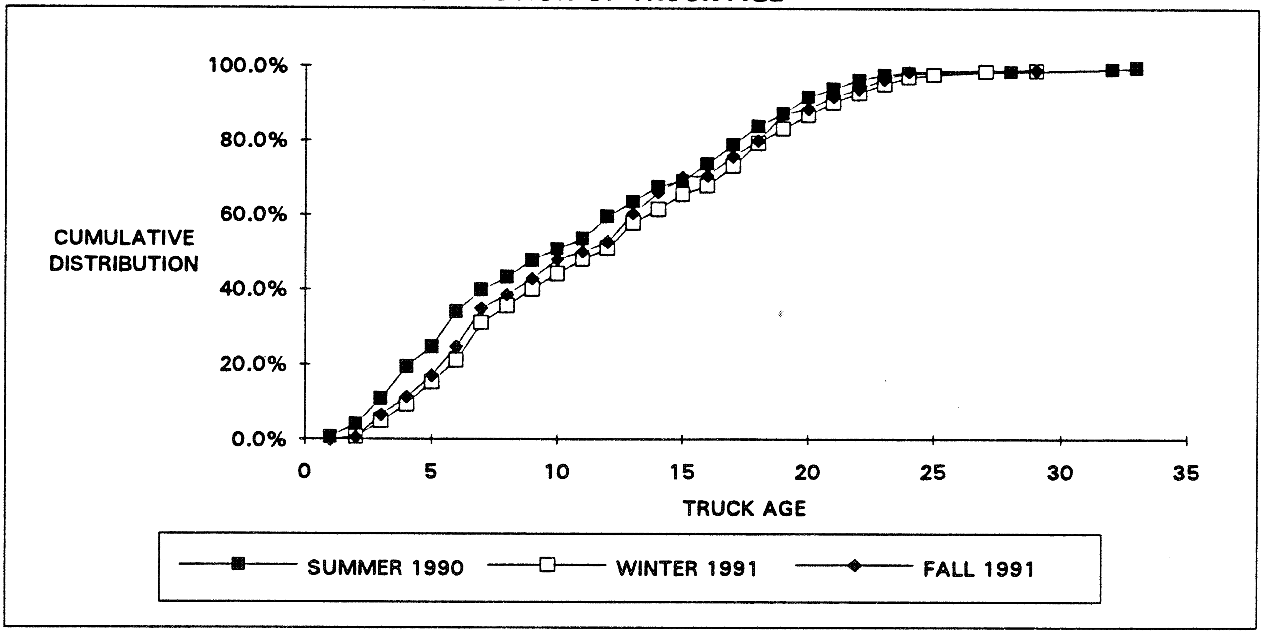


FIGURE 3.3.2: YEAR OF MANUFACTURE

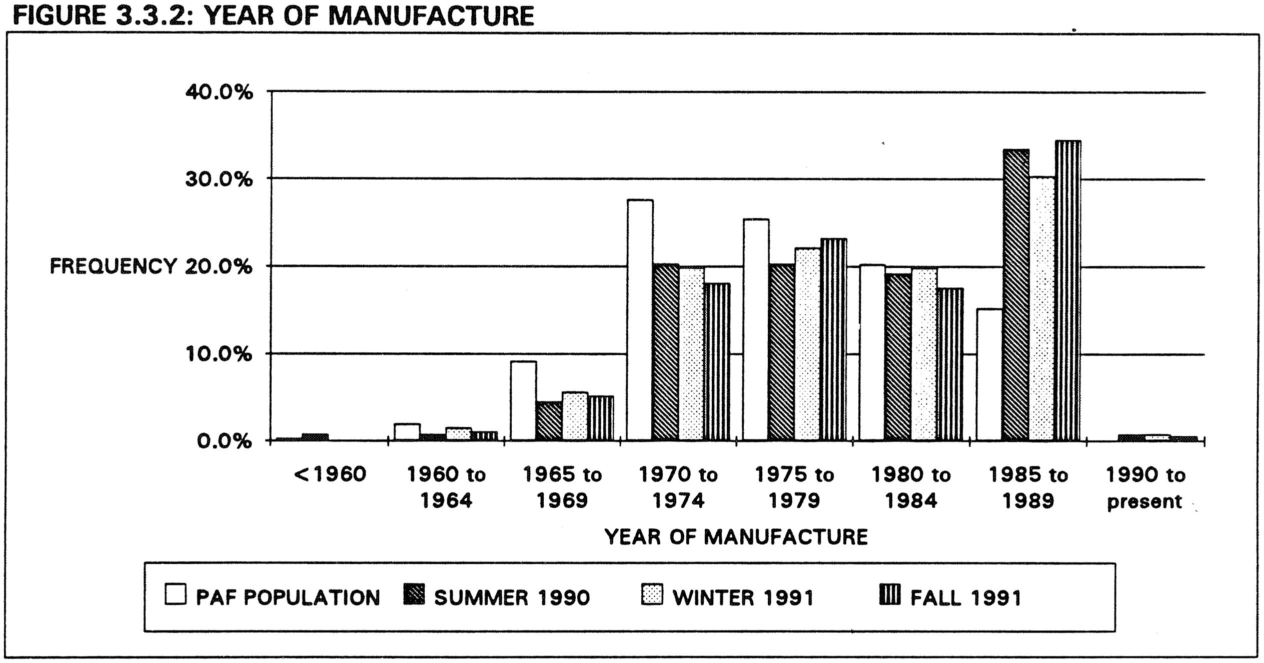


TABLE 3.4: AXLE CONFIGURATION

AXLE CONFIGURATION	SUMMER 1990	(SUMMER 1987)	WINTER 1991	FALL 1991
o oo	52.6%	(50.6%)	57.4%	57.4%
o oo oo	18.6%	(19.8%)	16.1%	16.1%
o ooo	13.4%	(8.6%)	14.5%	14.5%
o oo ooo	6.1%	(6.2%)	5.0%	5.0%
o o	5.7%	(6.2%)	4.5%	4.5%
OTHER	3.6%	(8.6%)	2.5%	2.5%

FIGURE 3.4.1: AXLE CONFIGURATION - SUMMERS: 1987 vs. 1990

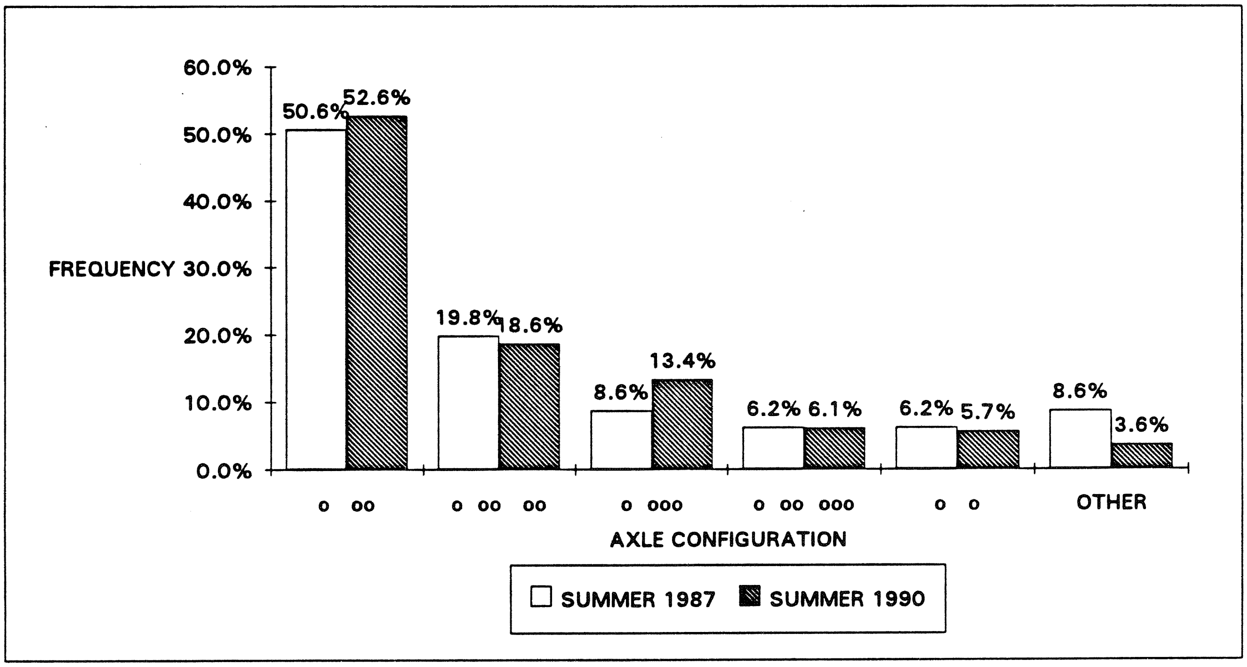


FIGURE 3.4.2: AXLE CONFIGURATION - SEASONAL COMPARISON

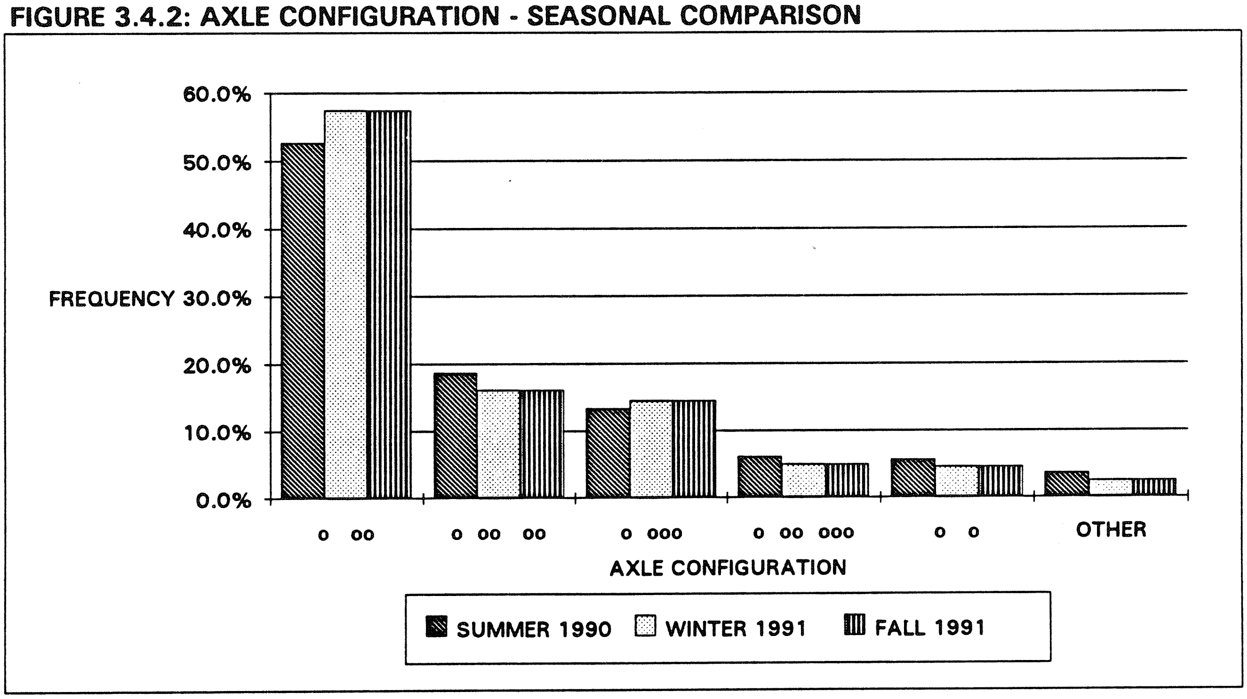


TABLE 3.5: NUMBER OF AXLES

NUMBER OF AXLES	SUMMER 1990	(SUMMER 1987)	WINTER 1991	FALL 1991
2	5.7%	6.2%	4.5%	1.1%
3	52.6%	51.9%	57.9%	60.6%
4	15.4%	11.1%	15.7%	15.0%
5	20.2%	22.2%	16.9%	17.2%
> 5	6.1%	8.6%	5.0%	6.1%

