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RECREATIONAL TRAVEL IMPACTS

Review of Recreational Travel and Recreational Vehicle Data

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16. Abstract

Recreational travel has grown markedly over the past several decades with a growth rate averaging over 5 percent per year. Although the growth rate slowed somewhat during the 1973 to 1975 period of energy and economic concerns, it has since recovered. Projections of future growth depend upon the data base used, however, barring major world events, recreational highway travel should continue to grow at the some rate which is faster than other highway travel between now and 1990, perhaps 1.5 to 2.0 times as fast. Recreational vehicle ownership has likewise experienced tremendous growth, except that production dropped sharply in 1974 to 1975. More growth is expected but the market will probably become saturated within a decade.

Recreational vehicles affect traffic in a manner similar to trucks, but to a lesser degree. New data collection efforts coupled with computer simulations have led to improved means of quantifying these effects. Recreational vehicles also possess rather unique safety problems such as sensitivity to wind gusts and to overturning. Highway planners/designers can take certain steps to help ameliorate these problems.

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PREFACE

This report covers activities and findings under Task A of Federal Highway Administration Contract No. DOT-FH-11-9226.

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Approved for:

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I. INTRODUCTION

Americans are traveling for recreational purposes to a far greater extent than they previously did, and it appears that this growth will continue. Such travel is due in part to the increasing number of hours people have available for personal use and the higher economic status which enables them to pursue recreational activities and travel. During the same period, the United States highways have improved immensely, with the institution of the Interstate Highway System as well as the imposition of higher design standards on other highways. Thus, people have the time and the financial resources to travel more and a transportation system available to them that encourages such travel.

Not only is recreational travel increasing, but the use of special, recreational vehicles (RVs) is becoming a bigger factor. The pattern of growth and use of such vehicles is paralleled individually by many families who pursue recreational travel. Commonly, a family that starts its recreational travel by staying in cabins and motels decides to try tent camping. From there, they will often graduate to a tent trailer, thence to a travel trailer, and finally to a motor home. The latter vehicles can be quite sophisticated, expensive, and heavy, featuring self-contained heating, air conditioning, plumbing, water supply, electrical power generation equipment, etc. A whole new industry has been spawned to provide services to the drivers of such vehicles. In addition to these homes away from home, recreational motorists often tow trailers or other vehicles behind them--most commonly boats, but also motorcycle trailers, off-road or four-wheel-drive vehicles, and automobiles to be used for transportation in the vicinity of their destination.

The growth of recreational traffic and the increasing use of larger, heavier recreational vehicles create potential problems for highway planners, whose goals may have been based on differing assumptions about transportation needs. A review of current planning activities clearly shows that the current and projected growth in recreational travel and in the use of recreational vehicles is not adequately accounted for. This research effort therefore has as its goal:

. Goal - to upgrade the transportation planner's ability to incorporate the needs and effects of recreational traffic and recreational vehicles in the transportation planning process.

The conduct of the work in this contract is directed toward this ultimate goal through the achievement of three specific objectives:

1. To examine recreational travel, its peaking characteristics, recent growth characteristics, and trends in recreational vehicle ownership and use.

2. To investigate recreational vehicle operating characteristics and the resulting effects on traffic performance and safety.

3. To determine data needs and planning procedures to adequately address recreational travel characteristics and traffic performance in the planning process.

The scope of the contract thus includes not only recreational travel in general but also, because of their several adverse impacts on traffic, the special recreational vehicles that compose a portion of recreational traffic. The contract will result in the identification of the current and projected trends in recreational travel, a description of the important peaking characteristics, in terms of location and time, of recreational travel, an exposition of the operational and safety effects resulting from a mix of recreational vehicles in the traffic stream, and the kinds of data and procedures needed to incorporate the above findings into more realistic transportation planning.

This interim report presents the findings of the first task of the contract. It deals with the collection, review, analysis, and assembly of information in four basic areas:

- Trends and projections in recreational travel;
- Trends and projections in recreational vehicle (RV) ownership;
- Effects of RVs on traffic operations; and
- Effects of RVs on traffic safety.

The task report provides details of each of these areas, with key references cited, followed by a summary of the findings. Appendices give details on annual visitations to recreation areas, socioeconomic characteristics of RV owners, recreational travel trends, and visitation projection methodology.

II. IMPORTANCE AND CHARACTERISTICS OF RECREATIONAL TRAVEL

Recreational travel by private vehicle constituted about 22.4 percent of all vehicle trips, and about 33.4 percent of all mileage in 1969-1970.[1] Such travel therefore involves generally longer than average trips. In fact, for auto trips to a place at least 100 miles from home, recreational travel (including visits to friends or relatives) accounted for 62.5 percent of all such trips in 1976, and 65.4 percent of the mileage.[2]

Recreation and recreational travel are recognized by many states as having a major economic impact. This impact is reflected in income not only through gasoline sales, but more importantly in sales of foods, beverages, lodging, entertainment, and many other commodities. Many have developed state agencies to promote tourism. These states, in turn, often attempt to measure the economic impact, but usually have to rely on secondary data such as gasoline tax receipts, liquor sales, park attendance, etc. They lack direct measures of, for instance, vehicle-miles of travel for recreational purposes.

Transportation planners have long realized that recreational traffic generates special kinds of demands on facilities, and that these demands are best characterized by the strong peaking characteristics of the traffic. Much of the earlier work is summarized in the Transportation and Traffic Engineering Handbook.[4]

The most obvious peaking is associated with the seasonality of recreational traffic. July and August ADT's can average twice the year-round monthly levels on rural recreational facilities.[5] Traffic on recreational highways also shows extremely high day-to-day fluctuations, with Sunday ADT's approaching twice the average for the other days of the week.[5] Data from I-91 in Massachusetts[6] indicate that on that facility the highest hourly volumes (one-way) occur between 6 and 10 p.m. on Sunday evening (the second highest hourly volumes are observed between 5 and 7 p.m. on Friday evening).

The effect of recreational traffic peaking is perhaps most evident when one compares, say, the 30th highest hour volumes as a percentage of annual average daily traffic (the K-factor) for a variety of facility types.[7] Whereas on an urban through route the K-factor is about 0.11, this ratio increases to over 0.15 for a main rural route, to about 0.23 for a route classified as partially recreational, and to 0.38 for a route classified as highly recreational.

Other data implies that such traffic may have higher than normal short-term fluctuations within an hour. Drew and Keese[8] examined 5-min flow rates for a variety of facilities and showed that the 5-min peaks, at a given hourly volume, were higher in areas of smaller population. For example, they estimated that peak 5-min flow to be about 30 percent higher than the average 5-min level for populations of 100,000.

Finally, it is an observation that there are strong week-to-week fluctuations during a season although this peaking phenomenon has not been studied and quantified to the same extent as the other types of fluctuations. In the last few years several models have been developed to help predict recreational or weekend traffic. Very recently a major study was completed for the Transportation Research Board (Project 7-9), to develop a model for predicting weekend recreational traffic.[9] Recognizing that recreation planners and analysts have developed data bases and knowledge enabling elaborate projections, at least in the near term, of demand for recreational resources, and that highway engineers have developed sophisticated techniques for assigning well-defined traffic demands to a highway network, the project focused on merging these two disciplines through the development of the Recreational Traffic Planning Model (RTPM). This computer-based model uses the data and concepts of recreational analysts and traffic engineers to calculate recreational traffic by merging recreation demand, recreational supply, and traffic assignment logic. Then, using components of the Urban Planning Battery, the recreational traffic demands on specified highway segments can be determined.

Data collected expressly for this project, plus analysis of preexisting data using the logic contained in the model, provide valuable insights about recreational traffic. These insights are preliminary and based on data from limited regions of the country, and should be confirmed through use of the improved model and with data from other regions. Nevertheless, most of these findings should be qualitatively of general applicability even though the numerical values may vary from region to region. The insights are conveniently organized into four categories: general recreational travel patterns on summer weekends; traffic demands near urban areas; traffic demands near recreational areas; and implications for the rural highway system.

General Travel Patterns: On a 2-day summer weekend, one recreational trip (one vehicle) is made in the north central census region for every five persons in the population; in the southern region, one trip is made for every six persons. Limited survey data indicate that only about half as many recreational trips are made on 3-day weekends as on 2-day weekends; however, the distribution of trip types, ranging from trips of a few hours to overnight to vacation, is also different between 2-day and 3-day weekends.

On 2-day summer weekends, 83 percent of recreational trips do not involve an overnight stay. Overnight trips are 16 percent of the total and vacations account for about 1 percent. On 3-day summer weekends, only 55 percent of the recreational trips involve only 1 day. Overnight trips account for 42 percent of the total, and vacation trips account for about 3 percent. It is important to recognize that on 3-day weekends the overnight trips increase not only in percentage but also in absolute numbers. There are 30 percent more overnight trips than on a 2-day weekend.

Trips made to visit friends and relatives contribute heavily to the increase in the overnight category on 3-day weekends. This type of recreational travel has not been considered in prior recreational studies but is obviously important for traffic prediction.

A survey of summer recreation behavior conducted for this project collected data on the times of the weekend when recreational trips were made. The results showed strong modal peaks for the times when outbound trips (from the residence) departed and when the return (to the residence) trips arrived. On the other hand, the arrival times at, and departure times from the recreation destination showed no strong peaks. Weekend recreational travel is keyed to the outbound departure and return arrival time preferences, rather than to arrival and departure time preferences at the recreation destination.

Demand Near Urban Areas: On a 2-day weekend (60 hours beginning at noon Friday and ending at midnight Sunday) only about 16 percent of recreational trips are of the overnight variety. However, it is these trips that contribute to the Friday afternoon peak. Forty-three percent of the weekend overnight trips depart from the residence between 4:00 and 7:00 p.m. From a population center of one million, about 13,700 trips are indicated in the 3-hour period. Commuter and other demands normally peak during these hours of any weekday, when it is typical to count about 22 percent of the weekday ADT. On a 3-day weekend, the Friday afternoon demand is enlarged because there are 30 percent more overnight trips, and 46 percent of them begin between 4:00 and 7:00 p.m. Over 19,000 overnight trips depart during these hours from an area with a population of one million.

Recreational traffic should not constitute a problem in urban areas on Saturday. There are concentrations of departures in both morning and afternoon, as well as of returns in the afternoon and evening. However, the peaks are broad and should not constitute a problem because they occur in conjunction with the reduced nonrecreational demands on Saturday.

On a 2-day weekend, most of 1-day duration or less trips are made on Sunday. The most serious outbound concentrations come on Sunday afternoon and may create problems on highways to nearby water recreation areas. However, the short recreational trips help create the greatest problem on a 2-day weekend when they return Sunday evening during the same time period as inbound arrivals from overnight trips. As a result, 49 percent of all recreational trips on a 2-day weekend return (arrive at normal residence) between 5:00 and 8:00 p.m. Another large fraction of overnight trips arrives between 8:00 and 10:00 p.m. Consequently, an urban area with major through or bypass highways must handle its own arrivals in the 5:00 to 8:00 p.m. interval plus sizable numbers of recreational through-trips that are still 1 to 2 hours from their destinations (normal residences).

Except for the Friday peak, available data indicate that a 3-day weekend should generate smaller peak demands near urban areas than a 2-day weekend.

Demand Near Recreational Areas: The most serious peaking of traffic demands should occur near recreational areas that receive most of their patronage from one population center or from several population centers from which travel times are equal. The peaks will correspond to but be offset from the outbound (from residence) departure peaks and inbound arrival times.

Particularly large demands will occur Sunday afternoons near and in areas with water recreation facilities that are less than 4 hours of travel from large population centers. The demands will be even more extreme when travel times are less than 1 hour.

Implications for the Rural Highway System: Part of the recreational traffic in the Friday peak will use major highway elements to other population centers or to links connecting to recreational areas. This demand should not constitute a serious problem beyond the typical commuting range, although the peak may be detectable at a large distance.

A more serious problem is likely on low capacity links that provide the most direct or timely access to recreational areas from large urban centers. These same links, especially those to water facilities, are likely to have peak demands on Sunday afternoons and evenings of 2-day weekends. Special problems in the rural areas may occur on common links to a recreational area from several large population centers that have equal travel times from the area.

III. RECREATIONAL TRAVEL TRENDS AND PROJECTIONS

The measurement of vehicular travel by trip purpose is essentially nonexistant. In previous years many states made origin-destination surveys, but such surveys are incredibly expensive on a state-wide basis, so are usually not conducted now except at specific locations for special reasons. Thus, the determination of the national extent of travel for recreational purposes is difficult, and must be approached from a variety of directions. This chapter considers three techniques--use of automatic traffic recorders on routes considered to carry primarily recreational traffic use of visitation data to recreational resources; and application of household survey data on travel habits.

Conceivably, other sources or approaches of estimating recreational travel could be used, as well. For example, state motor vehicle registrations might be considered as an indicator through increases in RV registrations. Unfortunately, most states do not differentiate between, for example, RVs built on a truck chassis and other vehicles built on similar chassis--both are trucks. Likewise, most states register pick-up campers just as they register pick-up trucks without the attached camper. Moreover, travel trailers are typically registered no differently than any other type of trailer of the same weight class.* Thus, state motor vehicle registrations are not useable for estimating travel trends.

In much the same way, state classification counts are also of little use for this purpose. Most states still use as categories, automobiles, buses, and trucks (broken down by weight or configuration). Some recognize trailers, others do not. Further, most of such counts are conducted on weekdays, whereas recreational travel is more concentrated on weekends. Even if classification counts were conducted throughout the 7-day week, and RVs were suitably categorized, such counts still would not detect normal automobiles being used for recreational travel.

Finally, state or national agencies could conceivably collect and apply suitable data to document recreational travel trends or make projections. We know of no such projections, and of no state-reported trends. Some survey data of a national character are available, and discussed later in this chapter.

* This subject will be dealt with more completely in a forthcoming report.

A. Traffic Volumes on Recreational Routes

This section deals with travel trends and projections based upon traffic counts on selected recreational routes. The data were provided through the courtesy of the Federal Highway Administration, Office of Highway Planning, and consist of historical traffic counts from "permanent" traffic recorders on selected routes.

Data from four states were included in this analysis. The states, and the routes therein, are listed below:

Delaware

Route U.S. 113 (Station D), north of Milford

Route U.S. 113 (Station J), south of Georgetown

Route DE 14 (Station R), north of Rehoboth

Route I-295 (Delaware Memorial Bridge), southeast of Wilmington

Kansas

Route U.S. 24 (Station 1-081), north of Manhattan

Route I-70 (Station 2-027), north of Wilson

Route I-70 (Station 3-098), west of Wakeeney

Route U.S. 77 (Station 5-018), north of Arkansas City

Minnesota

Highway 53 (Station 164), south of Eveleth

Highway 10 (Station 187), north of Rice

Highway 169 (Station 204), south of Onamia

Highway 71 (Station 210), north of Blackduck

Montana

Route U.S. 93 (Station A-8), south of Ravalli

Route I-15/U.S. 89 (Station A-9), west of Great Falls

Route U.S. 191 (Station A-19), north of West Yellowstone

Route U.S. 89 (Station A-20), north of Gardnier

Route I-90 (Station A-30), west of Superior Interchange

Traffic count data were available on most of these routes for every year since 1965 or 1966. They are summarized in Table 1. From these data, the growth trends were calculated for 2-year, 5-year, and 10-year periods. These trends can best be summarized as shown in Figure 1. Each point shown is the cumulative average annual daily traffic for the 15 of the 17 routes for which counts were available for every year between 1967 and 1975. The growth trend is remarkedly steady and consistent from year to year, with the exception of 1974, when the effects of the petroleum energy crisis caused a slight drop in aggregate travel on these routes. A great rebound occurred in 1975, however; the growth from 1974 to 1975 was greater, in percentage, than in any other year. With the exception of 1974-1975, the trend in the growth of traffic on these recreational travel routes is very nearly 5-1/2 percent per year (see Figure 1).

Differences in growth among the four states were noted. Over the last 10 years, the average annual daily traffic on the selected recreational routes in Minnesota and in Montana grew at a lower than average rate. The growth was above average in Delaware, and very must above average in Kansas (about twice the average growth rate). The trends over just the last 5 years were very similar, with Minnesota and Montana below average and Delaware and Kansas above average. Looking at just the last 2 years, when the energy crisis had its major impact, yields some suggestion as to the regional impacts on recreational travel. For these 2 years, recreational travel continued to grow on nearly all the routes examined, although the growth was greatest in Delaware and Montana, whereas it was below average in Kansas and Minnesota.

The trends reflected in the analysis of traffic counts can be used to project future recreational traffic. Using the 5-1/2 percent compounded growth rate suggested by Figure 1 yields a 1990 volume that is 2.2 times the 1975 level.

B. Visitation Data

The vehicle count data discussed above suffer from two major defects as indicators of recreational travel. First, even though they were taken on routes considered as serving primarily recreational traffic, the counts also include trips made for other purposes, and the amount of their contribution is unknown. Secondly, although they generally measure travel (ADT and section length) they do not distinguish between two vehicles, one of which may have traveled 10 miles and the other 1,000 miles. Further, changes in the distribution of trip lengths would not be apparent, if total ADT by the station remained constant.*

* This problem is greatly minimized in national counting programs, where a great network of counting stations is used. However, the ability to distinguish trip purpose is lost where all stations are aggregated.

TABLE 1

CHANGE IN ADT FOR RECREATIONAL ROUTES

State	Route	Station	ADT 1965	ADT 1970	ADT 1973	ADT 1975	Percent Change in ADT 1965-1975	Percent Change in ADT 1970-1975	Percent Change in ADT 1973-1975
Delaware	U.S. 113	D	8,606	11,859	14,425	13,259	+54.1	+11.8	- 8.1
	U.S. 113	J	NA	5,499	7,109	7,770	NA	+41.3	+ 9.3
	DE 14	R	8,866	12,792	16,628	16,960	+91.3	+32.6	+ 2.0
	I-295	Delaware Memorial Bridge	39,597	45,330	49,960	56,901	+43.7	+25.5	+13.9
Kansas	U.S. 24	1-081	2,056	2,400	2,820	2,592	+26.1	+ 8.0	- 8.1
	I-70	2-027	1,847	4,299	5,188	5,322	+188.1	+23.8	+ 2.6
	I-70	3-098	2,009	4,141	4,896	5,006	+149.2	+20.9	+ 2.3
	U.S. 77	5-018	2,559	3,183	4,740	4,826	+88.6	+51.6	+ 1.8
Minnesota	T.H. 53	164	3,191a/	3,905	5,060	5,784	+81.3a/	+48.1	+14.3
	T.H. 10	187	5,962a/	6,587	7,940	7,958	+33.5a/	+20.8	+ 0.2
	T.H. 169	204	3,044a/	3,482	3,886	3,765	+23.7a/	+ 8.1	- 3.1
	T.H. 71	210	510a/	569	667	644	+26.3a/	+13.2	- 3.5
Montana	U.S. 93	A-8	2,148	2,637	3,481	3,401	+58.3	+29.0	- 2.3
	I-15 & U.S. 89	A-9	4,029	4,496	4,858	5,115	+27.0	+13.8	+ 5.3
	U.S. 191	A-19	1,036a/	1,124	1,142	1,285	+24.0a/	+14.3	+12.5
	U.S. 89	A-20	564	666	715	731	+29.6	+ 9.8	+ 2.2
	I-90	A-30	1,669	2,130	2,962	3,069	+83.9	+44.1	+ 3.6

a/ 1966 data; 1965 not available.

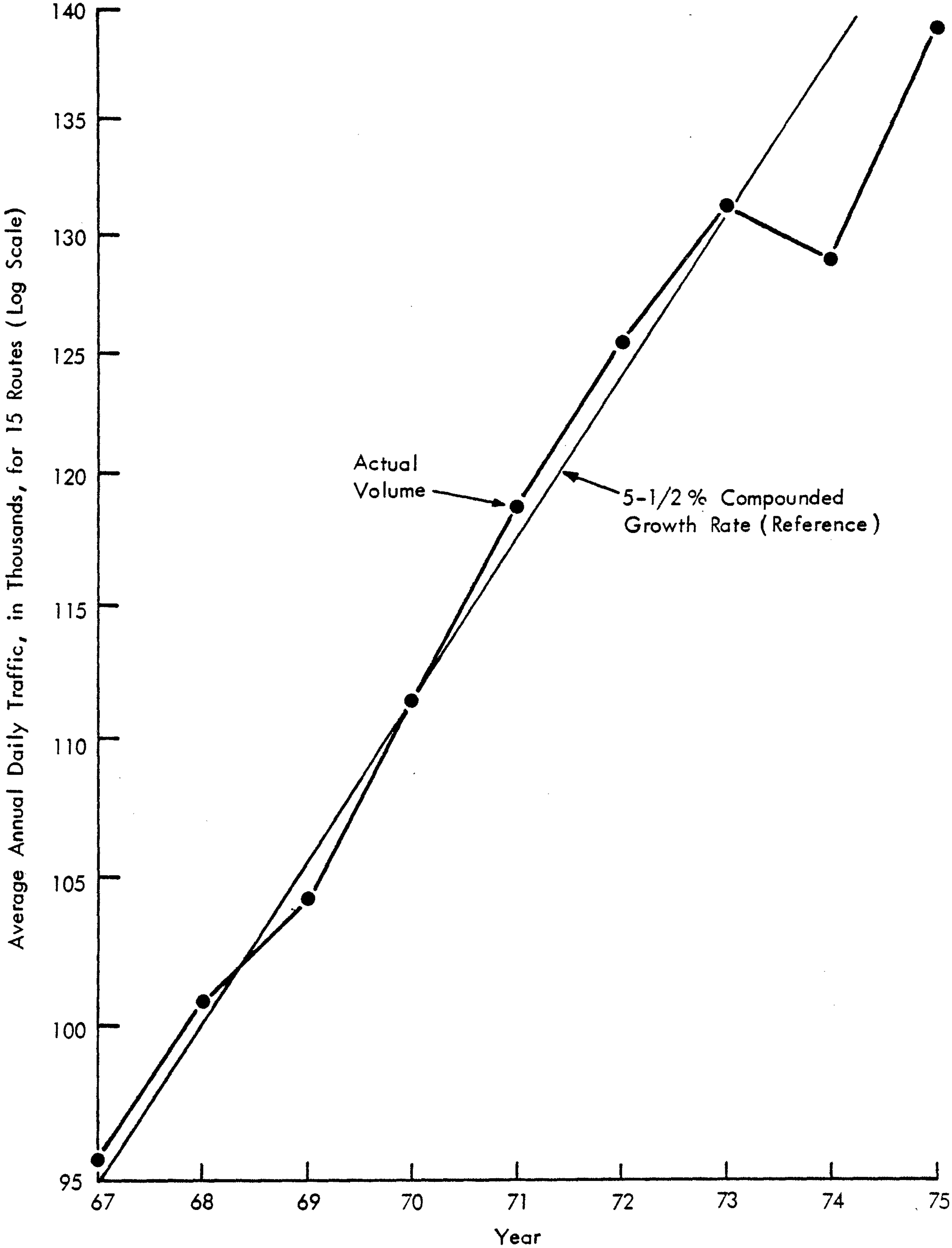

Figure 1 - Travel Trends on Recreational Routes

The first problem can be largely eliminated by locating traffic counters at the entrances to recreational areas. In effect, this is done in collecting "visitation" data, which show the number of visits to various recreational resources. Nevertheless, this method also lacks the ability of direct conversion into mileage--it is still a measure of "trips."

1. Trends in the Public Sector: A review of visitation data at recreation areas, including state parks and federal recreation areas administered by various government agencies, reinforces the general 25-year trend in recreation participation indicated in the Introduction. During this period, the recreation programs of these agencies have grown from incidental amenities to major programs providing outdoor recreation opportunities for millions of Americans. For example, the total attendance at state parks increased nearly fourfold between 1950 to 1975, growing from 114.2 million to 565.7 million. Since 1960, growth has been more than 118 percent, and for the shorter period 1967 to 1975, the increase has been nearly 45 percent (see Figure 2).10/

Without question, the growth in the number of visits to federally administered recreation areas has been phenomenal. Between 1950 to 1975, recorded visits to the national forests, national parks and national wildlife refuges increased more than 600 percent, while attendance at Corps of Engineers lakes increased by more than 2,250 percent (see Table 2).

Despite the energy crisis of 1973-1974, visits to most federally administered recreation areas continued to increase. In those areas where a decrease was recorded, the decline ranged from less than 1 percent at U.S. fish hatcheries, to 16 percent at Bureau of Land Management areas. In contrast, visitation increases ranged from 4.6 percent at TVA dams and steam plants, to 14.7 percent at Bureau of Reclamation projects during the same 2-year period.

From a previous MRI study for the U.S. Forest Service, we know there has been a significant regional shift in the number of visits made to state and federal recreation areas in the United States during the last 30 years (see Figure 3).11/ For example, in 1970, the Pacific Census Division* entertained the largest number of visitors, 227 million people.

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* The census divisions are as follows:

New England--ME, NH, VT, MA, CT, RI
Middle Atlantic--NY, PA, NJ
South Atlantic--MD, DE, WV, VA, NC, SC, GA, FL
East North Central--OH, MI, IN, WI, IL
East South Central--KY, TN, AL, MS
West North Central--MN, IA, MO, ND, SD, NE, KS
West South Central--AR, LA, OK, TX
Mountain--MT, WY, CO, NM, ID, UT, NV, AZ
Pacific--WA, OR, CA