FIGURE 3.5.1: NUMBER OF AXLES - SUMMERS: 1987 vs. 1990

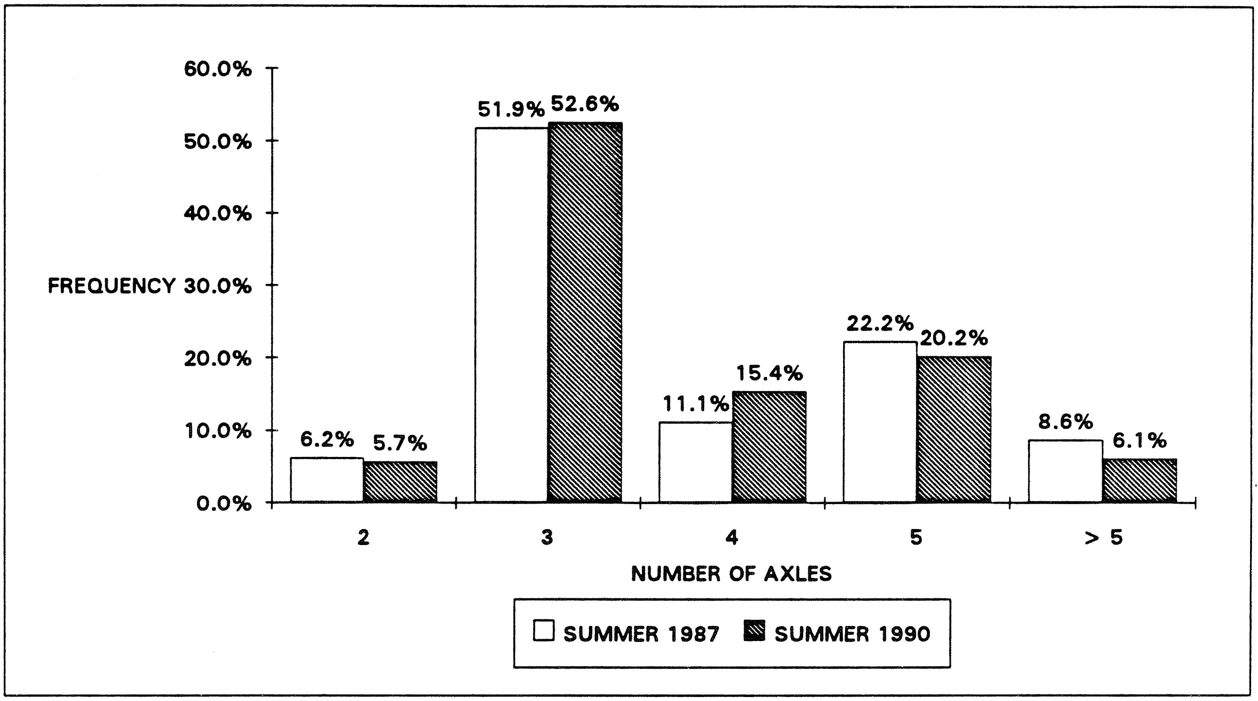


FIGURE 3.5.2: NUMBER OF AXLES - SEASONAL COMPARISON

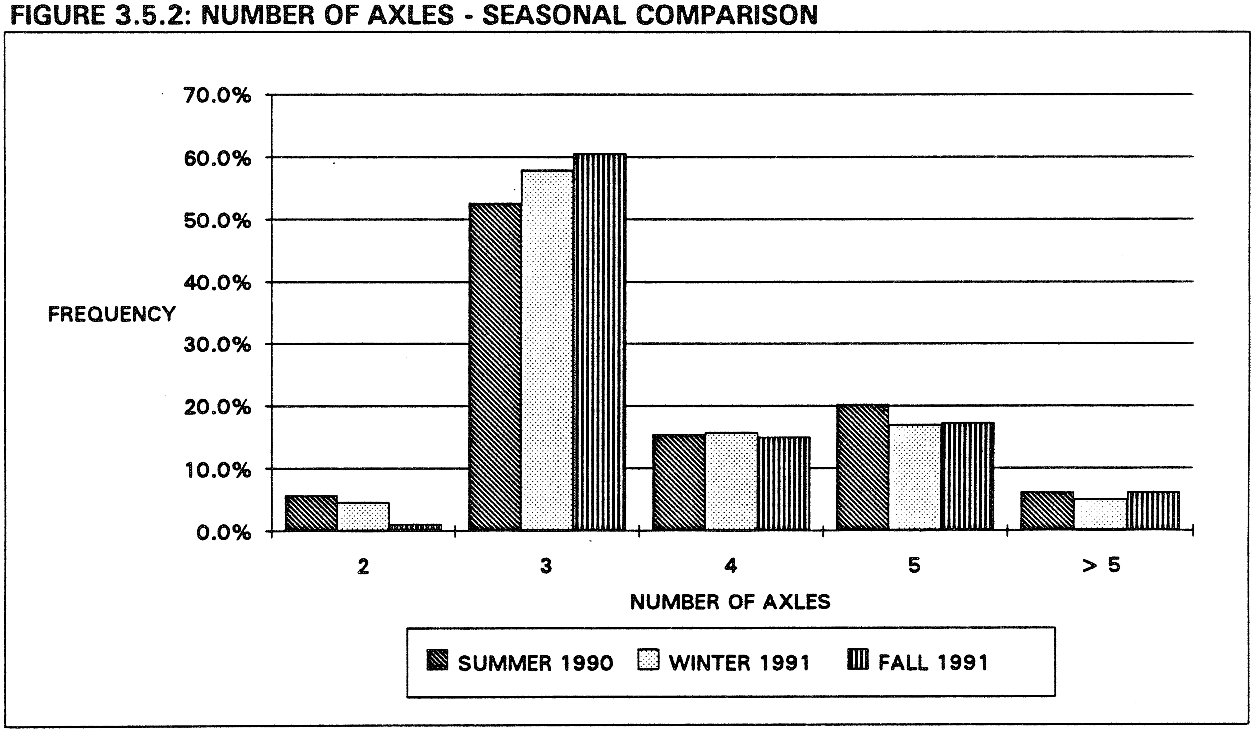


TABLE 3.6: VEHICLE TYPE

VEHICLE TYPE	SUMMER 1990	(SUMMER 1987)	WINTER 1991	FALL 1991
RIGID TRUCK	72.0%	66.3%	75.2%	75.5%
TRACTOR / TRAILER	26.0%	28.8%	21.0%	20.7%
TRUCK & TRAILER	1.6%	3.8%	0.8%	2.7%
ALL OTHER	0.4%	1.3%	3.1%	1.1%

FIGURE 3.6.1: VEHICLE TYPE - SUMMERS: 1987 vs. 1990

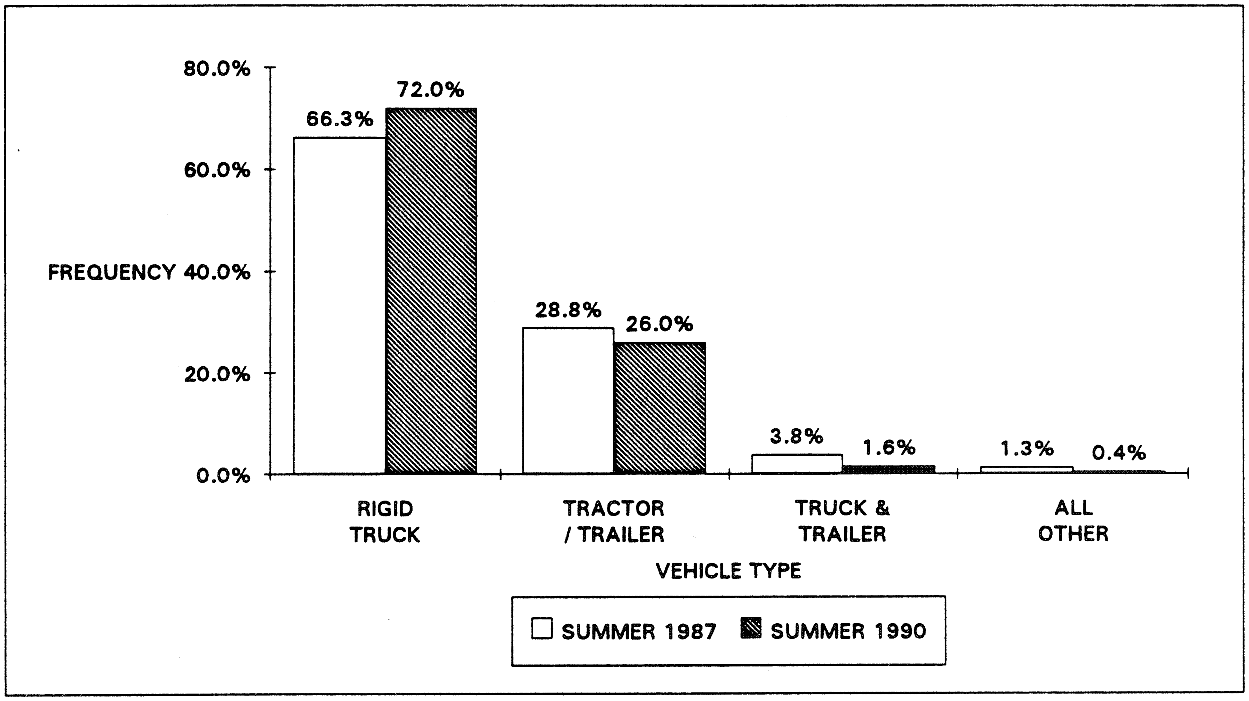


FIGURE 3.6.2: VEHICLE TYPE - SEASONAL COMPARISON

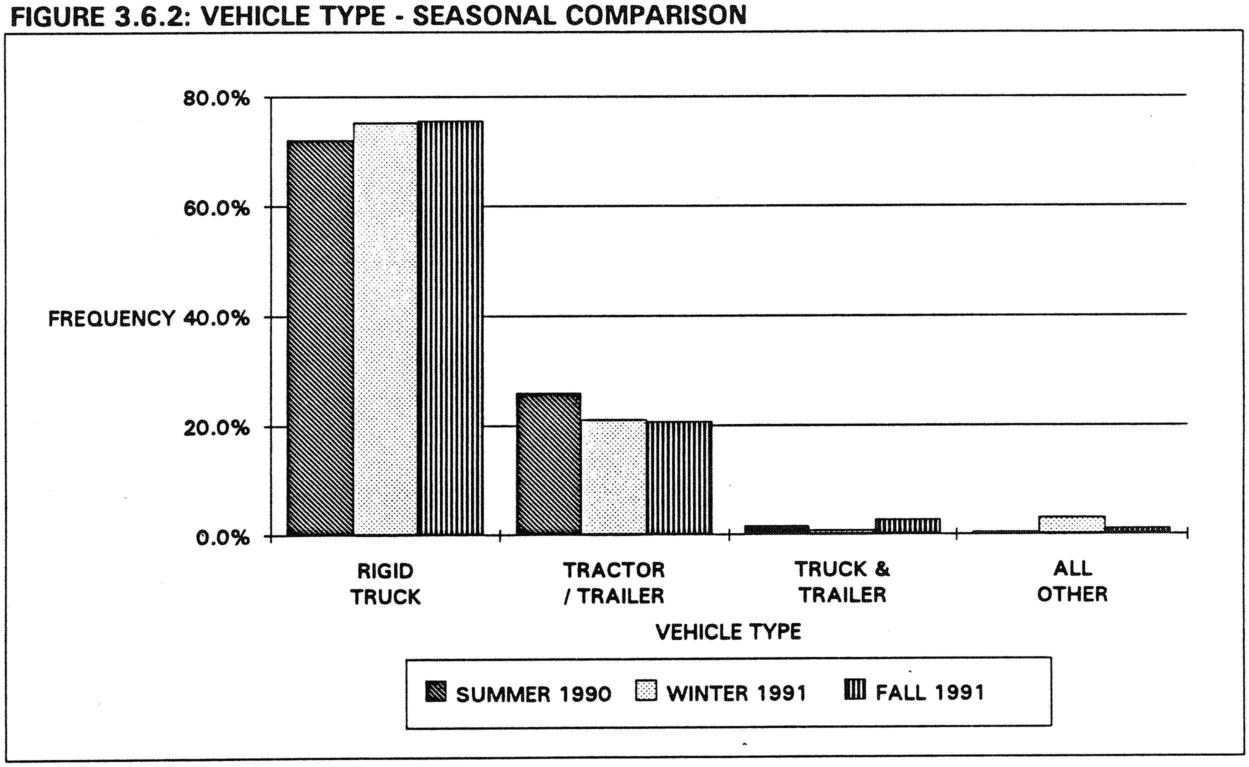


TABLE 3.7: BODY TYPE

BODY TYPE	SUMMER 1990	(SUMMER 1987)	WINTER 1991	FALL 1991
DUMP TRUCK	50.6%	(50.0%)	48.1%	48.4%
CONCRETE MIXER	16.5%	(17.5%)	20.2%	20.2%
TANKER	12.0%	(8.8%)	9.7%	9.6%
FLATBED	6.8%	(6.3%)	6.6%	5.9%
ALL OTHER	14.1%	(17.5%)	15.5%	16.0%