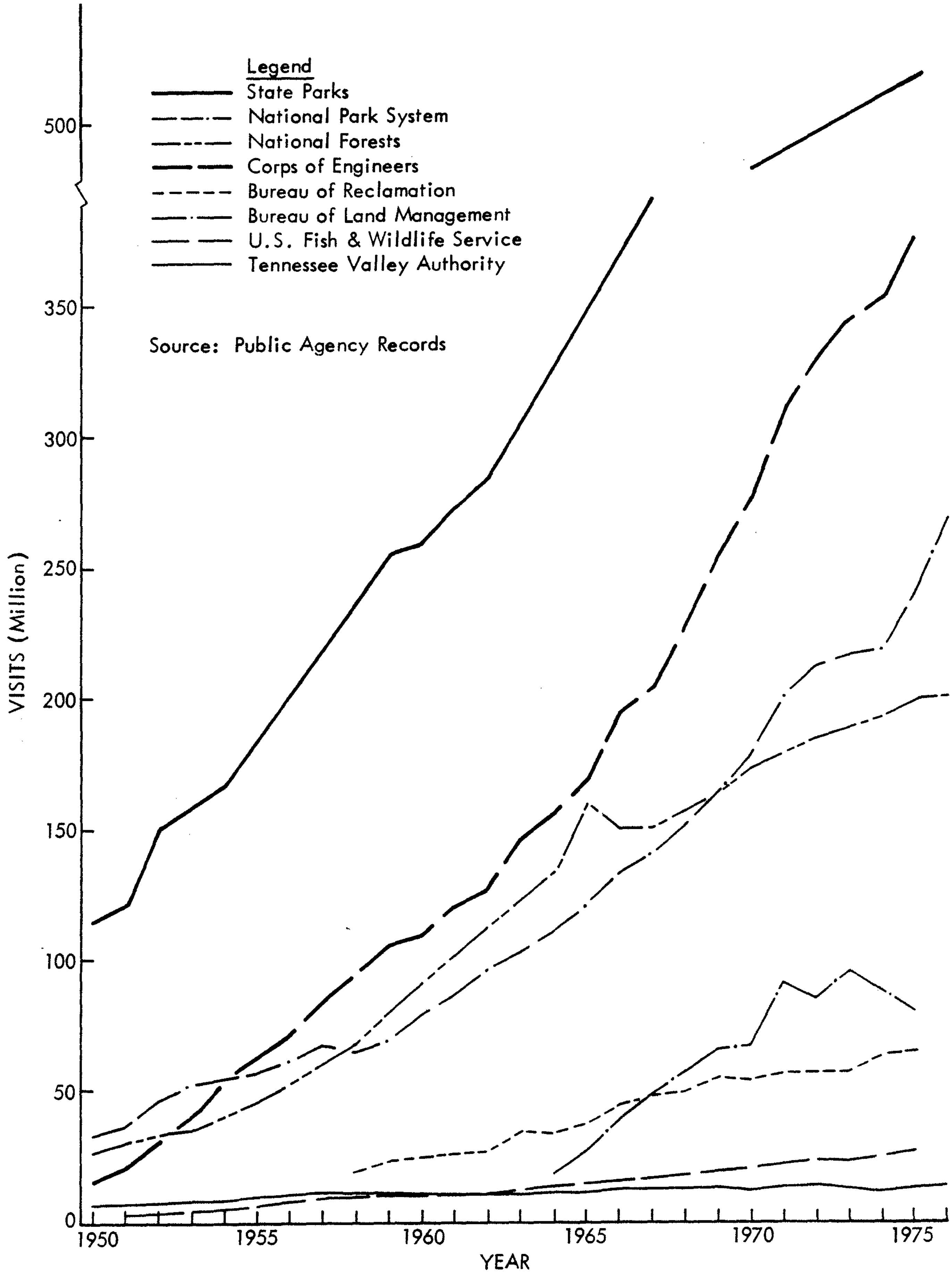


Figure 2 - Annual Visitation to Public Recreation Areas

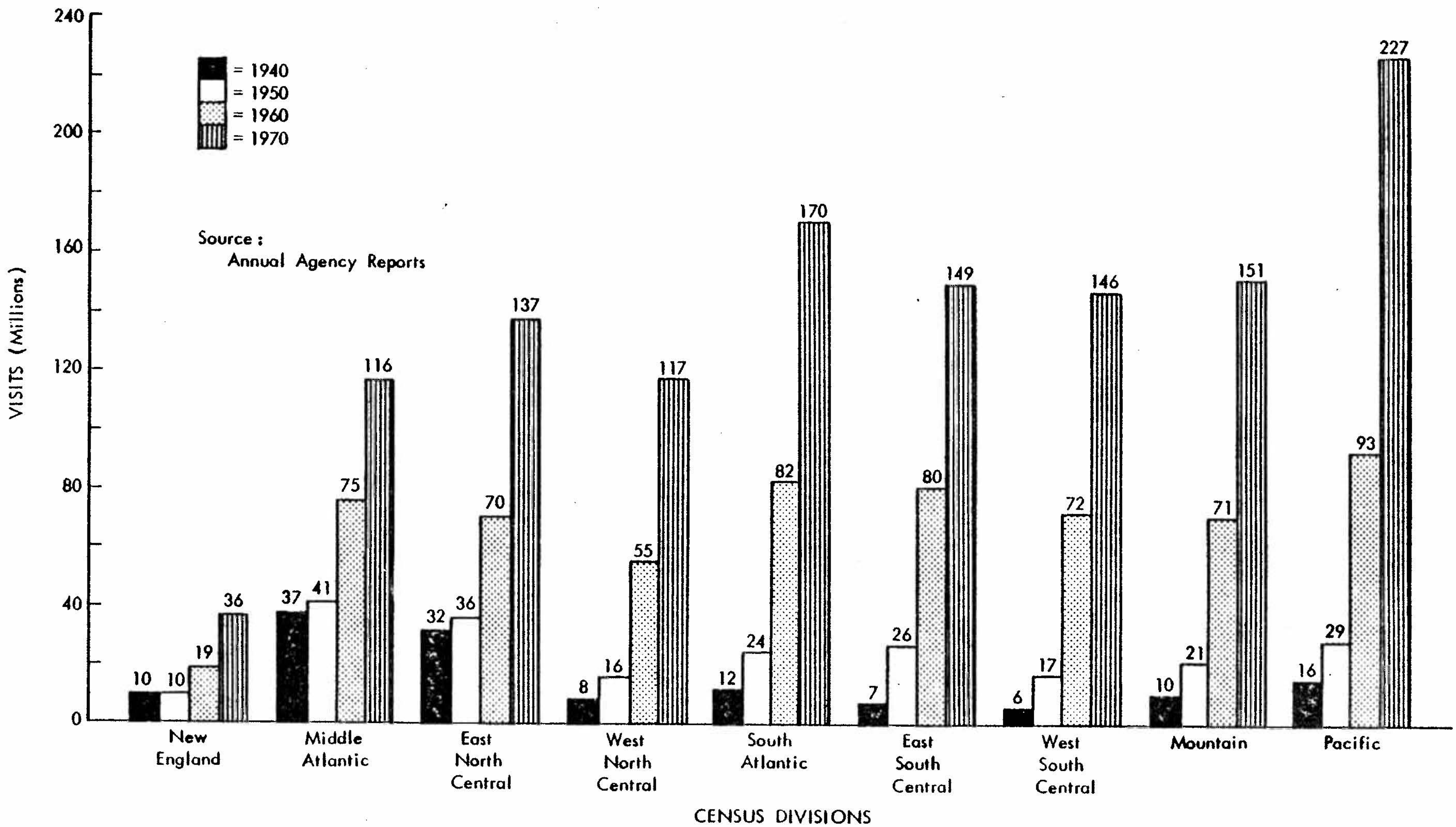


Figure 3 - Visitation to Federal and State Recreation Areas in the United States

Only 36 million people visited public recreation areas in the New England Division. The number of people visiting parks in all other census divisions ranged from 116 million for the Middle Atlantic to 170 million for the South Atlantic area. In the past 30 years (1940 to 1970) there has been less than a 400 percent increase in the number of visits to public areas in the New England, Middle Atlantic, and East North Central areas. All other regions have experienced rates of growth of more than 1,400 percent. The highest growth rates have occurred in the East South Central and West South Central census divisions. The number of visits to public areas in both of these divisions increased by more than 2,000 percent.

TABLE 2

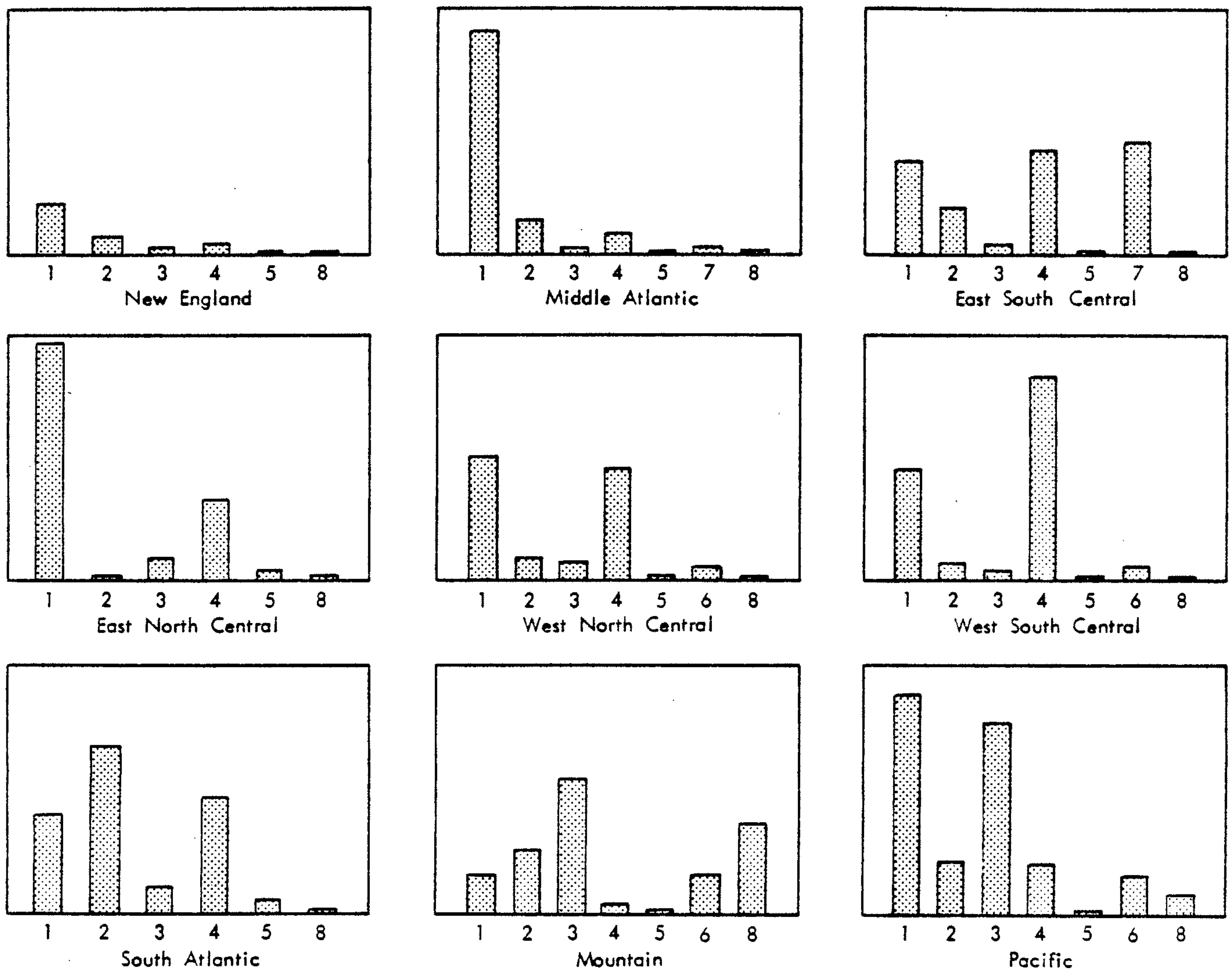
GROWTH IN RECREATION VISITATION TO FEDERALLY ADMINISTERED PROJECTS AND LANDS

	Visits or Attendance (percent change)		
	1950 to 1975	1960 to 1975	1967 to 1975
National Forests	627.8	115.1	33.1
National Parks	618.1	201.4	70.9
Corps of Engineers Lakes	2,250.0	244.9	84.3
Bureau of Land Management	NA	354.4[a]	63.8
National Wildlife Refuges	600.7[b]	124.4	69.8
Fish Hatcheries	NA	NA	34.9
TVA Dams and Steam Plants	110.4	29.2	10.2
Bureau of Reclamation Projects	NA	166.2	35.1

Source: Federal agencies administering projects and lands.
a/ 1964 to 1975
b/ 1951 to 1975

Since visitor statistics are influenced by the agencies providing the facilities, we also examined agency use on a regional basis. Figure 4 presents the relative regional visitation by public agencies (1970). State park departments in the New England, Middle Atlantic, and the East North Central areas are the most important recreation management agencies in terms of the number of visits entertained annually. Except in the Pacific Division, the states generally own the largest portion of public acreage in these areas. In terms of visitation, however, the state park departments are also important in the Pacific Census Division.

Corps of Engineers areas are important in the East North Central and West North Central, South Atlantic, East South Central, and West South Central divisions. Development of reservoirs in these areas has been particularly important during the last 30 years. New lakes in areas that had



LEGEND

1 - State Parks
2 - National Parks
3 - National Forests
4 - Corps of Engineers
5 - National Wildlife Refuges
6 - Bureau of Reclamation
7 - Tennessee Valley Authority
8 - Other Federal Agencies

Source: Annual Agency Reports

Figure 4 - Regional Importance of Public Recreation Management Agencies in the United States in 1970, by Number of Visits (No Scale; Levels are Relative)

few water recreation facilities have resulted in the Corps having the highest national rate of growth in visitation for the past 25 years. The Corps now ranks number one among federal agencies in the number of visits entertained annually.

Of course several regional organizations are also important. The Tennessee Valley Authority is an important agency in the East South Central area, and the Bureau of Reclamation entertains a large number of visitors in the Mountain Census Division.

Around three-fourths of the Forest Service acreage is located in the Mountain and Pacific census divisions. Forest Service lands have a great impact on recreation use in these areas. In fact, more than three-fourths of the total number of visitor-days at Forest Service areas occur in these two areas.* Nearly one-third of all visitor-days to Forest Service areas are accounted for in one state, California.

The National Park Service (NPS) entertained more than 267 million visitors in 1976. However, NPS areas are fairly well distributed across the country. As a result, Park Service areas have a major impact on total recreation visitation in only one census division, the South Atlantic. Several of the more important recreation areas in this division are the Blue Ridge Parkway, Colonial National Historical Park, Shenandoah National Park, and a number of Civil War battlefields.

The following discussion briefly describes the type of recreation programs administered by federal agencies, and the unique responsibility each agency has in providing recreation opportunities to the public.

a. <u>National Park Service</u>: The National Park Service, a bureau of the Department of the Interior, administers the national park system. The NPS is charged with conserving the scenery and the natural and historic objects and wildlife therein for the purpose of providing for the present enjoyment of these areas and at the same time leaving them unimpaired for the enjoyment of future generations.

The National Park Service currently administers 293 separate areas of different types, covering more than 31.2 million acres; these areas receive more than 267 million visits per year. Within the national park system are 25.8 million acres of natural areas, 4.9 million acres of recreation areas, and 540,000 acres of historical areas. The types of areas under the jurisdiction of the National Park Service include national parks, national monuments, national military parks, national battlefield parks and sites, national memorials and cemeteries, national capital parks, national historic sites and national recreation areas and parkways.

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* A visitor-day is roughly equivalent to a visit.

b. <u>Forest Service</u>: The United States Forest Service, administers the National Forest System, which includes more than 183.3 million acres in 154 different national forests in 42 states, Puerto Rico, and the Virgin Islands. Because of its nature, much of the system has high outdoor recreation value. The concepts of resource conservation, multiple use, and decentralized administration are the foundation of Forest Service policy. The national forests are used for many different outdoor recreation activities. The most common of these are pleasure driving and sightseeing. Other uses of national forests include hunting, fishing, camping, picnicking, skiing, hiking and riding, canoeing, resorts, summer homes, scenic roads, wilderness, and primitive areas. In 1976, more than 199 million visits were recorded at the national forests.

c. <u>The Corps of Engineers</u>: The Corps of Engineers, an integral part of the United States Army, constructs, maintains, and operates public parks and recreation facilities at reservoir areas as a part of multiple-purpose water projects. The various functions of the Corps of Engineers, provided by acts of Congress, are now carried out under a multiuse concept when compatible with the major project objective (i.e., flood control, navigation, hydroelectric power, etc.). The Corps has installed basic facilities for recreationists in areas including overlook stations for viewing the project, public sanitary facilities, parking areas, access roads, guard rails, fences, information signs, camping and picnicking facilities, and boat launching ramps. The recreation visits at Corps of Engineers projects were over 376 million in 1975.

d. <u>Bureau of Reclamation</u>: The Bureau of Reclamation, Department of Interior, constructs reservoirs for storage of water for irrigation, power, municipal and industrial developments, flood control, recreation, and fish and wildlife management. Bureau of Reclamation projects provide basic recreation facilities where possible, including access roads, parking areas, picnic areas, water supply, sanitation, and boat launching ramps. The National Park Service, by special agreement, cooperates with the Bureau of Reclamation in preparing plans for recreation development on Bureau projects. The Bureau also cooperates with the Bureau of Sport Fisheries and Wildlife in the planning of facilities to mitigate damages to, and for the enhancement of, fish and wildlife resources. When reservoirs are within national forest boundaries, the Bureau of Reclamation cooperates with the U.S. Forest Service in the development and operation of recreation facilities. It is the policy of the Bureau of Reclamation to transfer reservoir areas whenever possible to local, state, or other federal agencies for administration and further development of recreation resources. In 1975, the Bureau of Reclamation had constructed approximately 264 reservoirs with over 12,271 miles of shoreline; these areas supported over 64.7 million visits.

e. <u>Bureau of Land Management</u>: The Bureau of Land Management, Department of the Interior, manages those original public lands of the United States still under federal ownership which have not been set aside for other uses, such as national forests, etc. One-fifth of the nation's land (approximately 460 million acres) is under the jurisdiction of the Bureau of Land Management. These lands provide forage, fiber, and forests, water and wildlife, and space for outdoor recreation; the Bureau of Land Management seeks to balance usage in the public domain with the best interests of the public.

The recognition of recreation as a primary objective has resulted in the operation of a number of recreation areas on Bureau of Land Management lands including camping and picnicking sites, trailer space, swimming beaches, and boat launching ramps. Unusual national attractions have been identified on public domain lands including massive landslides, rare forest species, arcades, and other significant features. Visitor-days recorded on Bureau lands were approximately 79 million in 1975. Principal recreation activities on Bureau of Land Management lands include sightseeing, hunting, fishing, picnicking, and camping.

f. U.S. Fish and Wildlife Service: The U.S. Fish and Wildlife Service, Department of the Interior, is composed of the Bureau of Commercial Fisheries and the Bureau of Sport Fisheries and Wildlife (BSFW). The Bureau of Sport Fisheries and Wildlife is concerned with research and the production of fish and wildlife; they are also charged directly with protecting and regulating the hunting of migratory birds. The BSFW has numerous other functions relative to outdoor recreation. The responsibilities of the BSFW include the managing of federal wildlife refuges and fish hatcheries, and protecting rare and endangered species. While most of the BSFW activities relate to outdoor recreation, the fish hatcheries and wildlife refuges also constitute a substantial recreation resource. In 1975, 24.1 million visits were made to the nation's wildlife refuges, and more than 2.9 million persons visited the national fish hatcheries.

g. Tennessee Valley Authority: The Tennessee Valley Authority, a U.S. Government corporation, was developed on the concept that all the resources of a river basin are interrelated and should be developed under one unified plan for maximum effectiveness. The TVA built a system of multipurpose dams with the primary purposes of flood control, navigation, and electric power production. While the original TVA act made no specific reference to recreation, the planning and development of recreation and scenic potential have received consideration since the beginning of the TVA projects. The lakes created under the TVA cover a half-million acres and have shorelines totaling over 10,000 miles. These man-made lakes attracted 13.2 million recreation visitors in 1976.

Much of the popularity of the TVA projects can be attributed to the fact that they combine scenic beauty with water resources. They also offer a climate suitable to outdoor recreation during most of the year, and are within 2 days of automobile travel to more than half the people in the United States.

While flood control, navigation, and power development remain TVA's primary purposes, recreation values have been given high priority by TVA board members. On the shores of the TVA lakes are state parks, county and municipal parks; privately-owned fishing camps, boat docks, resorts, and vacation homes have been built on lake front sites. Campsites and marinas have also been sold to private clubs and to service organizations such as the YMCA and the Boy Scouts.

The TVA owns and manages only one major recreation area. The "Land Between the Lakes" is located between Kentucky and Barkley lakes in Western Kentucky; it runs approximately 40 miles in length (5 to 10 miles wide) and contains 170,000 acres of TVA land. The Land Between the Lakes was created as a national demonstration area in outdoor recreation and environmental education. The area entertains approximately 2 million visits annually.

2. Trends in the Private Sector: Another indication of the impact of recreational travel on the nation's highways is demonstrated by the growth in campground facilities serving campers and recreational vehicle owners. The wave of of touring campers pouring down our highways has produced a new phenomenon in recent years, regional and national franchised campgrounds. The rapid growth of camping has made a dramatic impact on recreation areas and on the vehicular traffic patterns of highways linking campgrounds with camper's points of origin.

In 1972, camping was predicted to become one of the fastest growing recreation markets in the mid- and late 1970's.12/ Total activity days of camping is the best market indicator for campgrounds, and the high growth rate in camping was projected to continue into the early 1980's. Furthermore, most of the camping equipment growth has been taking place in the motorized or recreation vehicle segment of camping so that demands for campground space should continue to grow.

It was estimated in 1973 that there were 17,000 to 19,000 campgrounds open and operating. Of these, about 7,000 were public and 10,000 to 12,000 were privately owned.13/ Since the future expansion of public campgrounds is expected to be relatively slow due to resource shortage, conservation policies, and budget restrictions, the bulk of the future growth in demand will probably be met by the private sector. Thus, it was estimated that demand for private campgrounds could easily achieve a growth rate of around 15 to 18 percent per year through the rest of the decade.

Growth has been maintained despite the energy crisis and the economic recession recorded in the last 2 years. According to representatives at Kampground of America (KOA), campground usage in the United States grew about 20 percent between 1972 to 1973.14/ With the energy crisis, there was a reduction of only about 5 percent in camper nights in 1974. The 1975 growth has been 19 percent greater than the 1974 figure, and in 1976, campground usage grew more than 15 percent above the 1975 figure.

The impact of the 1974 recession, however, was sufficient to cause many small franchises to go out of business, and the larger ones recorded a reduction in their annual growth rate. For example, KOA had a backlog of people waiting for franchises in 1973, and new franchises authorized totaled 172 in that year. By 1974, the combination of the energy crisis and economic recession had burst the expansion balloon, and only 20 new franchises were authorized. In 1975 and 1976, approximately 30 and 60 franchises were authorized, respectively. Thus, it would appear that the recent recession has not appreciably changed the overall growth potential for camping and the development of campgrounds.

3. Recreation Activity Participation Trends:* Underlying the interest in travel and increasing utilization of public and private sector resources is the changing recreation activity participation patterns of the American public. Numerous studies have discussed the association between participation and social and economic factors. Clawson and Knetsch feel that the four factors having the greatest effect on the demand for outdoor recreation are: growth in our population, the availability of leisure or free time, the increasing mobility in our modern society, and the disposable income people have to spend for outdoor recreation.15/

Other population factors such as age, sex, and race also affect participation. Young people tend to participate in active sports, while older individuals are interested in more passive activities. Women tend to participate less in the more aggressive and active types of sports than men. Also, racial and ethnic groups often have their own activities that are greatly influenced by culture and background. As the internal structure of our population changes, these various factors will have an impact on the type of recreation activities that will be pursued.

Leisure time and the 4-day workweek have received a great deal of publicity during the last few years. Many feel that leisure is increasing and it will have a great impact on future outdoor recreation participation. Indeed, the 4-day workweek enables people to have one more day to do as they please. But there are also problems associated with implementing the concept on a massive societywide basis. At least one authority has said that, in fact, the average American has no more free time than his great grandfather had 100 years ago.16/Whatever the case, recreation specialists generally agree that the size of blocks of leisure time and their timing have an important bearing on participation. Since our society appears to be headed toward longer weekends, the impact on recreation sites near metropolitan areas could be substantial.

Total personal income also has an effect on the quantity and types of outdoor recreation that are pursued. During the last 50 years, recreation expenditures have steadily increased as a percentage of total personal consumption expenditures. According to Department of Commerce

* Recreational vehicle travel as a contributor to this participation is discussed in the next chapter.

figures, expenditures in the "recreation" category have grown from approximately 3 percent of total personal consumption expenditures in the 1920's to over 6 percent at the present time. Since total aggregate personal consumption expenditures have also increased significantly during this period, both in current and constant dollars, total recreation expenditures have grown at a considerably higher rate than total personal consumption expenditures. Moreover, Department of Commerce figures for recreation spending do not include many elements of spending that are specific to leisure and recreation. Some research data developed recently indicate that leisure-specific expenditures had reached just slightly under 10 percent of total personal consumption expenditures by 1973.17/

Jensen discusses several other factors having an effect on outdoor recreation participation.18/ He believes that the ugliness and congestion of urbanization is driving people to rural areas for recreation. Jensen also feels that modern automation and technology has an impact on what people do in their spare time. Since many are tied to desks or employed in repetitive, trivial types of work activities, their outdoor leisure time gives them an opportunity for creativity. Better education also enables people to have a deeper appreciation for nature and history. These and other social changes have caused our nation to move from:

> "--feudalism, based on a stable agricultural society, through industrialism, based on a system of mass production, to a highly livable era characterized by freely disposable time and materials."18/

The social and economic factors listed above are only some of the complex variables influencing participation in outdoor recreation and the resultant travel patterns.

There have been only four major surveys of recreation participation conducted at the national level. Table 3 presents a comparison of annual per capita participation rates for similar types of recreation activities. Recognizing that each survey was conducted by different personnel utilizing unique research techniques and definitions, these data nevertheless show dramatic increases in participation for several recreation activities related to recreational travel. These activities include:

- Driving
- Camping
- Water-related activities (boating, water skiing, and fishing).

In general, recreation activities have become more important to the average American citizen during the past 10 to 15 years.

TABLE 3

RECREATION PARTICIPATION TRENDS 1960 to 1972[d/]

Activity	1960[a/]	1965[b/]	1970[c/]	1971/72[b/]
	(annual per capita participation)			
Attend Outdoor Concerts, Drama, Sports Events, etc.	4.0	5.5	3.6	13.0
Bicycling	5.1	9.5	6.6	16.9
Boating	1.9	2.5	2.5	3.3
Camping	0.9	1.3	2.3	2.1
Driving for Pleasure	20.7	20.7	--	27.2
Fishing	4.2	6.9	3.3	6.8
Horseback Riding	1.3	1.6	1.1	2.1
Picnicking	3.5	5.3	3.0	8.9
Playing Outdoor Games	12.7	23.3	12.2	25.6
Sightseeing	5.9	8.7	--	6.8
Swimming	6.5	8.6	9.0	6.3
Walking for Pleasure	17.9	30.2	11.2	23.4
Water Skiing	0.4	0.6	--	1.1

a/ Outdoor Recreation Resources Review Commission.

b/ U.S. Department of Interior, Bureau of Outdoor Recreation.

c/ Midwest Research Institute.

d/ Differing survey techniques and definitions preclude any but qualitative year-to-year comparisons.

4. Recreation Behavior During Recessions and Shortages: In view of the many uncertainties and questions about future economic growth and resource availability, we concluded several years ago that it would be important to test the response of recreation behavior to periods of economic uncertainty. Accordingly, we have made special studies of leisure and recreation behavior during periods of recession and during the recent "fuel crisis":

a. Recession: The percentage of total personal consumption expenditures (PCE) directed to the recreation category, as measured by the Department of Commerce, has grown steadily since 1955. As shown in Table 4, no major decline in the recreation percentage of total personal consumption expenditures was recorded in any of the recessionary years of 1958, 1970-71, and 1974-75. This behavior pattern clearly refutes the conventional wisdom that recreation expenditures are "discretionary," as opposed to "necessity," and therefore subject to deferment during periods of economic adversity. Since real (constant dollar) personal consumption expenditures declined in a few recessionary years, real expenditures for recreation also declined slightly, but nowhere near as much as would be expected from the conventional construct.

TABLE 4

PCE AND RECREATION EXPENDITURES

Year	Constant-Dollar PCE (billions)	Constant-Dollar Recreation Expenditures (billions)	Recreation as a Percent of PCE (%)
1956	281.4	14.84	5.3
1957	288.2	15.30	5.3
1958	290.1	16.70	5.4
1959	307.3	16.90	5.5
1960	316.1	17.60	5.6
1968	452.7	28.90	6.3
1969	469.1	29.88	6.4
1970	477.0	31.44	6.6
1971	495.4	31.99	6.3
1972	524.6	34.82	6.6
1973	551.9	35.83	6.5
1974	545.7	37.11	6.8
1975	553.8	37.66	6.8

Source: U.S. Department of Commerce.

Although total consumer expenditures for recreation held up with remarkable strength during periods of recession, there were significant differences among the various components of recreation expenditures. Expenditures for durable sporting goods, television sets and home entertainment products, and foreign travel tended to drop during recessionary periods and recover sharply 1 to 2 years later; by contrast, expenditures for most of the nondurable goods and service components remained relatively constant, and a few were even countercyclical.

This evidence suggests two hypotheses that might explain consumer recreation behavior during recessionary periods:

. Price Substitution: It is possible to maintain normal levels of recreation participation at lower-than-normal price levels for virtually any recreation activity. The price of participation for many recreation activities is normal, under any circumstances, and almost none of the major outdoor recreation activities can be associated with a fixed price. Thus, for example, a game of golf at a lavish overseas resort might cost as much as $50, while a game at a typical small-town municipal course is just $1 or $2. Thus, a golfer could maintain his traditional rate of participation during periods of economic difficulty simply by shifting to lower priced facilities. Similar price substitutions are available for almost all outdoor recreation activities.

. Deferral of Major Purchases: Another way to maintain traditional participation rates at a reduced cash outlay is to defer or delay normal big-ticket purchases and/or expensive maintenance. Thus, such major durables as recreation vehicles, boats, and television sets can be retained and used a year or two past the normal trade-in date during economically bad times.

On the basis of available evidence, we conclude that the concept of recreation as "things to be done if there is enough money left over after necessities" is no longer valid, if indeed it ever was valid in the first place. Recreation is obviously considered an integral part of life by nearly all American families, and they treat recreation participation and recreation expenditures during periods of economic stress in the same way they treat expenditures for necessities: major purchases are deferred, and lower priced goods and services are substituted for higher priced counterparts; thus, basic participation rates remain as close as possible to normal levels.

b. Fuel Shortage: Consumer recreation behavior in response to the fuel crisis of 1973-74 and the subsequent sharp gasoline price hike was in many ways similar to the response to recessionary years. During the few months when actual severe physical shortages occurred, recreation participation and vacation driving did, in fact, decrease drastically. As soon as the acute shortages were over, however, participation headed right back toward precrisis levels, despite the rapid increases in gasoline price. As a result, the impact of the changing supply/demand price relationship for gasoline and other petroleum fuels has had much less impact on recreation behavior than many individuals predicted. For example, as discussed further in Section IV, sales of recreational vehicles suffered only a temporary setback, and by 1976 reached an all-time peak.