FIGURE 3.7.1: BODY TYPE - SUMMERS: 1987 vs. 1990

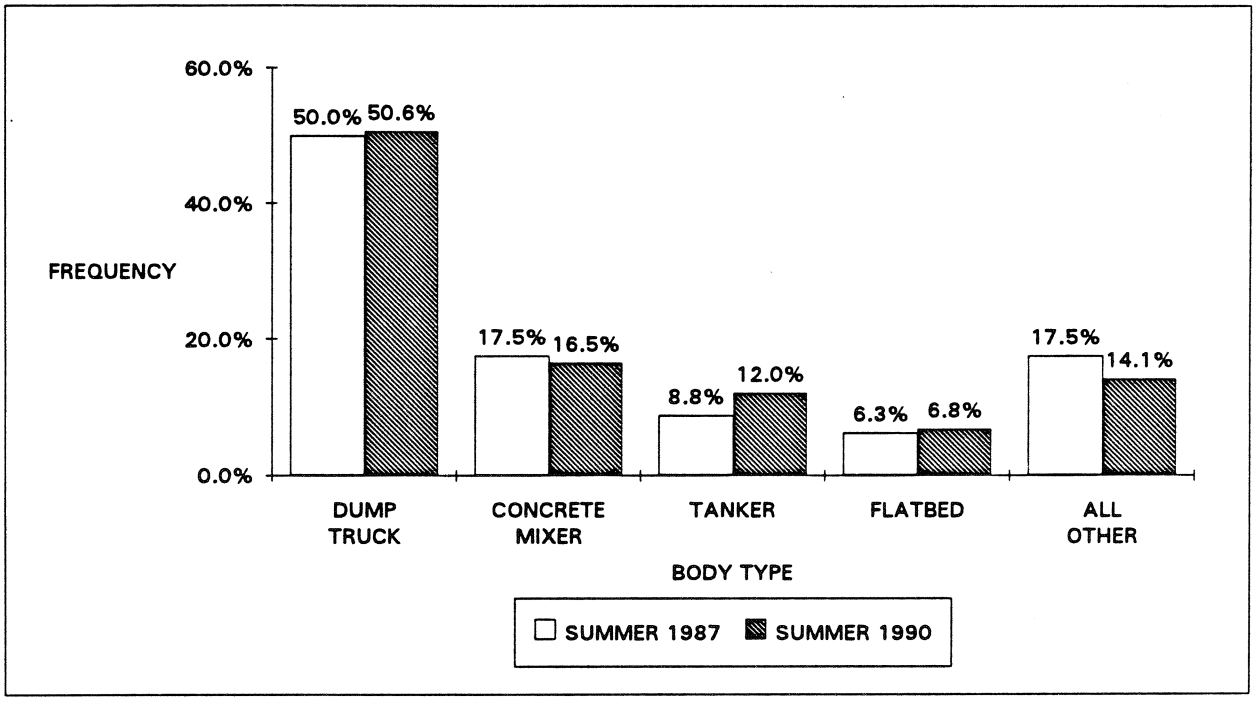


FIGURE 3.7.2: BODY TYPE - SEASONAL COMPARISON

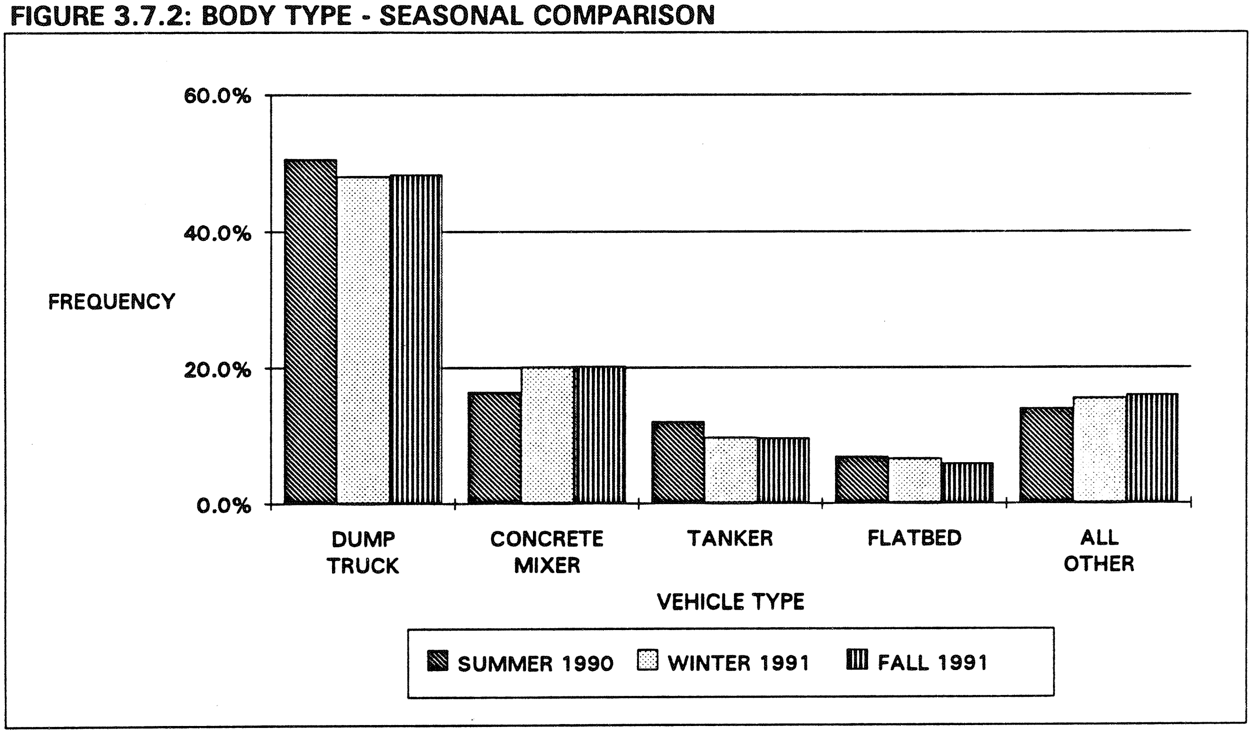


TABLE 3.8: PERMIT VEHICLE TARE WEIGHTS

TARE WEIGHT (POUNDS)	SUMMER 1990	WINTER 1991	FALL 1991
10000 to 20000	2.2%	9.4%	2.4%
20001 to 30000	62.2%	65.6%	67.5%
30001 to 40000	31.1%	21.9%	28.9%
more than 40000	4.4%	3.1%	1.2%

FIGURE 3.8.1: CUMULATIVE DISTRIBUTION OF PERMIT VEHICLE TARE WEIGHTS

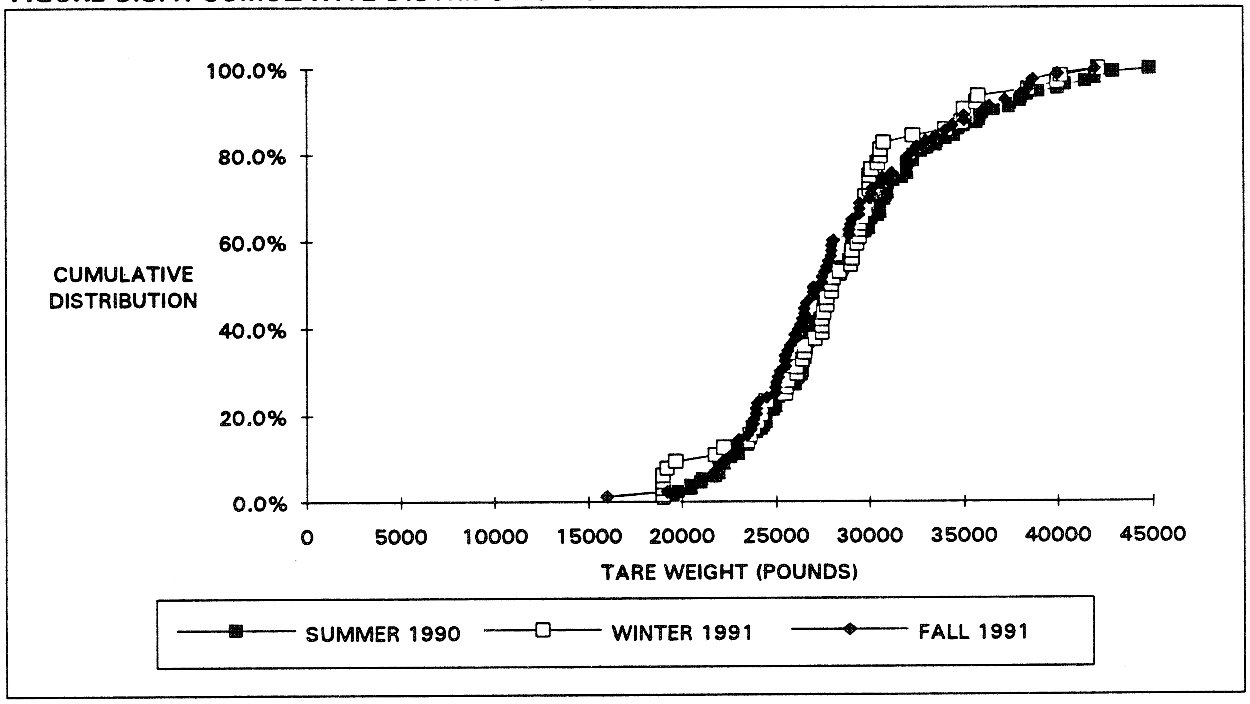
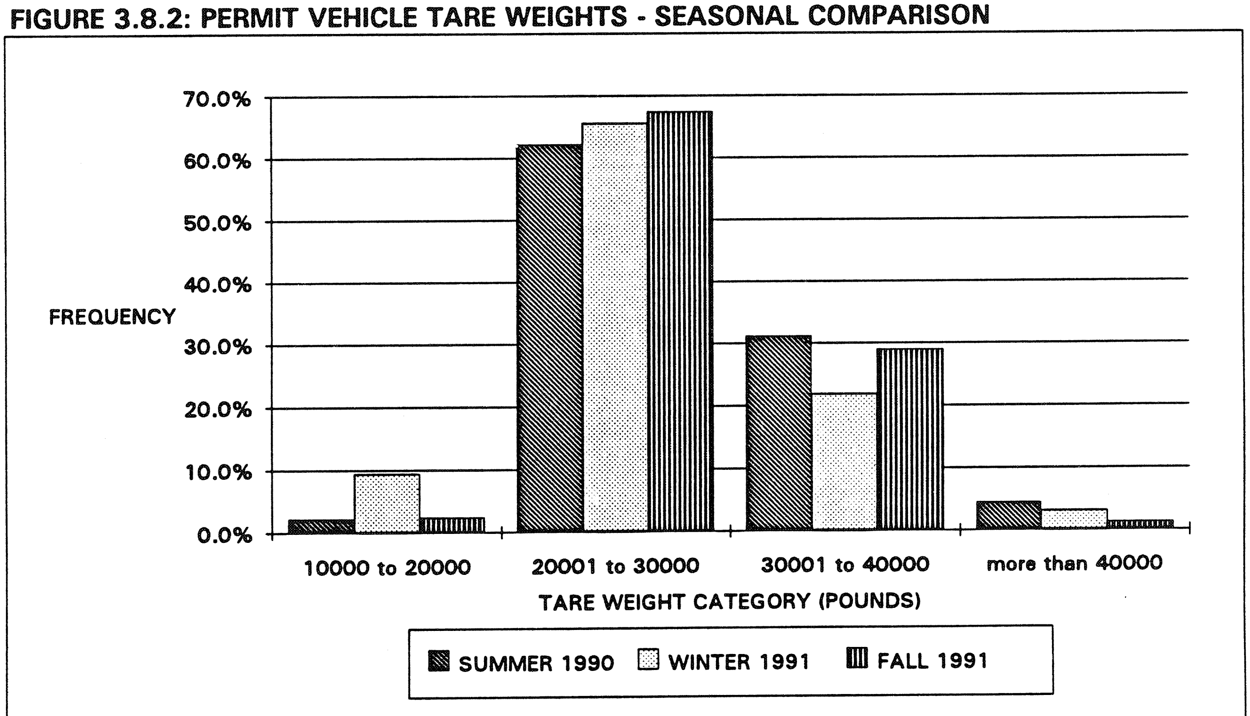


FIGURE 3.8.2: PERMIT VEHICLE TARE WEIGHTS - SEASONAL COMPARISON



NOTE: The graph above shows only the tare weight of the vehicles that made loaded trips on the survey day. In our opinion, more than 20% of the respondents did not understand "tare".

TABLE 3.9: OPERATOR PERMIT VEHICLE FLEET SIZE

OPERATOR SIZE (Number of Trucks)	PAF POPULATION	SAMPLE	SUMMER 199	WINTER 1991	FALL 1991
1	12.3%	12.2%	7.9%	8.3%	10.6%
2 to 6	35.6%	36.0%	29.7%	28.0%	26.6%
7 to19	30.0%	29.6%	28.9%	30.4%	26.6%
20 and more	22.1%	22.1%	33.5%	33.2%	36.2%

FIGURE 3.9.1: CUMULATIVE DISTRIBUTION OF OPERATOR PERMIT VEHICLE FLEET SIZE

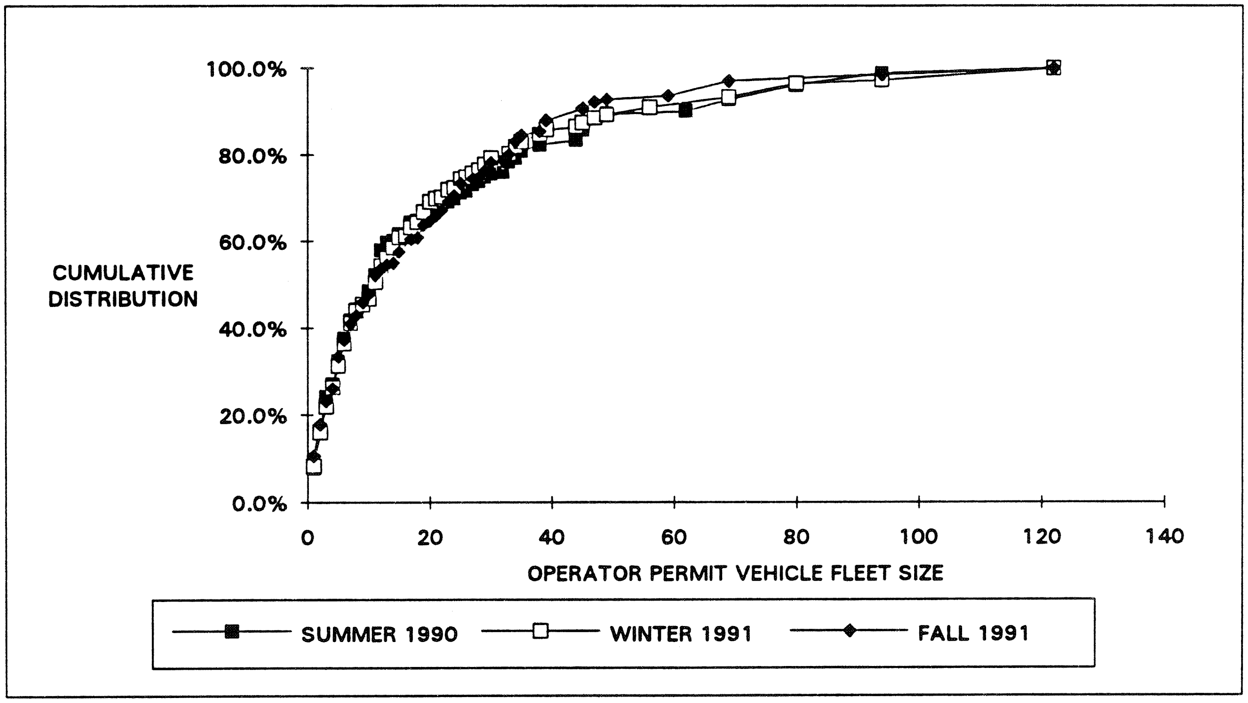


FIGURE 3.9.2: OPERATOR PERMIT VEHICLE FLEET SIZE

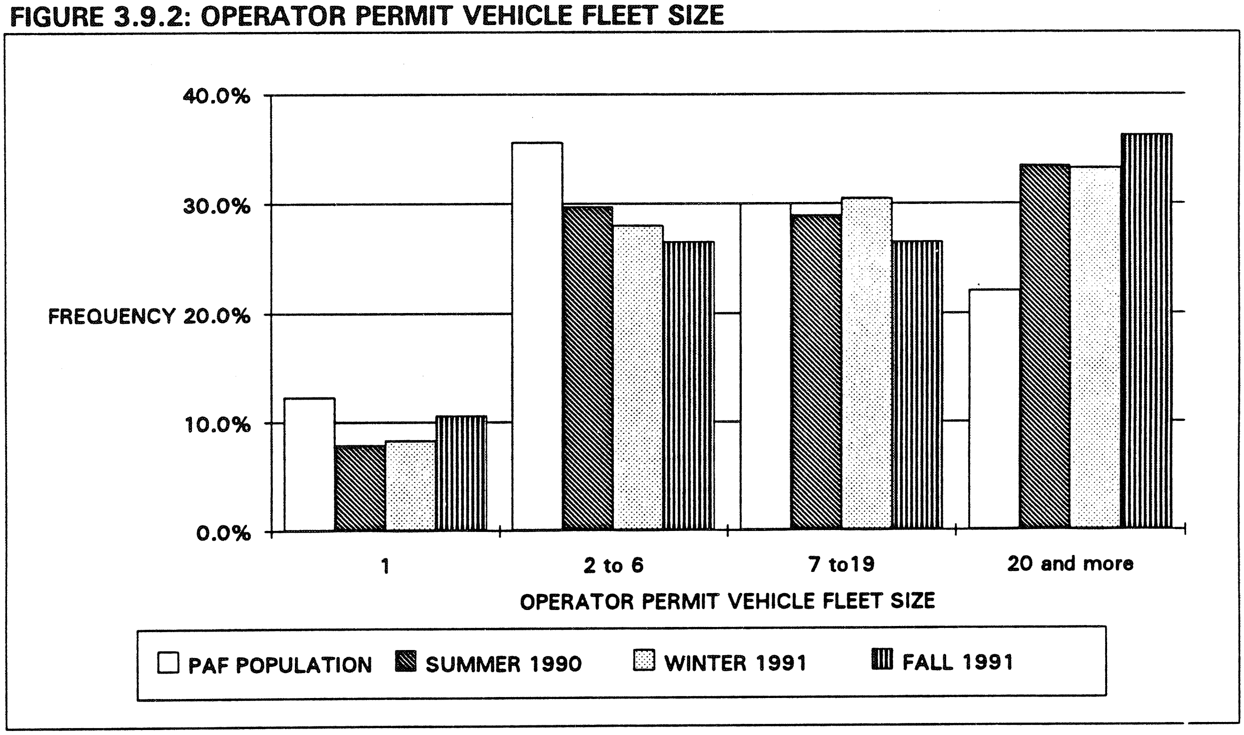


TABLE 3.10: PRIMARY BUSINESS

PRIMARY BUSINESS	SUMMER 1990	WINTER 1991	FALL 1991
CONSTRUCTION	26.4%	29.5%	30.7%
READY-MIX CONCRETE	22.3%	23.2%	20.0%
UTILITIES (inc. SANITATION)	10.6%	10.2%	11.7%
FOR-HIRE TRANSPORTATION	9.1%	7.7%	9.8%
MINING AND QUARRYING	10.6%	6.3%	8.3%
AGRICULTURE	3.8%	4.6%	3.4%
RETAIL TRADE (excl. OIL DELIVERIES)	3.8%	3.9%	3.4%
OIL RETAIL TRADE	4.5%	3.5%	3.4%
HIGHWAY MAINTENANCE AND CONSTRUCTION	2.6%	3.2%	2.0%
MANUFACTURING (excl. READY-MIX CONCRETE)	3.0%	2.8%	2.4%
FORESTRY AND LUMBERING	1.9%	2.5%	2.0%
WHOLESALE TRADE	1.5%	2.5%	2.4%
OTHER	NA	0.4%	0.5%