This conclusion is also supported by the previously presented data on attendance at major recreation resources. At worst, aggregate attendance at the four most important resource classes (state parks, national parks, national forests, and Corps of Engineers facilities) showed a slight decline in growth rate during the 1973-74 period, but no overall decline.

We expect, within these aggregate totals, that there was travel distance substitution comparable with the price substitution noticed in recreation expenditures. For example, it is obvious, just on the basis of location, that the majority of visitors to Yellowstone and Carlsbad Cavern national parks originate in metropolitan areas that are quite far away. By contrast, it is known that most of the visitors to Yosemite National Park are residents of nearby metropolitan areas in California. [19] The data in Table 5 clearly support the distance substitution hypothesis; while Yellowstone and Carlsbad Cavern parks shared visitation declines in 1974, Yosemite visitation held up quite well.

TABLE 5

VISITATION TO SELECTED NATIONAL PARKS: 1972-1975
(thousands of visitors)

Park	1972	1973	1974	1975
Yellowstone	2,237	2,062	1,929	2,240
Carlsbad Caverns	856	840	672	790
Yosemite	2,190	2,254	2,274	2,537

Source: National Park Service

The conclusion regarding behavior during periods of fuel shortage is similar to that regarding behavior during periods of economic crisis. Total aggregate participation generally remains at traditional levels; the effects of the economic disturbance are offset by price and distance substitutions. At least at current price levels, fuel conservation is apparently regarded as a collective but not an individual responsibility.

C. Travel Survey Findings

Most surveys yield data reflecting the status of travel at the time of the survey. Such data are not useful in showing trends or making projections unless repeated at intervals, or compared with other surveys that collected compatable data by similar techniques. Unfortunately, most surveys conducted in the last 20-25 years have been one-of-a kind. Perhaps the major exception is the 1976 National Travel Survey,[2] which closely followed the protocol of an earlier (1972) survey conducted by the U.S. Bureau of Census.[3] These surveys provide most of the findings in this section, but other key bits of data are also available. For example, a 1961 report[20] found that 35.3 percent of all vehicle mileage was for purposes of "social and recreation," with 43.0 percent associated with earning a living, 17.8 percent for family business, and 3.9 percent other. These data pertain to 1-year surveys conducted in 21 states during the period 1951-1958. A later study[1] covering 1969 and early 1970 yielded similar findings--that 22.4 percent of all trips, but 33.4 percent of all mileage, was in the category, social/recreational.

The two major surveys, however, provide a fair amount of detail. Appendix C contains much of the 1976 vis-a-vis 1972 findings regarding long-distance personal travel as measured in these surveys--round trips to destinations over 100 miles away. As such, this is predominately rural, inter-city travel and comes closest to yielding information useful to planners of rural facilities. Nevertheless, such travel comprises only a small part of the total (17 percent of all automobile travel21/).

The surveys covered all modes and purposes of personal travel, and presented results in terms of trips, person-trips, and person-miles. Table 6 contains selected findings from the surveys (some values are taken directly from the reports, others calculated from data therein). In the 4-year span between surveys, total mileage for such trips increased about 60 percent, due to a combination of more trips (up 50 percent) and a 7 percent increase in the average trip length.

TABLE 6

SELECTED TRAVEL STATISTICS

Quantity	1972	1976	Percent Increase
Total Person-Trips (millions)	458	706	54
Total Person-Miles (billions)	369	609	65
Persons per Trip	1.94	2.00	3
Total Trips (millions)	236	353	50
Total Miles (billions)	190	304	60
Average Miles per Trip	806	862	7
Person-Trips by Auto/Truck (%)	85.2	84.3	-1
Person-Miles by Auto/Truck (%)	69.4	71.0	2
Person-Trips to Visit Friends or Relatives (%)	38.4	35.8	-7
Person-Trips for Other Pleasure (%)	25.7	32.1	25
Person-Miles to Visit Friends or Relatives (%)	38.7	37.5	-3
Person-Miles for Other Pleasure (%)	24.4	32.2	32
Person-Trips for Recreation (%)	64.1	67.9	6
Person-Miles for Recreation (%)	63.1	69.7	10

Source: U.S. Travel Data Center.

The increase in total person-miles and total miles for 1972 to 1976 appears to be at the extreme high end of the likely estimates of such travel when compared against other sources. For example, the Bureau of the Census conducted a National Travel Survey in 1967 and 1972. The increase from 1967 to 1972 was 81 percent in total person trips but only 27 percent in total person-miles and for the same period FHWA found that total vehicle miles of travel increased 31 percent.

The Bureau of the Census is presently conducting the 1977 National Travel Survey and when available, these will provide travel data from a much larger sample (24,000 versus 6,000 household) and conducted by home interview versus telephone contact and mail interview by the U.S. Travel Data Center. Since intercity person-miles grew only 27 percent in the period of 1967 to 1972, a relatively high travel growth period in comparison with the 1972 to 1977 period it is highly probable that the Bureau of the Census survey will obtain 27 percent or less growth for the 1972 to 1977 period. However, the other relationships obtained of the U.S. Travel Data Center on trips by mode, trip purpose, and time period are considered as being very likely indicators of change.

The fraction of the trips utilizing autos (or trucks) declined very slightly (1 percent) although the mileage increased somewhat (2 percent), indicating that this mode tended to show slightly more relative growth in mileage than the other modes.* Changes in trip purpose were much more dramatic, however. On the basis of person-trips, travel to visit friends and relatives declined 7 percent but travel for other pleasure increased 25 percent. The two categories combined, representing all social/recreational travel, increased 6 percent in person-trips. A similar, but more pronounced, growth is indicated by person-miles of travel, which increased 10 percent in the social/recreation category. Thus, although total (long distance) travel increased substantially in this 4-year period, social/recreational travel increased more than the rest of such travel.

Analysis of these and other statistics in Appendix C and the source documents enables estimates** of the changes by modality and purpose. The major result for the purpose of this study is that, for the 4-year period, social/recreational mileage increased 88 percent. Auto/truck mileage increased less rapidly, but:

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* Air, bus, rail, bicycle, motorcycle, and mixed mode.

** These estimates assume, for example, that the average occupancy for all trips to visit friends or relatives (2.33 persons in 1976) is applicable to the auto/truck trips for this purpose (which comprised 89.1 percent of the total person-trips). Access to the original data sets would enable extraction of more precise estimates.

Increased Auto/Truck Mileage for Recreation = 80.1 percent.

Increased Auto/Truck Mileage for Other Purposes = 11.7 percent.

Stated differently, total auto/truck mileage on long trips for purposes of recreation increased at a rate of about 16 percent annually, whereas other long distance auto/truck mileage increased less than 3 percent per year.

D. Recreational Travel Projections

Numerical data and other evidence cited in previous sections of this report are employed as a basis for estimating probable future U.S. recreation behavior. Let us first examine visitation projections.

1. Visitation to Recreation Resources: Data on visitation to various classes of recreation resources previously presented can be employed as input to mathematically derived projections of future attendance. In this analysis, we have confined the mathematical investigation to attendance at state parks, national parks, Corps of Engineers areas, and national forests, since these four classes of facilities account for over 88 percent of the total public sector recreation visits reported.* Employing annual visitation as the dependent variable in all cases, we developed both linear and logarithmic functions with the independent variables of time, total U.S. population, and total personal consumption expenditures, for both short-term (10 to 15 years) and long-term (20 to 30 years) data series. Single rather than multiple regressions were employed to isolate the influence of each independent variable; moreover, multiple regression is not really useful for projections because the independent variables are all based on population forecasts.

Table 7 shows the historical and forecast data for the three independent variables employed in the regression analyses; Table 8 shows projected values for the dependent variables through 1990, developed from the best-fit regression analyses. The details are in Appendix D.

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* By and large, no official agency projections are available on a national basis. The Corps of Engineers and the National Park Service do not publish projections, and only make them as needed for specific projects (or parks). The U.S. Forest Service has recently begun to make projections of recreation use of national forests, in response to the Federal Recreation Planning Act.

TABLE 7

PROJECTED U.S. POPULATION AND TOTAL PERSONAL CONSUMPTION EXPENDITURES, 1975-2000

Year	Total Population (millions)[a]	Total Personal Consumption Expenditures: Millions of Current Dollars	Total Personal Consumption Expenditures: Millions of Constant 1972 Dollars
1975	213.0	973.2	770.3
1976	214.5	1,059	798.2
1980	220.2	1,401	869
1985	229.1	1,875	1,001
1990	237.4	2,395	1,141
2000	249.1	3,205	1,373

a/ Series II-X.
Sources: U.S. Department of Commerce.
Midwest Research Institute.

TABLE 8

RECREATION VISITATION PROJECTIONS, 1975-1990
(millions of visitors)

Resources	Equation[a]	Visitation: Actual 1975	Projected 1975	Projected 1980	Projected 1985	Projected 1990	Growth (%) 1975-1990
State Parks	1	565.7	568	644	737	825	46
Corps of Engineers	2	376.0	376	453	548	637	69
National Parks	3	238.8	239	304	408	537	125
	4	238.8	249	361	521	753	215
	5	238.8	242	291	351	408	71
National Forests	6	199.2	198	220	246	271	36

Sources: Base Year: National Recreation and Park Association
Corps of Engineers
National Park Service
U.S. Forest Service
a/ Projections: Midwest Research Institute, using equations in Appendix D.

Conventional wisdom would presumably indicate that the best correlations would be obtained either by logarithmic time correlations or linear population correlations. In fact, linear population correlations did provide the best fit in three of the four cases, and logarithmic time correlations provided the best fit with historical National Park Service data. It is somewhat surprising that logarithmic time correlations were comparatively poor for the other three resource classes; it is less surprising that logarithmic population provided reasonably good fits, since the growth in population is so slow that there is not a great deal of difference between linear and logarithmic relationships within the ranges of historical data.

Nevertheless, the results clearly illustrate the inherent fallacy of trying to develop a single most accurate forecast of future visitation, as opposed to various alternative projections of future visitations. In point of fact, actual levels of future visitation by 1990 will, to a large extent, depend on policies adopted by the resource management agencies, government officials concerned with transportation policy, private sector suppliers of recreation goods and services, and individual consumers. In this context, a projection derived from a curve that fits historic data perfectly, with R^2 equal to 1.00, would be no more "accurate" than a projection derived by some other technique. Moreover, significant variances among future projected values can be developed out of curves with equally good historical data fits, depending on whether a linear of logarithmic representation is chosen by the analyst.

Thus, state park visitations are projected to increase about 46 percent over this 15-year period, compared with increases of 69 percent and 37 percent for Corps of Engineers facilities and National Forests, respectively. National Park visitations proved more difficult to project, and quite different results were obtained using three equations that fit the existing data almost equally as well. However, using the third estimate (the most conservative and the one using the same equation form as used for the other resources--a linear projection based on population) yields a projected 71 percent increase. The combination of all four projections gives a net 55 percent increase in visitation, which represents an increase of 3 percent per year.

This projected visitation increase is, of course, considerably less than what might be expected if total miles traveled for recreation (5-1/2 percent per year--see Figure 1). Relatively little survey data are available upon which to base a projection--just the 1972 and 1976 surveys (two data points). Those data suggest a far higher growth rate--16 percent per year (in long distance travel) if the trend continues. We tend not to believe this, and suggest that either the period 1972-1976 was not typical of future growth or, despite their precautions, the two surveys are not strictly comparable. Another survey is strongly recommended, perhaps in 1980. FHWA and others are sponsoring a combined NPTS and NTS in 1977 which should provide good data on travel growth from 1972 to 1977.

Finally, it is instructive to compare these projections with estimates of future total travel. The Federal Highway Administration recently predicted that, compared with an annual growth rate of 4.6 percent over the prior 20 years, growth from 1975 to 1990 would be at a rate of 2 to 3 percent per year. Some states have also made statewide projections, Indiana, for example, anticipates only a 1.8 percent per year growth through 1995.[22/] Comparing total projections with recreational travel projections suggests that the latter will grow much more rapidly than will travel for other purposes.

IV. RECREATIONAL VEHICLE OWNERSHIP AND USE TRENDS AND PROJECTIONS

A. Trends in Recreation Equipment Ownership

1. Recreational Vehicles: The production of recreational vehicles (RVs) and components has climbed steadily since 1961 when first records were kept by the Recreation Vehicle Association, except for the industry nose dive during the energy crisis and economic recession of 1973-1975. After a record sales year in 1972, production of motor homes, travel and camping trailers, truck campers, and other recreational vehicles fell sharply during the energy shortage. In that bleak period, sales slumped and several manufacturers were forced to close their doors. By 1975, the short-term industry crisis had been reversed, and production has been rising steadily since (see Table 9).

The recreational vehicle industry produces five major recreational vehicles or components including travel trailers, truck campers, camping trailers, motor homes, and pickup covers. Sales of RV units have exceeded $1 billion each year since 1969 and reached a record $4.2 billion in 1976. An important trend in the 1976 sales figures is the large increase in the sale of motor homes and travel trailers. These units represent the top of the RV line in terms of cost, with average retail prices in excess of $10,000 to $11,000 for motor homes and $3,400 to $4,000 for travel trailers.

While total production of RVs has increased steadily in most cases during the period of record, there has been a shift in the makeup of production among various types of vehicles produced. Historically, the production of travel trailers dominated the industry. However, 1976 production figures indicate that the production of motor homes has become the leader, followed by pickup covers. Motor home production has been spurred by the public's continued acceptance of large motor homes and the growing interest in "mini" motor homes, a recent addition to manufacturers' lines. The interest of the motoring public in van conversion is another reason for the growth of motor homes. These vans are replacing a lot of station wagons, according to Thomas H. Corson, Chairman, Coachmen Industries, Inc.

The only decline is in truck campers, which are losing sales to the mini-motor home. In addition to being less expensive than truck campers, according to RVIA spokesmen, the small motor home is more convenient since the driver can climb into the back of the unit without getting out of the vehicle.[23]

Representatives of the RV industry forecast that through 1980, recreational vehicle sales of all types will increase, though at slowing rates: 13 percent in 1977, 8 percent in 1978, 7 percent in 1979, and 7 percent in 1980.[24] However, RV sales other than pickup covers are forecasted to increase more rapidly, at 17 percent in 1977, 14 percent in 1978, and averaging 10 percent per year for 1979-1981.