FIGURE 3.10.1: SEASONAL COMPARISON OF PERMIT VEHICLES BY PRIMARY BUSINESS

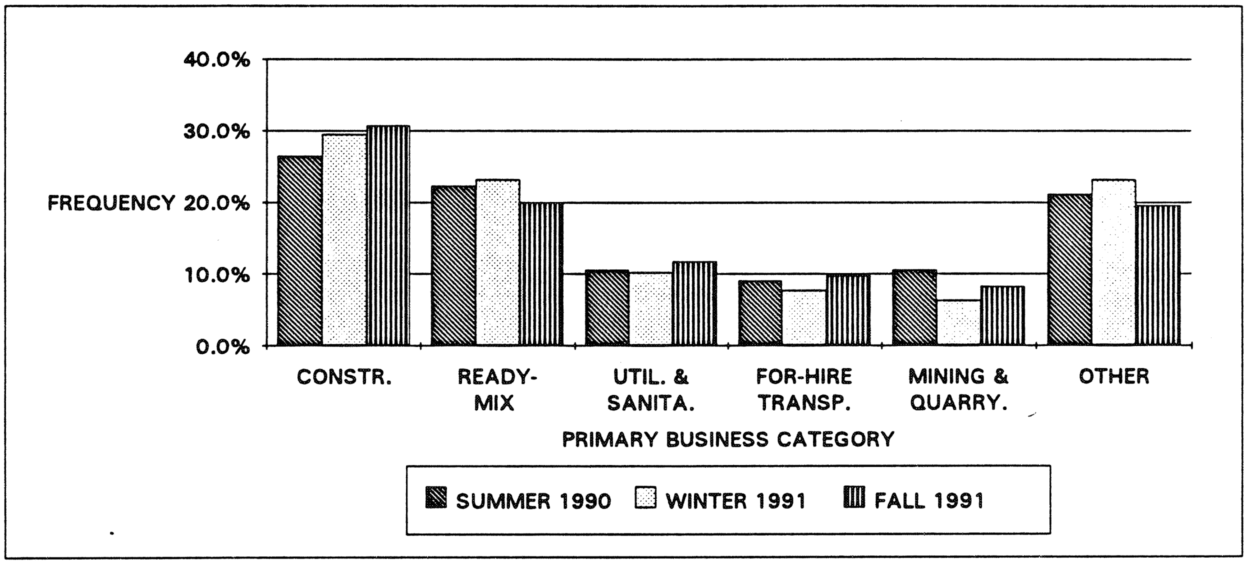


FIGURE 3.10.2: DISTRIBUTION OF PERMIT VEHICLES BY PRIMARY BUSINESS

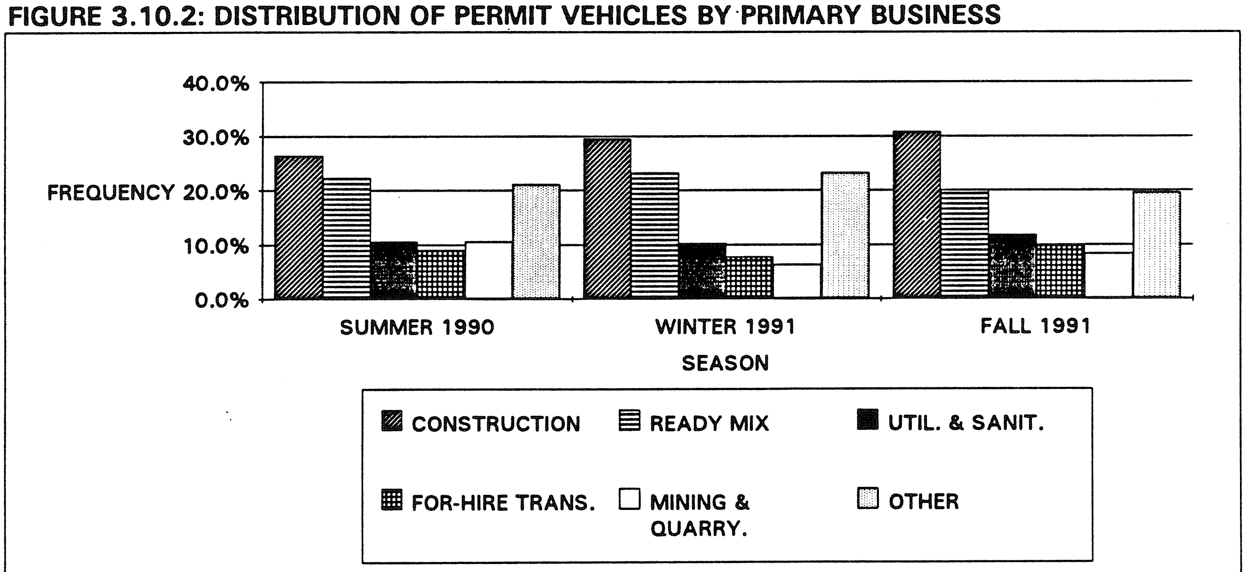


TABLE 3.11: PERMIT VEHICLE FLEET USAGE

PRIMARY BUSINESS	% of permit vehicles on the road on survey day SUMMER 1990	WINTER 1991	FALL 1991
CONSTRUCTION	71.4%	15.5%	50.8%
READY-MIX CONCRETE	66.1%	27.3%	53.7%
UTILITIES (incl. SANITATION)	57.1%	55.2%	41.7%
FOR-HIRE TRANSPORTATION	70.8%	31.8%	70.0%
MINING AND QUARRYING	78.6%	11.1%	58.8%
OTHER	42.9%	44.6%	37.5%

Note: the % of permit vehicles on the road on survey day in the table above is based on at least 15 answers for each business category.

FIGURE 3.11.1: SEASONAL COMPARISON OF TRUCK USAGE BY BUSINESS CATEGORY

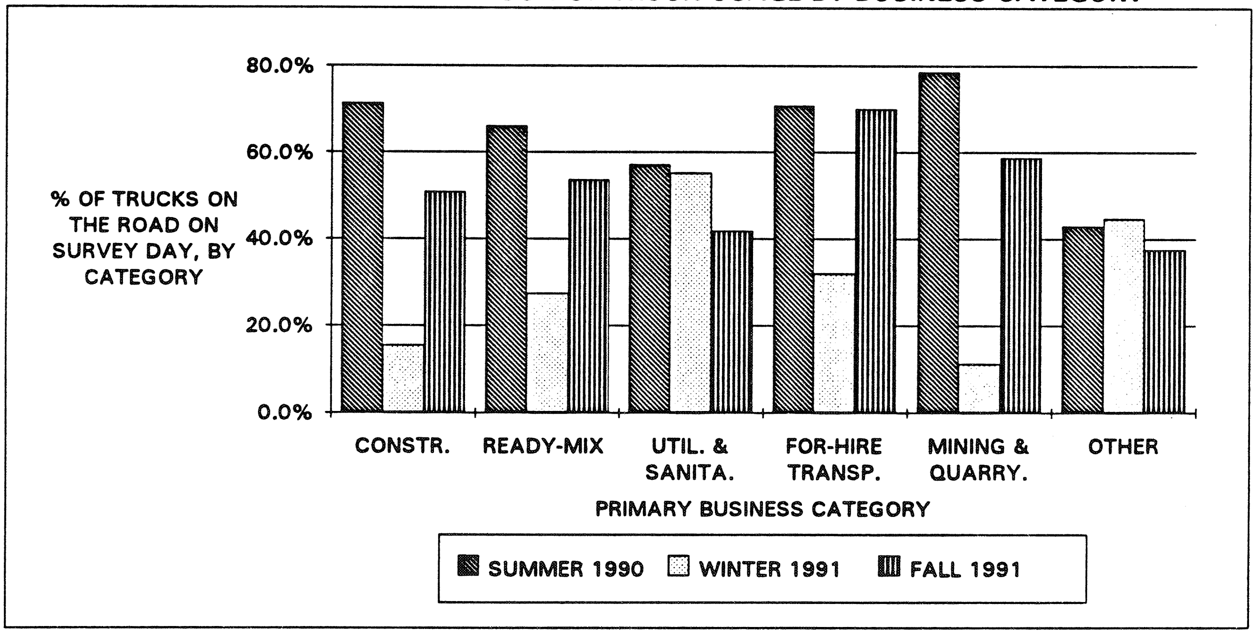


FIGURE 3.11.2: PERCENTAGE OF TRUCK ACTIVITY BY PRIMARY BUSINESS

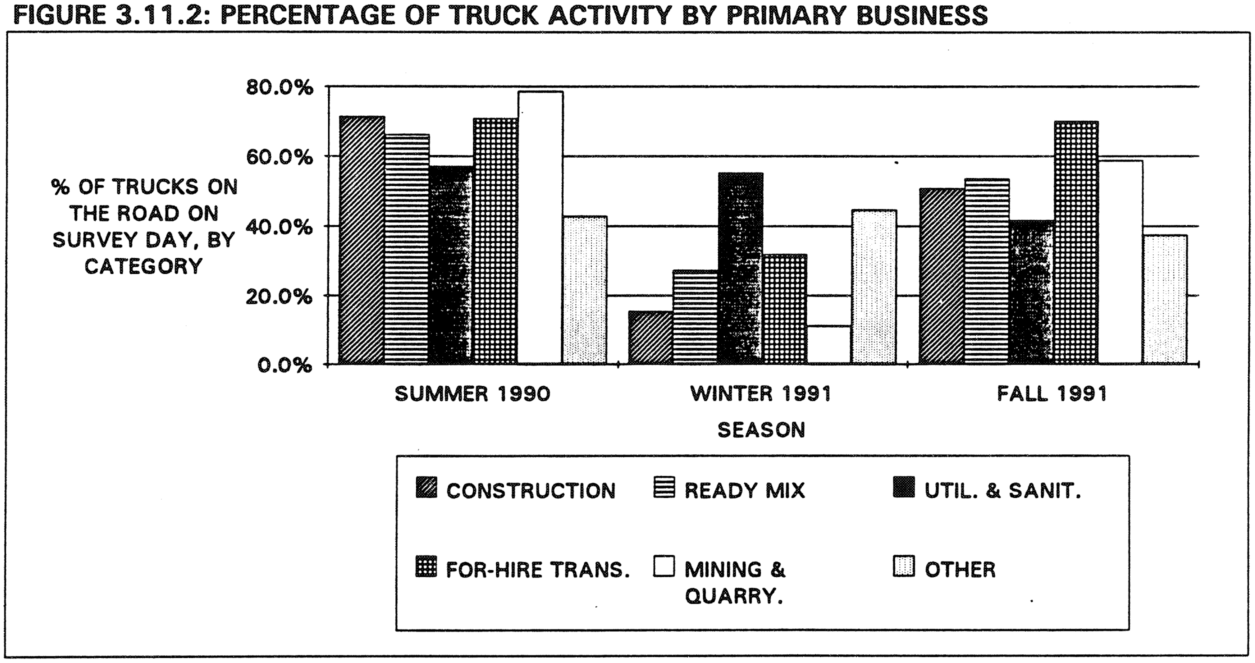


TABLE 3.12: PERMIT VEHICLE FLEET ACTIVITY

PERMITTED TRUCK STATUS	SUMMER 1990	WINTER 1991	FALL 1991
ON THE ROAD	63.5%	29.5%	49.8%
STANDBY	22.9%	27.8%	22.7%
SERVICED	5.3%	10.4%	8.7%
NO WORK	3.4%	13.9%	8.7%
SEASONAL	1.9%	16.7%	6.8%
OTHER	3.0%	1.7%	3.4%

FIG. 3.12.1: SEASONAL COMPARISON OF TRUCK ACTIVITY

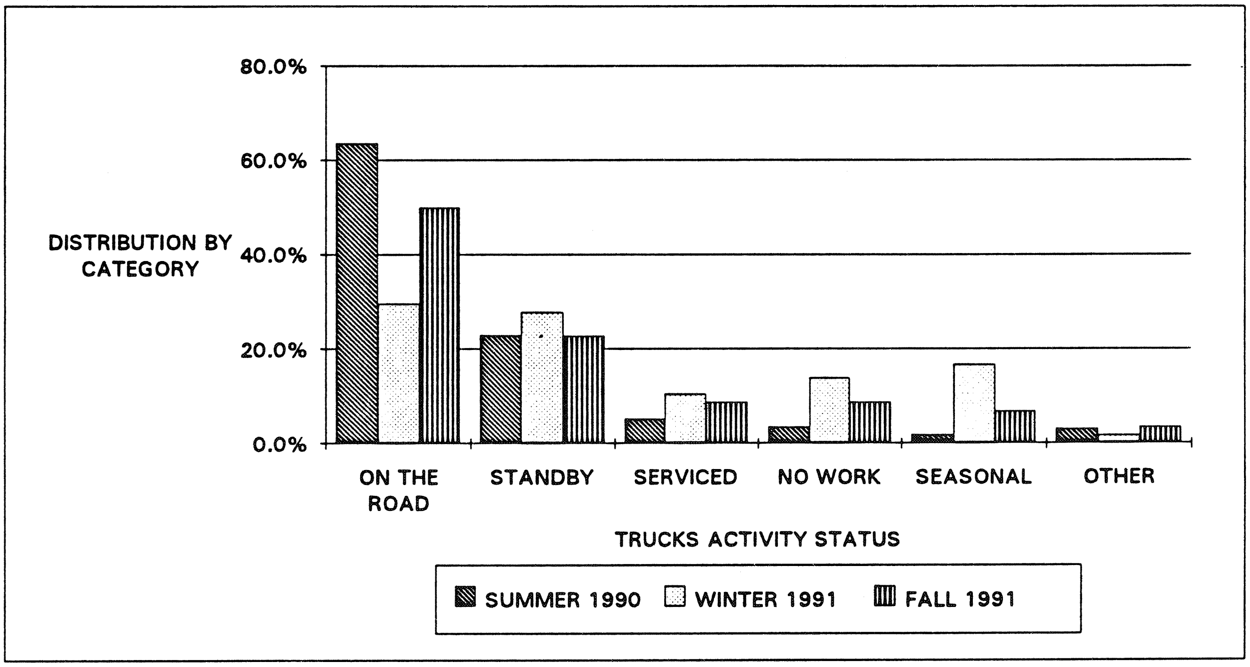


FIG. 3.12.2: SEASONAL COMPARISON OF REASONS FOR TRUCK INACTIVITY ON SURVEY DAY

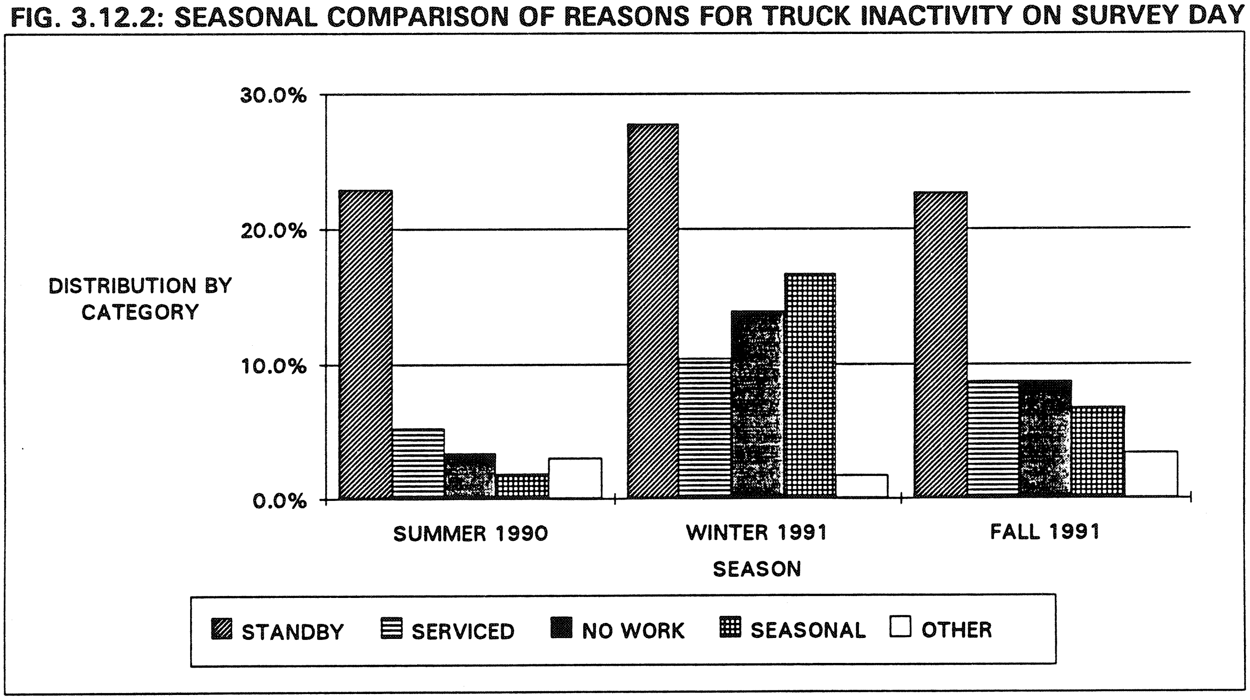


TABLE 3.13: TRIP MILEAGE AND DURATION STATISTICS

	TRIP MILEAGE (miles)			TRIP DURATION (minutes)		
	SUMMER 1990	WINTER 1991	FALL 1991	SUMMER 1990	WINTER 1991	FALL 1991
MEAN	21	27	16	44	59	38
MEDIAN	13	15	8	30	37	30
ST.DEV	26	40	20	37	67	42
MINIMUM	1	1	1	5	5	2
MAXIMUM	405	389	189	307	510	465

FIGURE 3.13.1: CUMULATIVE DISTRIBUTION OF TRIP MILEAGE

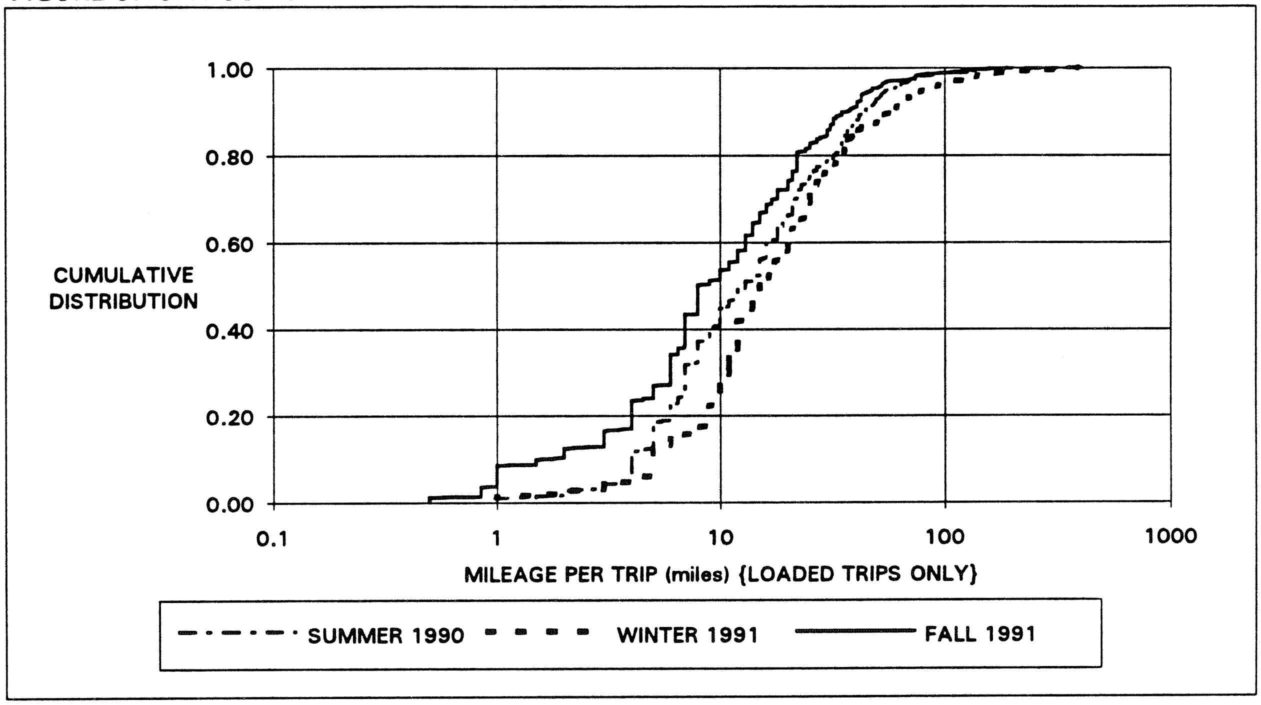


FIGURE 3.13.2: CUMULATIVE DISTRIBUTION OF TRIP DURATION

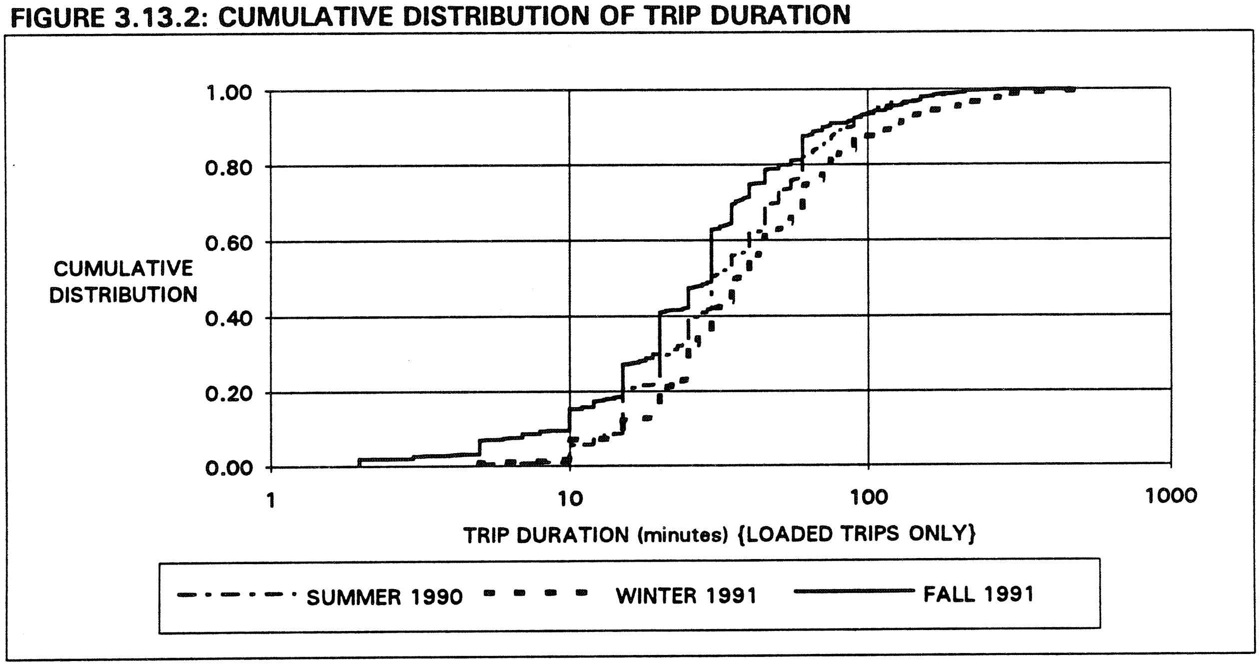


TABLE 3.14: GROSS VEHICLE WEIGHT AND E.S.A.L. STATISTICS

	GROSS VEHICLE WEIGHT (POUNDS)			TRUCK E.S.A.L. (All road classes)		
	SUMMER 1990	WINTER 1991	FALL 1991	SUMMER 1990	WINTER 1991	FALL 1991
MEAN	73,006	67,296	66,858	6.8	5.7	5.5
MEDIAN	69,800	69,240	67,740	5.5	5.4	5.3
ST.DEV	20,428	20,369	20,678	4.7	4.7	3.8
MINIMUM	23,700	26,500	20,730	0.1	0.2	0.2
MAXIMUM	133,000	123,620	124,000	31.7	33.8	21.5

FIGURE 3.14.1: CUMULATIVE DISTRIBUTION OF GROSS VEHICLE WEIGHTS

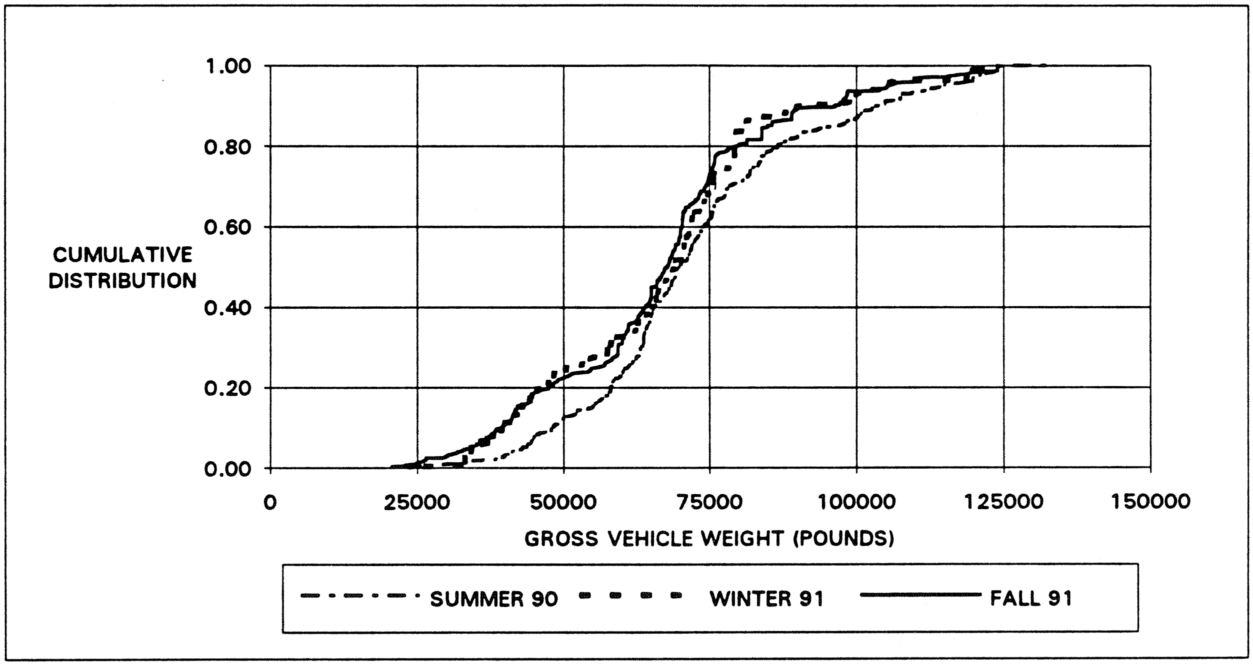


FIGURE 3.14.2: DISTRIBUTION OF TRUCK E.S.A.L.