TABLE 9

RECREATIONAL VEHICLE SHIPMENT AND RETAIL SALES TRENDS 1961 TO 1976

Year	Total Sales (thousands)	Units Produced and Shipped					
		Travel Trailers	Truck Campers	Camping Trailers	Motor Homes	Pickup Covers	Total Production
1961	87,040	28,800	15,800	18,000	--	--	62,600
1962	112,033	40,600	16,700	23,000	--	--	80,300
1963	156,478	51,500	26,800	40,300	--	--	118,600
1964	198,535	64,200	34,800	52,000	-- b/	--	151,000
1965	308,236	76,600	44,300	67,220	4,710	--	192,830
1966	370,781	87,300	54,500	72,300	5,710	--	219,810
1967	446,441	94,500	61,600	79,280	9,050	-- a/	244,430
1968	791,790	115,200	79,500	125,200	13,200	150,000	483,100
1969	1,077,037	144,000	92,500	141,000	23,100	113,500	514,100
1970	1,149,924	138,000	95,900	116,100	30,300	91,700	472,000
1971	1,629,483	190,800	107,200	95,800	57,200	98,400	549,400
1972	2,364,909	250,800	105,100	110,200	116,800	164,600	747,500
1973	2,322,407	212,300	89,800	97,700	129,000	223,700	752,500
1974	1,392,092	126,300	45,400	55,200	68,900	233,400	529,200
1975	2,320,000	150,600	44,300	48,100	96,600	212,500	552,100
1976	4,283,873	189,700	42,000	53,300	256,100	215,200	756,300

Source: Recreation Vehicle Industry Association and Recreational Vehicle Institute; various industry sources for years before 1968, compiled by Recreational Vehicle Institute.

a/ Data for pickup covers not available prior to 1968.

b/ Data for motor homes not available prior to 1965.

2. Boats: Boating is also an important recreation activity. It impacts on recreational travel both because of travel to and from marinas, lakes, and rivers, but also because of the common practice of towing the boat on a trailer to and from the boating location. An estimated 50.5 million persons participate in recreation boating, making use of waterways more than once or twice during 1976. There are a total of 10,105,000 recreation boats on all waterways in the United States (see Table 10).

TABLE 10

NUMBER OF RECREATION BOATS BY TYPE-1976

Type	Number
Inboard motor boats	900,000
Outboard boats	5,900,000
Sailboats	825,000
Rowboats, canoes, etc.	2,480,000
Total	10,105,000

Source: National Association of Engine and Boat Manufacturers.

Sales in 1974-75 of gasoline outboard motors, outboard boats and boat trailers appear to have been influenced by the recent energy crisis and economic recession, but to a lesser degree than recreational vehicles. However, in 1976 this trend was reversed and sales exceeded 1975 figures (see Table 11).

A significant trend in boating has been the increase in the average horsepower of motors sold since 1950. During the 26-year span (1950-1976), the average horsepower of motors sold increased from 6.9 to 42.1 horsepower. Only during the energy crisis years did the average power of boat motors remain constant. In 1976, the horsepower of boat motors continued its historical climb, rising to 42.1 horsepower. These trends may indicate the public's desire for power driven boats exceeds its interest in energy conservation.

TABLE 11

ANNUAL VOLUME OF SALES FOR OUTBOARD BOATS, INBOARD/OUTDRIVE BOATS, MOTORS AND TRAILERS 1950 TO 1976

Year	Gasoline Outboard Motors, Owned (thousands)	Sales: Gasoline Outboard Motor Units (thousands)	Sales: Average Horsepower of Motors	Sales: Outboard Boats (thousands)	Sales: Inboard/ Outdrive Boats (thousands)	Sales: Boat Trailers (thousands)
1950	2,811	367	6.9	131	--	--
1951	3,010	284	8.9	154	--	--
1952	3,219	337	8.4	164	--	--
1953	3,419	463	9.0	231	--	--
1954	3,740	479	10.3	223	--	103
1955	4,210	515	12.9	258	--	129
1956	4,700	642	14.2	302	--	151
1957	5,040	550	16.3	320	--	165
1958	5,385	504	20.7	316	--	178
1959	5,650	540	23.7	329	--	186
1960	5,800	468	27.4	294	--	206
1961	6,100	343	29.9	237	--	178
1962	6,244	360	30.3	239	a/	160
1963	6,390	362	30.5	245	8	148
1964	6,564	390	30.3	250	12	130
1965	6,645	393	28.2	250	17	130
1966	6,784	440	29.9	266	32	153
1967	6,904	444	30.1	260	36	160
1968	6,988	500	31.5	283	42	200
1969	7,101	510	33.1	310	49	235
1970	7,215	430	31.0	276	43	213
1971	7,300	495	35.6	278	44	220
1972	7,400	535	38.1	375	63	265
1973	7,510	585	40.8	448	78	330
1974	7,595	545	40.5	425	70	325
1975	7,649	435	40.3	328	70	255
1976	7,700	468	42.1	341	80	285

Source: Boating, A Statistical Report on America's Top Family Sport (presented jointly by MAREX and NAEBM)
a/ Unit volume of outboard boats shipped prior to 1963 included inboard/outdrive units.

B. Economic and Social Profile of Recreational Vehicle Owners*

While there is no typical recreational vehicle owner, the majority of the recreational vehicles in the United States are owned by upper income families, with a mature head of household having some college education and engaged in a responsible position. A recent Woodall Publishing Company profile of recreational vehicle (RV) owners[25/] indicated that 68.9 percent of the RV owners have annual incomes exceeding $15,000, with 23.7 percent having annual incomes above $25,000. Similarly, 61.2 percent of the RV owners are either engaged in professional occupations or are retired; the largest proportion of RV owners (36.2 percent) are professional/executive managers, and 25.0 percent are retired. The Woodall Survey also indicated that 52.0 percent of RV's are owned by individuals having some college education, and that the largest proportion of owners are between 55 to 64 years of age (30.4 percent), with 90 percent of all RV owners being more than 35 years of age.

In 1976, RV owner profiles indicate a marked change from an earlier study of RV owners made in 1968.[26/] A comparison of the 1968 Woodall Survey and the 1976 survey indicates that a greater proportion of RV owners today are older and are in a higher income bracket than was recorded in the late 1960's.

In 1973, it was estimated all RVs were used to travel more than 16.9 billion miles (see Table 12) and were involved in the consumption of more than 2.0 billion gallons of gasoline that year. This is 2.65 percent of the total automobile fuel consumption in 1973.[28/] Of this total, nearly 1.8 billion gallons of gasoline were used by self-contained RV's for recreation purposes.[27/] Although travel trailers were involved in more total miles (nearly 7 billion in 1973), the average motor home was used over twice as much as the average travel trailer. The total mileage difference is obviously the result of the travel trailer dominating the RV industry up to that time.

The use patterns (distance traveled) by the various classes of RV owners are shown in Table 13. Over four-fifths of the annual use by travel trailer owners occurs within the 3,500-mile range, with over half of the trips in the 1,500- to 3,500-mile range. In contrast, over 90 percent of the motor home use is beyond the 3,000-mile range, with 27 percent in the 11,000- to 15,000-mile range. Truck camper travel patterns are similar to travel trailer patterns, and over four-fifths of the camping trailer use occurs within the 3,000-mile range. Clearly the motor home dominates long distance use; however, some of this use is no doubt nonrecreational travel. Also, large numbers of motor homes were recently purchased and the fleet age is much younger than that of travel trailers. New vehicles are driven much more in the first 2 years than later.

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* See Appendix B for detailed data.

TABLE 12

AVERAGE MILES TRAVELED AND FUEL BURNED PER YEAR BY RECREATIONAL VEHICLE TYPE, 1973

Type	Total Average Miles Traveled Per Year	Weighted Average Miles Traveled Per Year	Gasoline Consumption Per Year (million gallons)	
			Total	Recreation Purposes
Travel Trailer	6,807,600,000	3,660	811	811
Motor Homes	3,064,250,000	8,755	383	345
Camping Trailer	2,679,600,000	2,310	285	285
Truck Camper	4,355,400,000	4,894	581	349
Totals	16,906,850,000	19,619	2,060	1,790

Source: Robert R. Nathan Associates, Inc.

TABLE 13

AVERAGE MILES TRAVELED PER YEAR BY RECREATIONAL VEHICLE TYPE, 1973

Miles	Travel Trailer (Percent)	Motor Home (Percent)	Camping Trailer (Percent)	Truck Camper (Percent)
500 or less	11	1	16	4
500 to 1,500	19	1	39	18
1,500 to 3,000	33	7	28	22
3,000 to 3,500	20	19	11	18
3,500 to 7,000	9	18	6	12
7,000 to 9,000	--	21	--	13
9,000 to 11,000	5	6	--	2
11,000 to 15,000	3	27	--	11

Source: Robert R. Nathan Associates, Inc.

A more recent view of RV travel patterns is provided by the data in Table 14. In this table all classes of RVs are put into a single category. It is quite obvious that a large portion of the RV use is confined to short trips. For example, in 1976, 35 percent of the total vacation travel was under 1,000 miles per RV. Actually, nearly one-fifth (17.3 percent) of the RVs were used less than 100 miles that year. In contrast, an additional 35.3 percent of the RVs were used more than 3,000 miles in 1976, with 17.7 percent used more than 5,500 miles that year. These data provide one other important insight. During and after the energy crisis, there appears to have been little change in the overall travel patterns of RV owners.

TABLE 14

DISTRIBUTION BY TRIP LENGTH OF VACATION MILES TRAVELED IN RECREATIONAL VEHICLES, 1974 TO 1976

Miles Traveled	1974	1975	1976
1 to 100	15.98	12.21	17.34
101 to 200	1.59	3.18	1.76
201 to 300	3.01	2.65	1.41
301 to 400	1.77	1.95	0.88
401 to 500	3.37	3.36	4.07
501 to 600	2.84	2.65	0.70
601 to 700	0.71	0.88	0.35
701 to 800	2.30	1.76	1.41
801 to 900	1.59	1.59	0.17
901 to 1,000	4.26	5.48	6.90
1,001 to 1,500	7.63	7.96	6.37
1,501 to 2,000	8.34	9.02	10.61
2,001 to 2,500	4.26	5.66	3.89
2,501 to 3,000	8.17	5.66	8.67
3,001 to 3,500	3.90	3.71	1.76
3,501 to 4,000	6.03	7.43	7.78
4,001 to 4,500	2.13	2.65	1.59
4,501 to 5,000	5.50	3.89	5.48
5,001 to 5,500	1.24	1.76	1.06
More than 5,500	15.27	16.46	17.69
			100.00

Source: Recreation Vehicle Industry Association.

C. Recreational Vehicle Ownership Projections

Boats and recreational vehicles, the two most important types of recreation equipment from the standpoint of highway demands, provide a sharp contrast between a mature, saturated market activity and a new, high growth activity.

Because of the obvious difficulties in combining unit shipments for equipment as diverse as pickup covers, motor homes, camping trailers, truck campers, and travel trailers, we have concentrated our recreational vehicle analysis on total dollar recreational vehicle sales. During the 8-year period (1969 to 1976) dollar sales increased at a rate of 16.3 percent per year; for a 16-year period (1961 to 1976) the average annual increase was slightly over 28 percent per year.

Table 15 shows the projections through 1990. Equation 8 (see Appendix D) uses personal consumption expenditures. Projection with Equation 9 which uses just a time trend, again highlights the inherent fallacy of trend-line forecasting and reliance on a high numerical value of the coefficient of correlation to select a forecasting equation. In this case, the "best" equation, as measured by R^2, is the 16-year logarithmic time correlation; it provided a 1990 projection that was obviously absurd at $40,635 million in 1985. The linear PCE correlation, with a slightly lower numerical value of the coefficient of correlation, produces a projection that 1990 expenditures, in current dollars, will be 3.38 times 1976 expenditures.

TABLE 15

PROJECTED RECREATIONAL VEHICLE SALES, 1976 TO 1990
(millions of dollars)

Year	Sales Projection Equation 8
1976 (actual)	4,284
1976 (projected)	4,255
1980 (projected)	6,843
1985 (projected)	10,430
1990 (projected)	14,365

Sources: Base Year: RVI.
Projections: MRI (see Appendix D).

Boating, and specifically power boating, is a classic illustration of a recreation market that is largely saturated from an interest standpoint. Specifically, we conclude from both participation data and data on power boat sales and ownership that boating has already attracted almost as many participants as it is likely to attract over the next few decades, and that future growth in boating activity will be primarily a result of increasing frequency of boating by current participants rather than the addition of new participants. The data in Table 11 show, for example, that the average annual growth rate in boat ownership over the last decade has been a scant one-half of 1 percent over population growth. The average annual increase in the number of boats owned is 47,400, which represents only about 25 percent of the average yearly new boat sales. Thus, from the supplier's standpoint, the boating business is largely a replacement rather than a new-entrant market.

The best fit (see Appendix D) of the historical data was a linear population relationship. It lends to the projections shown in Table 16.

TABLE 16

PROJECTED BOAT OWNERSHIP, 1975 TO 1990
(thousands)

Year	Boat Ownership
1975 (actual)	9,740
1975 (projected)	9,734
1980 (projected)	10,500
1985 (projected)	11,530
1990 (projected)	12,581

Sources: Base Year: MAREX, NAEBM.
Projections: MRI.

Over the last 10 years, the ratio of boat trailers sold to total boats sold (outboard plus inboard outdrive) has ranged from 0.541 to 0.683. The ratio of trailers to boats has generally been highest during periods when boats of 20 horsepower and over constituted a relatively high portion of total boat sales, including the early 1970's and the early 1960's. When the percentage of high-powered boats was relatively low, as in the late 1960's and the 1950's, the ratio of trailers to boats was also lower. This finding is very much as might be expected. We would therefore expect that any future decline in average boat horsepower would also be accompanied by a corresponding decline in trailer sales.

We believe that the real future of recreational vehicles will be much more like that of boating than would be indicated by any projecting equation derived from historical data, no matter how high the numerical value of the coefficient of correlation. We believe that the time is approaching, within the next decade at least, when virtually everybody who really wants to own a recreational vehicle will own one. This point was obviously reached in the boating market about 20 years ago, and was reached by snowmobiles about 5 years ago. At the present time, there is no mathematical way of estimating the ownership level at which recreational vehicles will reach this interest-limited level of market saturation. By analogy with boating and other recreation activities involving expensive equipment, we expect that this level will be reached within the next 10 years. Subsequently, recreational vehicle usage will continue to grow, but more slowly than in the past, as a result of the steadily increasing frequency of use on the part of a relatively constant percentage of users within the total population.