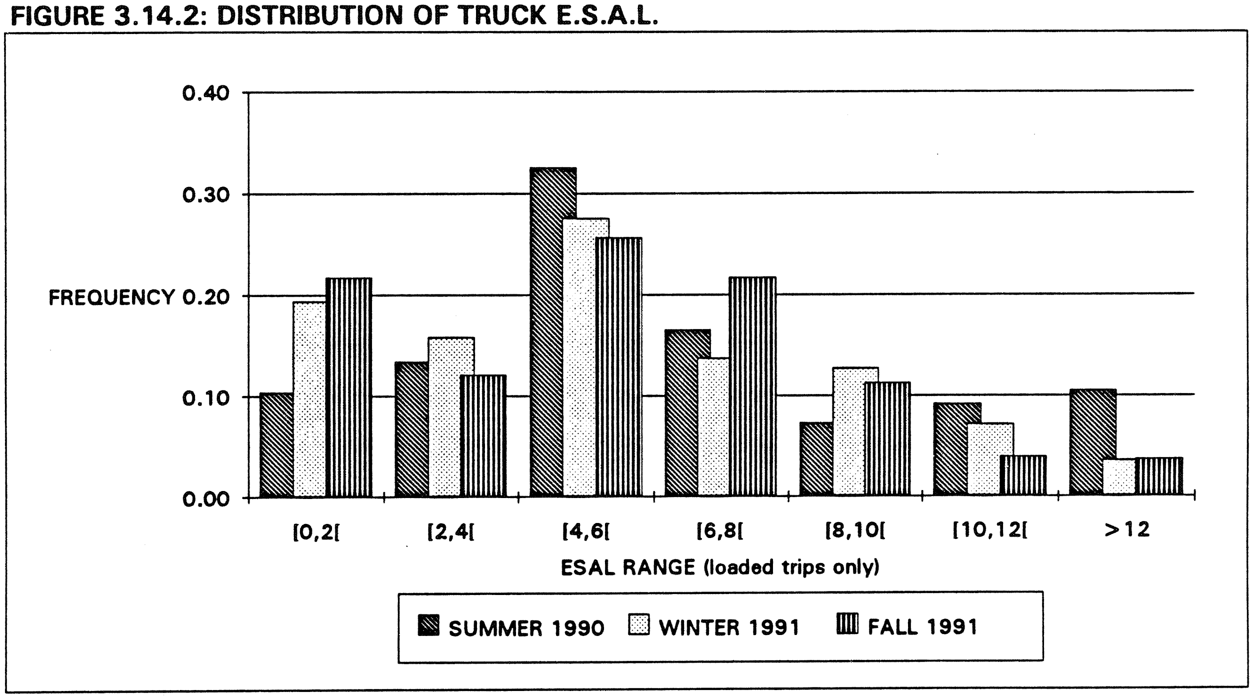


TABLE 3.15: COMPARISON OF REPORTED GVW BETWEEN SUMMERS

GVW (POUNDS)	All Permit Categories		Permits 7 and 7A only	
	Summer 1987	Summer 1990	Summer 1987	Summer 1990
Average	70,100	73,000	70,800	75,300
Median	65,500	69,800	69,900	69,200
Minimum	23,600	23,700	35,300	33,100
Maximum	121,700	133,000	111,000	133,000
Stdev	20,710	20,430	14,680	23,460
Number of Trips	602	631	212	138

NOTE: In the last two columns, the number of trips used reflects only that less complete information was available for the Summer 1990 survey.

FIGURE 3.15.1: BETWEEN SUMMERS COMPARISON OF GVW (ALL PERMITS)

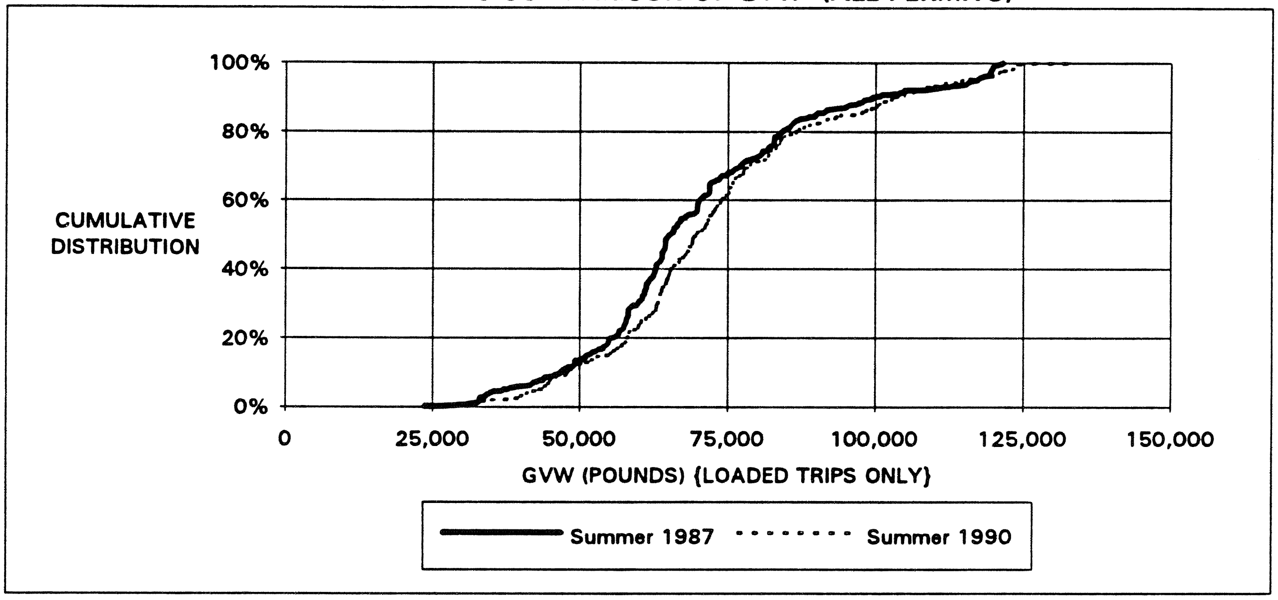
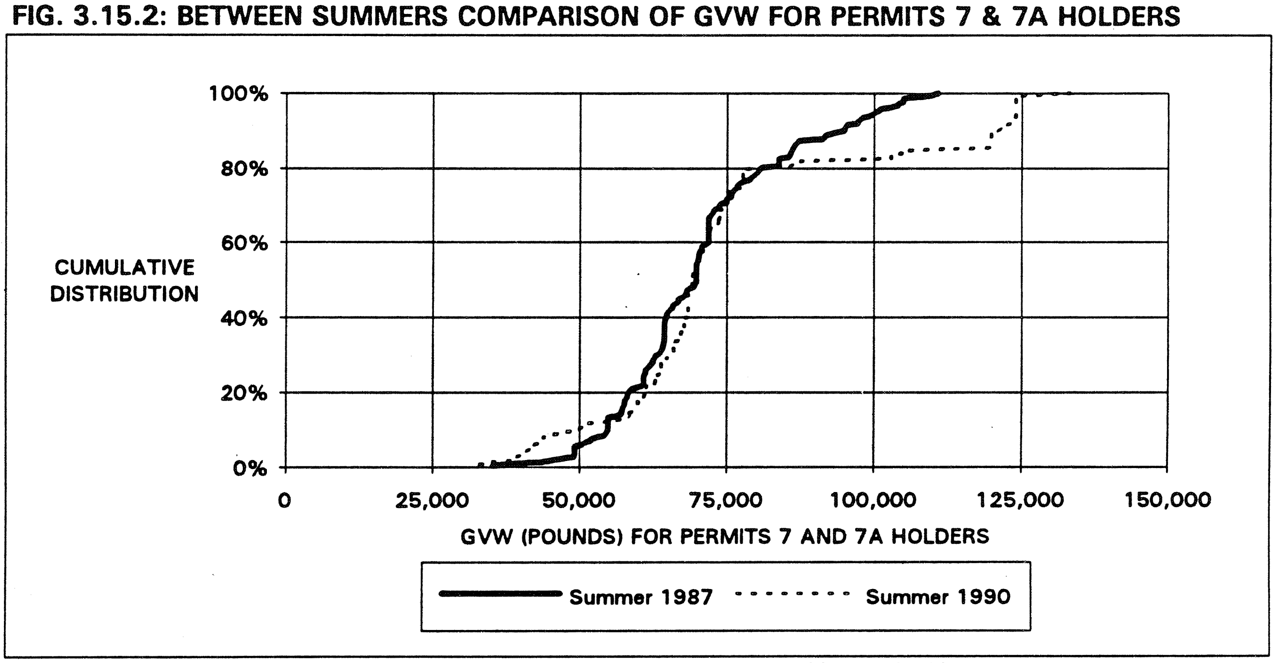


FIG. 3.15.2: BETWEEN SUMMERS COMPARISON OF GVW FOR PERMITS 7 & 7A HOLDERS



NOTE: Max. GVW for permits 7 and 7A was reduced from 145% to 135% of the federal limits between 1987 and 1990.

TABLE 3.16: DISTRIBUTION OF RESPONDENTS BY PERMIT WEIGHT LIMIT

Highest Weight Limit Permit Held	WEIGHT LIMIT	SAMPLE OF 916		SUMMER 1990		WINTER 1991		FALL 1991	
		Number	%	Number	%	Number	%	Number	%
1 and/or 1A	125% FED	230	25.1%	82	27.1%	88	26.2%	73	27.5%
1&7 and/or 1A&7A	135% FED	141	15.4%	43	14.2%	50	14.9%	35	13.2%
2	82000 lbs	208	22.7%	66	21.8%	75	22.3%	62	23.4%
6	120000 lbs	104	11.4%	38	12.5%	41	12.2%	33	12.5%
	Other	80	8.7%	25	8.3%	33	9.8%	23	8.7%
	Unknown	*153*	*16.7%*	*49*	*16.2%*	*49*	*14.6%*	*39*	*14.7%*
	TOTAL	916	100.0%	303	100.0%	336	100.0%	265	100.0%