V. POSSIBLE ALTERNATIVE FUTURES

The numerical projections contained in the preceding sections are all based on historical correlations; accordingly, use of any of these projections as a forecast involves the inherent assumption that the social and economic future for the United States over the next 20 years will continue in the same general direction as it has over the last 20 years. This "no surprise" future involves continued growth in real GNP and real personal consumption expenditures, continued inflation but at rates somewhat lower than the last few years, continued increases in energy prices in relation to other goods and services, but no major shifts in either regulations or taxation regarding personal transportation or recreation equipment. According to many sources, this "no surprise" future is not, in fact, very likely. Particularly with regard to energy, a case can be made that some combination of pricing, taxation, and regulation will have to be undertaken with sufficient severity and impact that the patterns of automobile and recreational vehicle usage will, in fact, be drastically changed. As previously indicated, the public's historical approach to the substantial increase in petroleum prices has largely been to ignore that price increase; since a doubling of prices has not been sufficient to curtail use, some more drastic actions will have to be taken.

We view the overall policy and impact of this sort of energy-scarce future as the key to any surprise future, with regard to recreation activities. Mainly, consumers will modify their behavior in such a way as to maximize the opportunity for continued high levels of recreation participation. If the price (or tax) on gasoline or certain classes of vehicles is raised above whatever threshold value is necessary to cause serious disruption, we feel that the most obvious response will be a corresponding shift toward more fuel-efficient vehicles, so that rates of utilization can be maintained. Other specific possible results of a drastic price increase or supply reduction for petroleum products or vehicle types include the following:

- Since the recreational vehicle, either alone or as a load on an automobile, is needed primarily at the destination, and is an inefficient means of long haul transportation, fuel inefficiencies could be minimized by moving to smaller, more efficient vehicles (a trend already beginning to occur), as well as switching from bring-along recreational vehicles to recreational vehicles purchased for use (or rented) only within major destination areas. Under this hypothesis, long haul transportation would be in fuel-efficient small cars, without heavy loads, or even by public transportation.

. The same sort of evolution could occur in boating, with a higher percentage of boats being permanently located at marinas, rather than being transported in heavy boat trailers with their attendant fuel penalties. A substantial hike in boat fuel prices might, curiously enough, actually tend to increase the market for boats. Whereas at the present time many owners use the same boats for water skiing and point-to-point water transportation, high fuel costs might lead many boating families to purchase more specialized boats: large boats for accommodations, and smaller, more fuel-efficient boats for skiing and transportation.

Mass transportation has never been a major means of recreation access, except to recreation resources within major urban areas or on the immediate urban fringe. In the National Recreation Access Study,[29] MRI found a combination of barriers that effectively limit the use of mass transportation for recreation access:

. To be effective in serving recreationists, mass transit must provide coordinated long haul services between metropolitan areas and resource centers, and internal circulation transportation within recreation resource complexes. Such coordination of long haul and internal circulation transportation rarely, if ever, exists in U.S. outdoor recreation facilities.

. About a third of the traditional outdoor recreation activities require users to bring certain kinds of equipment that are impossible, or at least extremely difficult, to transport on current public transportation vehicles. Because most trips involve multiple activities, it was concluded that equipment constraints probably bar the use of public transportation to about half the population.

. Significant percentages of the American public perceive the social environment of mass transportation as incompatible with family recreation. At best, the crowded bus syndrome disrupts the traditional easy family association that is possible in a private vehicle; and at worst, many people fear for their safety on public transportation.

In light of the findings of the National Recreation Access Study, we conclude that the mere offering of public transportation services, even if greatly improved over today's standards, will be insufficient to divert significant numbers of recreationists away from their private vehicles. Public transportation could become a major factor in recreation access and internal circulation transportation only through some combination of strict and severe disincentives for the use of private vehicles and extremely high gasoline prices or taxes.

In light of surveys and other analyses presented in the early 1970's, we are frankly surprised that the 4-day, 40-hour workweek has not been adopted more widely over the recent years. The concept incorporates so many advantages, from a recreation standpoint, that many recreation specialists, including those on the MRI staff, believed that the "compressed workweek" would become very popular by the mid- to late 1970's. This has obviously not yet happened, but since the advantages are still there, it could easily happen. In all probability, the 4-day workweek has been opposed by employers as likely to lead to a shorter workweek: once the 4-day principle is established, so this argument goes, there will be tremendous pressure to reduce the workday from 10 hours back to the "traditional" 8 hours, with the effect of reducing the total workweek to 32 hours--a shift with drastic consequences to the economy. At this time, we would revise our earlier predictions and conclude that widespread adoption of the 4-day workweek is contingent on, and would probably follow, negotiation of the total workweek down from its traditional 40 hours to a value closer to 35 hours.

If the 4-day workweek were to become fairly widespread, there would be several beneficial impacts on transportation. First, presuming that there was to be a reasonable split between Friday and Monday as the third nonwork weekend day, weekend traffic peaks would be distributed more evenly over 4-1/2 days rather than the 2-1/2 day period as is now the case. The effect on total recreation fuel consumption is somewhat less clear. Presumably, a larger number of full days available for recreation pursuits might encourage greater use of boats and recreational vehicles, thus increasing fuel consumption and demands on the recreation-area highway systems. On the other hand, if the total aggregate annual participation in various activities remains relatively constant, the amount of long distance travel per unit of recreation participation might decrease and therefore improve fuel efficiency somewhat.

In the long run, some recreation specialists have postulated that with a 4-day workweek, larger numbers of workers would decide to maintain a permanent residence in what would previously have been described as a summer home or vacation home location. This would involve either commuting longer distances to work on a daily basis, or leaving the family at the vacation-oriented residence and making some arrangement for minimum sleeping accommodations near the location of work for the 3 nights during which an absence from bome would be necessary. This sort of existence, of course, would greatly reduce the extent to which recreational vehicles were used for long haul transportation between urban residences and vacation areas. Such a development, therefore, would be fuel efficient and would also ease highway loads.

It is possible to speculate about an almost infinite number of possible evolutionary or "surprise" futures, but that is not very productive. Unless there is a dramatic revolution in lifestyle and outlook, we expect that most U.S. citizens will continue to react to foreseen and unforeseen economic changes, resource shortages and the like with behavior patterns that can logically be expected to serve the goal of preserving and increasing participation in their preferred recreation activities.

VI. OPERATIONAL EFFECTS OF RVS

Recreational vehicles, especially motor homes and cars pulling large trailers, have poorer acceleration and speed maintenance capabilities than most passenger cars. For this reason they tend to impact traffic flow in a manner analogous to trucks and buses.

Two-lane (two-way) traffic and multilane (one-way) traffic behave differently in many respects, so it is most useful to treat the RV operational effects separately. The first portion of this section outlines the common approach to two-lane traffic, and traces the history of subsequent developments in vehicle equivalencies, etc. The second portion presents a briefer history pertaining to multilane flows, drawing upon similarities to two-lane concepts where applicable.

A. Two-Lane Highway Design and Operation

1. Currently Used Procedures: Current procedures and practices are based primarily on the Highway Capacity Manual (HCM)30/ and AASHTO publications.31,32/ The three documents employ the same fundamental postulates and information, and they frequently refer to one another, but they do differ in some details and nomenclature. The procedures can be used either for design- i.e., establishing the geometrics to serve a future demand--or for evaluation, where traffic characteristics are estimated on the basis of current demand and the existing facility.

All procedures are based on the relations between the several interacting variables shown in Figure 5, taken as an example from the HCM.30/ Operating speed, the ordinate, is the highest overall speed at which a driver (passenger car) can travel on a given highway under favorable weather conditions and under prevailing traffic conditions without at any time exceeding the safe speed as determined by the design speed on a section-by-section basis. The design speed is that speed for which the most restrictive geometric features are safe.

The horizontal scale in Figure 5 is the ratio of traffic volume to capacity. The traffic is the number of vehicles that pass over a section (both directions) in an identified time period, usually 1 hour. Capacity is the maximum number of vehicles that can pass over the section in the time period. (In the AASHTO documents this maximum is called possible capacity.) As shown by Figure 5, speeds and service are highest at small volumes and diminish as volume approaches capacity.

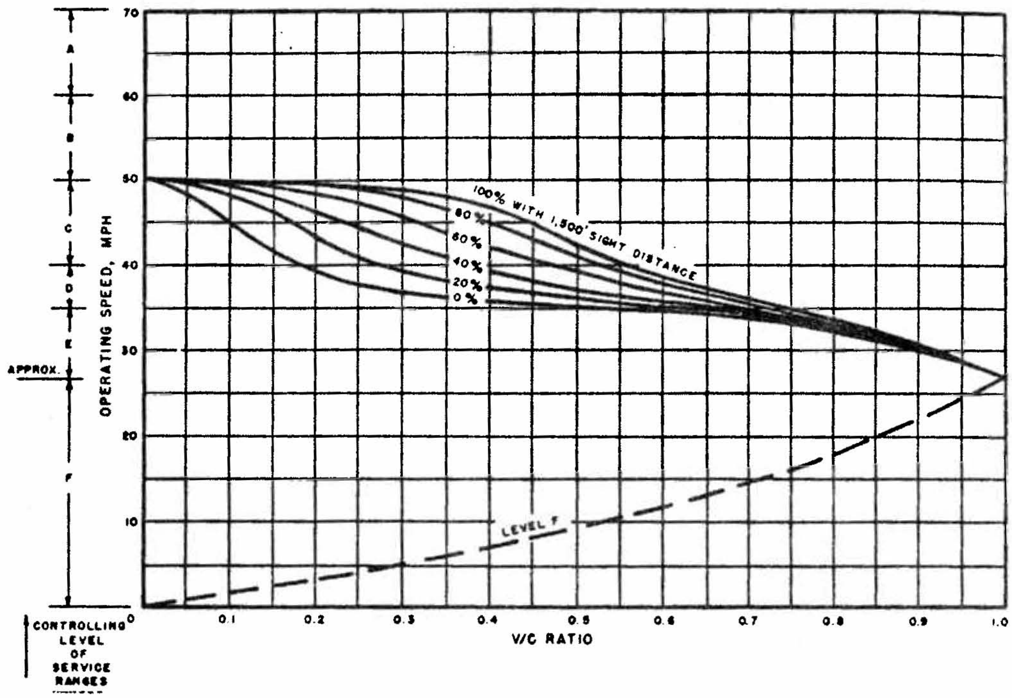

Figure 5 - Relationships Between V/C Ratio and Operating Speed, Overall For Both Directions of Travel, On Two-Lane Rural Highways With Average Highway Speed of 50 mph, Under Uninterrupted Flow Conditions (From Reference 30)

For two-lane facilities two qualities of the highway influence operating speeds and service. They are the average highway speed and the percent of highway with passing sight distance of 1,500 ft (457 m) or more. The average highway speed is a weighted average of design speeds on the sections that are considered together. The design speeds depend on lane width, shoulder width, proximity of obstructions, stopping sight distances, and the curvature and superelevation of horizontal curves. An overall measure of alignment characteristics is contained in the "percent with passing sight distance equal to or greater than 1,500 ft (457 m)."

Figures like Figure 5 are based on a large amount of field data. These data are employed to estimate the traffic volume that can be served at a specified service level. The service level is specified through the volume-to-capacity ratio, v/c. The associated operating speed is indicated on the appropriate figure for average highway speed and percent sight distance. The volume that can be served (the service volume) is calculated at:

$$SV = 2{,}000\ (V/C) W_L T_L$$

where SV = service volume (mixed vehicles* per hour, total for both directions);

V/C = volume-to-capacity ratio;

W_L = adjustment for lane width and lateral clearance at the level of service associated with V/C; and

T_L = truck adjustment factor (or truck factor) at level of service associated with V/C.

The effect of the vehicle population enters through the truck factor, T_L, which depends on the percent of trucks and also includes the influence of the grade or type of terrain. The truck adjustment factor is based on the concept that a truck in the traffic stream is equivalent to more than one passenger car. Truck adjustment factors are available in tables for a number of conditions.[30,31,32] They can also be calculated using the equivalence concept:

$$T_L = 100/(100 - P_T + E_T P_T)$$

where P_T = percent trucks in the mixed flow

E_T = passenger car equivalent of a truck

The E_T can be related to the average speed of a truck on the grade or section analyzed as shown in Figure 6. The HCM recommends truck speeds be based on a truck with weight-to-horsepower ratio of 325 lb/NHP for two-lane highways.

* Includes passenger cars, trucks, buses, recreational vehicles, etc.

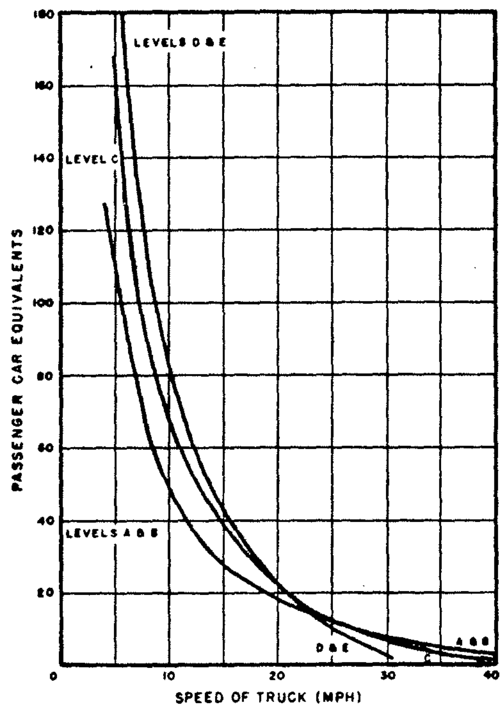

Figure 6 - Passenger Car Equivalents for Various Average Truck Speeds on Two-Lane Highways (From Reference 30)

Bus adjustment factors and the passenger car equivalents of buses also are available,[30,31,32] but these references are not explicit on the best procedure for simultaneous application of factors for both trucks and buses.

The numerical values for T_L and E_T are based on field data that have been assembled using a model developed more than 25 years ago by Mr. William P. Walker of the Federal Highway Administration. The details of the model had not been documented or published until recently, in conjunction with Canadian studies of the operational effects of RVs.[33,34,35] The model and methods developed by Walker can be applied to estimate the passenger car equivalents of any types of vehicles that impede part or all of the passenger cars. The data required are the speeds and headways of the vehicles on the section of interest and in the flow of interest. These data can be obtained in the field, or may be supplied in part by estimates or performance calculations. No attempt had been made to obtain equivalents for both trucks and recreational vehicles using Walker's method until the Canadian work was reported.