FIGURE 3.16.1: DISTRIBUTION OF PERMITTED WEIGHT LIMIT CATEGORIES BY SURVEY

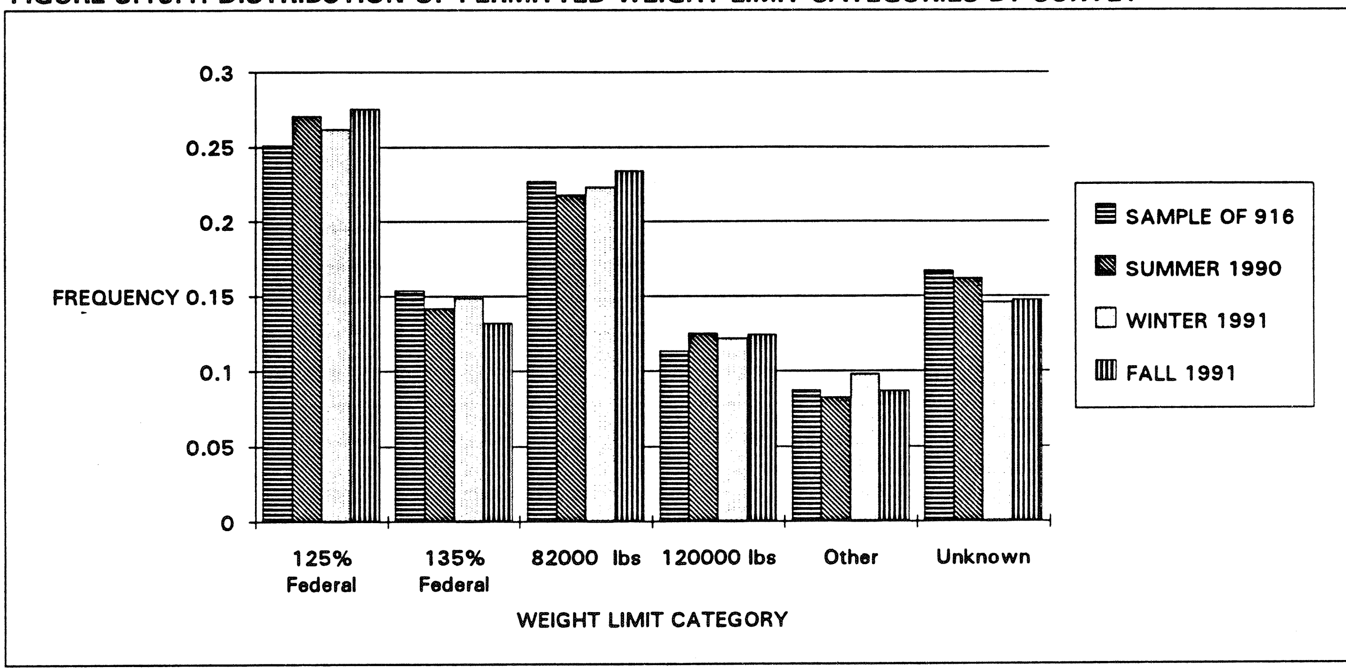
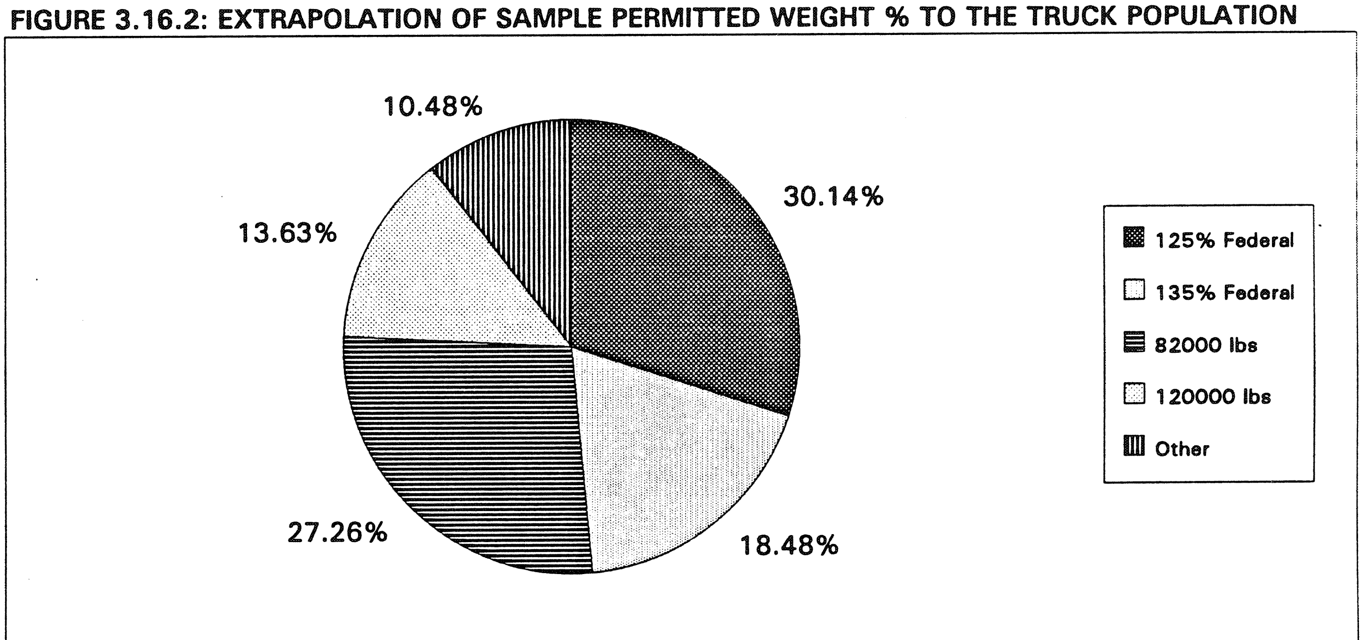


FIGURE 3.16.2: EXTRAPOLATION OF SAMPLE PERMITTED WEIGHT % TO THE TRUCK POPULATION



NOTE: To calculate extrapolated percentages for each weight limit category, it was assumed that the composition of permits in the unknown category was similar to that of the known rest of the sample.

TABLE 3.17: TRUCK STATISTICS ON WEIGHT COMPLIANCE

CATEGORY	Summer 87	Summer 90	Winter 91	Fall 91
Number of trucks that made loaded trips on survey day	154	120	59	76
Number of trucks in exceedence of permit weight limits	23	53	26	38
Percentage of trucks in exceedence of permit limits	15%	44%	44%	50%
Number of exceedences due to incorrect # of axles	3	23	12	16
% of exceedences due to incorrect # of axles	13%	43%	46%	42%

Season	Permit Type Permit Weight Limit # of Axles Required	1 125% Fed. 2 to 4	7 135% Fed. 2 to 4	1A 125% Fed. > 4	7A 135% Fed. > 4	2 82000lbs >2	6 120000lbs >4	3, 5, 5A (*) (**)	Total
Summer 1987	*Number of Trucks*	*48*	*32*	*17*	*11*	*25*	*17*	*4*	*154*
	Number of Exceedence	*12*	*2*	*3*	*0*	*2*	*4*	*0*	*23*
	% of Exceedences	*25%*	*6%*	*18%*	*0%*	*8%*	*24%*	*0%*	*15%*
Summer 1990	Number of Trucks	37	18	5	4	32	18	6	120
	Number of Exceedence	20	6	4	4	7	7	5	53
	% of Exceedences	54%	33%	80%	100%	22%	39%	83%	44%
Winter 1991	Number of Trucks	14	7	2	1	22	12	1	59
	Number of Exceedence	8	3	2	0	6	7	0	26
	% of Exceedences	57%	43%	100%	0%	27%	58%	0%	44%
Fall 1991	Number of Trucks	21	15	2	4	19	13	2	76
	Number of Exceedence	12	9	1	3	4	8	1	38
	% of Exceedences	57%	60%	50%	75%	21%	62%	50%	50%

NOTES: Shading of the results for a category indicates that the number of sampled trucks in this category may be too small to give statistically reliable results.

(*): The weight limit for permit 3 is 73280 lbs; permits 5 and 5A allow up to 105,000 lbs.

(**): Permit 3 applies to trucks with 3 axles or more. At least 5 axles are needed for permits 5 and 5A.

FIG. 3.17.1: SEASONAL COMPARISON OF TRUCK WEIGHT COMPLIANCE BY WEIGHT LIMIT

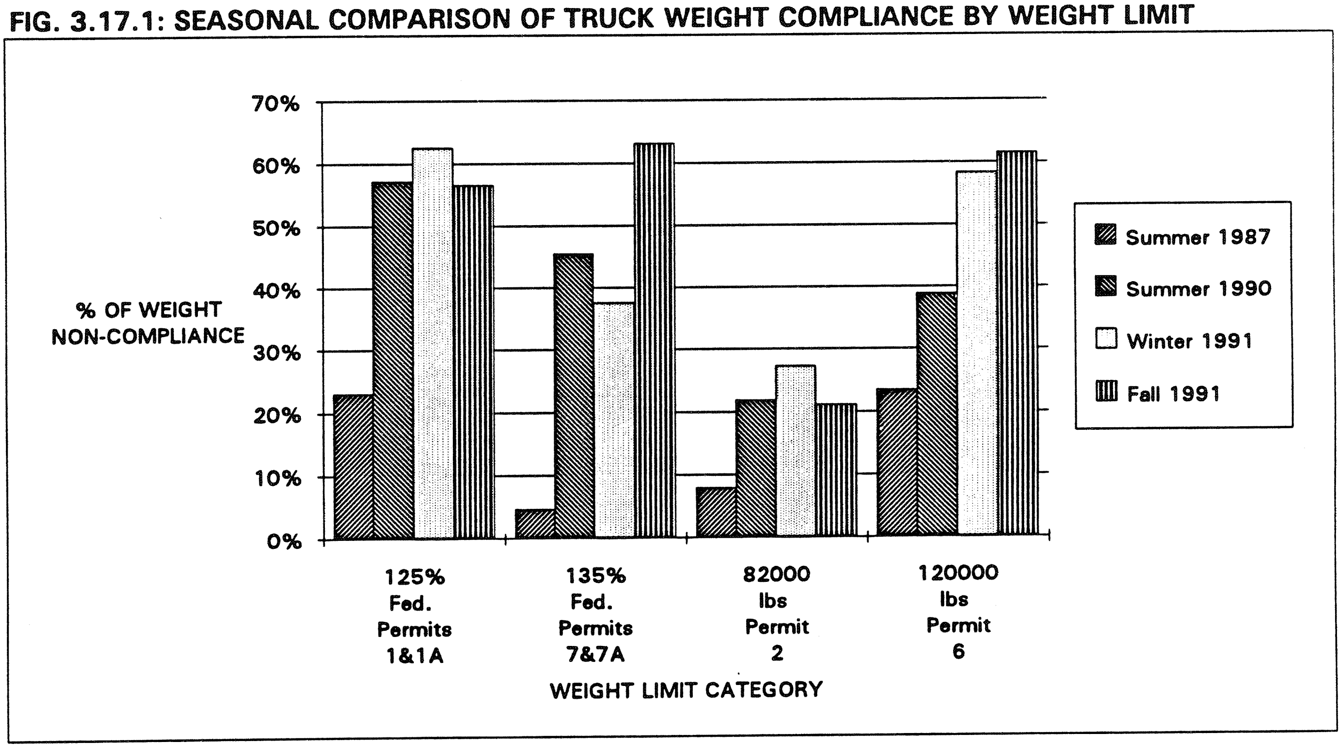


TABLE 3.18: TRIP STATISTICS ON WEIGHT COMPLIANCE

GENERAL STATISTICS ON TRIP WEIGHT NON-COMPLIANCE

CATEGORY	Summer 87	Summer 90	Winter 91	Fall 91
Number of loaded trips on survey day	602	528	181	330
Number of trips in exceedence of permit weight limits	58	245	75	164
Percentage of trips in exceedence of permit limits	10%	46%	41%	50%
Number of exceedences due to incorrect # of axles	4	101	28	79
% of exceedences due to incorrect # of axles	7%	41%	37%	48%

NOTE: During a trip, a truck can exceed the weight limits for several reasons: it may simply be over the limit stipulated by the permit or the permit may not apply because the configuration of the truck does not match the permit requirements or because the truck is outside the geographic area of validity of the permit. Only excessive GVW was considered in this analysis.

STATISTICS ON TRIP WEIGHT NON-COMPLINACE BY PERMIT CATEGORY

Season	Permit type Weight limit # of axles	1 125% Fed. 2 to 4	7 135% Fed. 2 to 4	1A 125% Fed. > 4	7A 135% Fed. > 4	2 82000lbs >2	6 120000lbs >4	3, 5, 5A (*) (**)	Total
Summer 1987	*Number of trips*	*40*	*2*	*5*	*0*	*7*	*4*	*0*	*58*
	Average (lbs)	*3,702*	*2,098*	*7,670*		*1,057*	*850*		*3,473*
	Median (lbs)	*2,218*	*2,098*	*10,895*		*1,100*	*940*		*2,095*
	Maximum (lbs)	*19,500*	*3,565*	*12,075*		*2,700*	*1,160*		*19,500*
	Stdev (lbs)	*4,410*	*2,075*	*5,506*		*794*	*380*		*4,294*
Summer 1990	Number of trips	100	35	16	22	24	26	22	245
	Average (lbs)	7,224	24,275	16,856	14,970	17,266	16,747	13,916	13,580
	Median (lbs)	4,435	24,500	14,000	16,890	20,500	15,000	10,740	11,500
	Maximum (lbs)	23,700	54,500	27,000	23,020	36,480	25,500	41,460	54,500
	Stdev (lbs)	7,485	19,985	5,780	5,852	9,608	6,348	11,755	12,020
Winter 1991	Number of trips	25	15	5	0	14	16	0	75
	Average (lbs)	4,390	3,310	17,936		22,547	11,589		10,000
	Median (lbs)	4,020	2,340	20,100		22,000	9,950		6,060
	Maximum (lbs)	6,780	8,415	24,220		38,180	20,180		38,180
	Stdev (lbs)	1,700	2,553	7,120		12,808	5,640		9,720
Fall 1991	Number of trips	47	37	2	13	23	40	2	164
	Average (lbs)	6,316	17,546	9,020	10,088	15,778	14,801	21,500	12,760
	Median (lbs)	5,450	8,515	9,020	9,000	13,725	16,690	21,500	11,370
	Maximum (lbs)	17,625	45,500	12,100	18,800	34,840	20,000	21,800	45,500
	Stdev (lbs)	4,463	17,459	4,356	5,651	9,792	4,897	424	10,735

NOTES: Shading of the results for a category indicates that the number of sampled trucks in this category may be too small to give statistically reliable results.
(*): The weight limit for permit 3 is 73280 lbs; permits 5 and 5A allow up to 105,000 lbs.
(**): Permit 3 applies to trucks with 3 axles or more. At least 5 axles are needed for permits 5 and 5A.