2. Improvements Using Recent Canadian Research: Werner and Morrall[33,34,35] collected extensive field data, analyzed and employed the data, and presented the results in detail. The data were collected on Canadian highways serving park areas where large numbers of recreational vehicles appear in the traffic. The data were identified by vehicle type and included spot speeds, lane occupied (where multiple lanes were available), and time headways. Data were collected on level terrain and on nearby sustained grades. Data samples were also obtained on vehicle weights by direct measurement and rated horsepowers, by interview and inspection.

The data were used to identify the characteristics of the passenger car, RV, bus, and truck populations. Walker's method was used to estimate passenger car equivalents for trucks, buses, and RVs. The equivalents also were calculated for high density conditions using a method reported by Gwynn et al.[36] The results are shown here in Tables 17 and 18. The equivalents for RVs provide the needed numerics to employ current procedures to estimate the speeds and service in recreational traffic.

Werner and Morrall[33,34,35] emphasize the desirability of combining the effects of all vehicle types into one adjustment factor. That is, when the traffic contains trucks, buses and RVs the adjustment factor should be calculated as:

$$C_c = 100/(100-P_T-P_B-P_R+P_TE_T+P_BE_B+P_RE_R)$$

where P_T, P_B and P_R are percentages of trucks, buses and recreational vehicles, and E_T, E_B, and E_R are the passenger car equivalents.

TABLE 17

PASSENGER CAR EQUIVALENTS OF TRUCKS, BUSES AND RECREATIONAL VEHICLES ON TWO-LANE HIGHWAYS ON SPECIFIC INDIVIDUAL SUBSECTIONS OR GRADES* (From reference 27)

Grade %	Length on Grade Miles	Passenger Car Equivalent (for all percentages of vehicles)											
		Levels of Service A and B				Level of Service C				Levels of Service D and E			
		Trucks	Buses	RV's**	PV's***	Trucks	Buses	RV's	PV's	Trucks	Buses	RV's	PV's
0-2	All	2	2	2.3	1.0	2	2	1.6	1.0	2	2	1.6	1.0
3	1/4	5	2	2.3	1.0	3	2	1.6	1.0	2	2	1.6	1.0
	1/2	10	For	For	For	10	For	For	For	7	For	For	For
	3/4	14	all	all	all	16	all	all	all	14	all	all	all
	1	17	grade	grade	grade	21	grade	grade	grade	20	grade	grade	grade
	1 1/2	19	lengths	lengths	lengths	25	lengths	lengths	lengths	26	lengths	lengths	lengths
	2	21				27				29			
	3	22				29				31			
	4	23				31				32			
4	1/4	7	2	2.3	1.0	6	2	1.6	1.0	3	2	1.6	1.0
	1/2	16	For	For	For	20	For	For	For	20	For	For	For
	3/4	22	all	all	all	30	all	all	all	32	all	all	all
	1	26	grade	grade	grade	35	grade	grade	grade	39	grade	grade	grade
	1 1/2	28	lengths	lengths	lengths	39	lengths	lengths	lengths	44	lengths	lengths	lengths
	2	30				42				47			
	3	31				44				50			
	4	32				46				52			
5	1/4	10	4	2.3	1.0	10	3	1.6	1.0	7	2	1.6	1.0
	1/2	24	For	2.7	For	33	For	1.6	For	37	For	For	For
	3/4	29	all	2.9	all	42	all	1.6	all	47	all	all	all
	1	33	grade	3.0	grade	47	grade	1.6	grade	54	grade	grade	grade
	1 1/2	35	lengths	3.2	lengths	51	lengths	1.6	lengths	59	lengths	lengths	lengths
	2	37		3.3		54		1.6		63			
	3	39		3.5		56		1.6		66			
	4	40		3.6		57		1.9		68			
6	1/4	14	7	2.9	1.0	17	6	1.6	1.0	16	4	1.6	1.0
	1/2	33	For	3.6	For	47	For	2.0	For	54	For	For	For
	3/4	39	all	4.3	all	56	all	2.3	all	65	all	all	all
	1	41	grade	4.4	grade	59	grade	2.5	grade	70	grade	grade	grade
	1 1/2	44	lengths	4.8	lengths	62	lengths	2.9	lengths	75	lengths	lengths	lengths
	2	46		4.9		65		3.0		80			
	3	48		4.9		68		3.0		84			
	4	50		5.0		71		3.1		87			
7	1/4	22	12	3.3	1.2	32	12	2.2	1.0	35	10	1.6	1.0
	1/2	44	For	3.7	1.4	63	For	2.6	For	75	For	For	For
	3/4	50	all	4.6	1.5	71	all	2.7	all	84	all	all	all
	1	53	grade	4.8	1.6	74	grade	2.8	grade	90	grade	grade	grade
	1 1/2	56	lengths	4.8	1.7	79	lengths	2.9	lengths	95	lengths	lengths	lengths
	2	58		4.9	1.8	82		3.0		100			
	3	60		4.9	1.9	85		3.0		104			
	4	62		5.0	1.9	87		3.1		108			

* Values for trucks are from Table 10.10, page 305, and for buses from Table 10.11, page 306, 1965 HCM
** RV's - recreational vehicles
*** PV's - passenger vehicles

TABLE 18

SPEEDS AND AVERAGE GENERALIZED PASSENGER CAR EQUIVALENTS OF TRUCKS, BUSES, RECREATIONAL VEHICLES AND PASSENGER CARS ON TWO-LANE HIGHWAYS, OVER EXTENDED SECTION LENGTHS (INCLUDING UPGRADES, DOWNGRADES, AND LEVEL SUBSECTIONS)

(From reference 27)

Equivalent	Level of Service	(Speed) and Equivalent, for: Level Terrain	Rolling Terrain	Mountainous Terrain
E_t	A	(47.5*) 2.0**	(40.0) 4.0	(32.5) 7.0
for trucks	B and C	(41.0) 2.2	(34.5) 5.0	(26.5) 10.0
	D and E	(35.0) 2.0	(31.5) 5.0	(26.0) 12.0
E_b	A	(48.0) 1.8	(43.0) 3.0	(35.0) 5.7
for buses	B and C	(41.5) 2.0	(38.0) 3.4	(32.5) 6.0
	D and E	(36.0) 1.6	(33.5) 2.9	(30.0) 6.5
E_r	A	(46.0) 2.2	(41.5) 3.2	(37.0) 5.0
for recreational vehicles	B and C	(40.0) 2.5	(37.0) 3.9	(34.0) 5.2
	D and E	35.0 1.6	33.0 3.3	31.0 5.2
E_p	A	(60.0) 1.0	(50.0) 1.3	(45.0) 2.3
for passenger car	B and C	(50.0) 1.0	(45.5) 1.0	(40.0) 2.5
	D and E	(36.0) 1.0	(35.5) 1.0	(35.0) 1.0

* mph

** Some of the values for trucks and buses have been readjusted from those shown in Table 10.9a, page 304, 1965 HCM.

The data[33,34,35] also show that even passenger cars are operated at lower speeds on steep sustained grades than they are on similar facilities on level terrain. As a result the authors find an "equivalent" greater than 1.0 for passenger cars on steep grades. It should be recognized that the equivalent is greater than 1.0 because the procedure envisions the cars on the grade as though they were immersed in a flow on level terrain. In essence, passenger car traffic flow on level terrain was retained as the base for calculating equivalents.

3. Computer Simulation Developments: Computerized traffic models or simulations have been employed by many to provide predictions of traffic characteristics on two-lane highways. One of the first comprehensive models was developed by Janoff and others at the Franklin Institute Research Laboratories (FIRL)[37] as part of a series of projects to develop systems to aid in passing maneuvers. The model treated vehicle acceleration and speed performance in a very elementary manner, but that was sufficient for the intended application. Other phases in the FIRL projects provided the best available data on passing behavior.[38,39,40] This aspect of two-lane traffic, studied previously by Crawford,[41] is a very important part of two-lane traffic models.

Heimbach et al.[42] improved the FIRL model and applied it to a project for North Carolina and FHWA. The acceleration and speed capabilities of trucks on graded were accurately represented, although passenger car capabilities were still treated in a very approximate manner. Field data were collected to adjust and test the model. The data included time headways and overall travel times for samples of vehicles on several highway sections. The headway data were used to improve the arrival rate characteristics of modeled traffic entering the simulated highway sections. The overall travel times were used to determine how the model should be adjusted to simulate highways with different design speeds. The model was employed to evaluate the service benefits that would accrue from highway improvements.

4. Midwest Research Institute Advancements: More recently a model was developed and employed for NCHRP by St. John et al., of Midwest Research Institute (MRI) to determine the influence of various vehicle types on the traffic characteristics of two-lane highways.[43] The model contains a good representation of the acceleration and speed maintenance capabilities of passenger cars, recreational vehicles, and trucks; the observed preferences of drivers in the use of acceleration; the passing decisions made by drivers; the alignment of the simulated highway; the sight distances; and pass, no-pass zoning.

The representations of acceleration and speed maintenance capabilities are based on field test data obtained on the project or reported in the literature. Engineering concepts were used to develop analytical forms for speed and acceleration in terms of the measurable characteristics of the vehicles, such as weight, horsepower, gear ratios, frontal area, and overall configuration. These analytical forms can be used to estimate the acceleration and speed capabilities of future vehicles that may have altered characteristics.

Field data were collected on passing behavior to supplement the findings from the FIRL projects. The data were extended to lower vehicle speeds and to situations where the impeded vehicle would have to pass more than one vehicle to get ahead of the delayed queue. The data also indicated that passing opportunities that occur immediately after entering the passing zone are more likely to be accepted than equivalent opportunities that arise within passing zones. The data did not indicate any effect of vehicle length on the acceptance of passing opportunities, but the sample sizes for this kind of comparison were small.

The two-lane traffic model[43] was validated using field data and data in the literature. Overall average speed distributions and passing frequencies could be duplicated. However, field data did not cover a sufficient range of truck, bus, and RV flows to enable validation of the sensitivity to these vehicles.

The model was exercised to evaluate the influence of trucks and RVs on traffic. Most model runs were made with a highway design speed such that the 85 percentile speed of passenger cars would be 65 mph (105 km/hr) in light traffic on level terrain with alignments that provide 46 to 80 percent no-passing. The results indicated that the detrimental influences of low performance vehicles can be estimated from their speeds when traveling alone over the alignment of interest. It was also found that the adjustment factor for low performance vehicles should be a nonlinear fraction of the percentage of such vehicles in the traffic mix.[44]

An adjustment factor, F, was formulated as:

$$F = 1/\left\{ 2\sum_{i=1}^{n} \left[\frac{P_i}{100} (\nu_i - 1)\right] + 1\right\}^{\frac{1}{2}}$$

where P_i = percent of ith vehicle type (truck, bus, or RV) in the traffic;
ν_i = equivalence kernel for ith vehicle type; and
n = number of vehicle types other than passenger cars.

F is employed like C_c the combined adjustment factor, except for one important difference. On a sustained grade, the basis for traffic operating conditions is a vehicle population of 100 percent passenger cars operating on the grade. In upgrade flows, the average speed is reduced by the grade, whereas, in downgrade flows there is a small but negligible increase in speed. This approach differs from that of Werner and Morrall[35/] where passenger car flows on level terrain are used as the basis for traffic operating conditions on all alignments.

The above formulation for the adjustment factor, F, explicitly separates the vehicle equivalence concept into the two dominating influences--the characteristics (capabilities) of the vehicles in the traffic mix, represented by the equivalence kernels, ν_i, and the composition of the traffic mix by vehicle, type, represented by the percentages, P_i. The required nonlinearity is brought about by the square root function in the equation for F.

The equivalence kernels, ν_i, have a simple physical interpretation. For a single type, ν_i, of (nonpassenger) vehicle in the traffic mix, and for the situation where that type represents a vanishingly small percentage of the total number of vehicles, ν_i is just the conventional vehicle equivalence. Thus, for example, an isolated recreational vehicle with $\nu_i = 4$ is "equivalent" to four passenger vehicles in a traffic stream composed almost entirely of passenger vehicles.

As suggested above, the actual values of the ν_i rest upon the determination of the free-flow operating speed of the vehicle type on a facility of interest. These speeds can be observed in the field or, more conveniently, obtained by computer simulation. The latter approach has been followed for several types of vehicles in rolling terrain and on long grades, and the speed results together with the equivalence kernels are given in Tables 19 and 20.

Table 21 shows how the elements of the RV population might be grouped into three classes for an economic representation of the current population. Figure 7 shows the mean speeds for a purely passenger car population. The total flow is both ways; the speeds on the sustained grades are for the upgrade direction. (The downgrade speeds are essentially equal to the level terrain speeds).

Tables 19 and 20 together with Figure 7 and the equation for F can be used to estimate speeds on two-lane highways with a vehicle population that includes passenger cars, trucks and RVs. Because the equivalence kernels depend only on the speeds of isolated vehicles (and the highway alignment), the methods can be readily applied to estimate the influence of future vehicles on traffic speeds and operation.

For an illustration of the application of these concepts, assume a two-way volume of 600 vehicles per hour on a sustained 4 percent grade. If all of these were passenger vehicles, their average speed upgrade would be about 50 mph (81 km/h), as read from Figure 7. However, suppose this volume contains trucks and recreational vehicles in the following percentages, where the vehicle types are defined in Table 20:

TABLE 19

ZERO-TRAFFIC SPEEDS (FT/SEC) AND EQUIVALENCE KERNELS, ν, IN ROLLING TERRAIN[a/]

(From reference 43)

Vehicle		Site[b/]							
		NCSU 3-1969 (Severe)				Pacheco Pass (Moderate)			
		Direction One (Westbound) Overall Upgrade		Direction Two (Eastbound) Overall Downgrade		Direction One (Eastbound) Overall Upgrade		Direction Two (Westbound) Overall Downgrade	
Simulation Type Number	Description	Speed	ν	Speed	ν	Speed	ν	Speed	ν
1	Truck, 400 lb/NHP, 895 lb/ft^2	59.6	12.6	65.7	7.65	62.4	10.04	82.9	1.87
2	Truck, 300 lb/NHP, 580 lb/ft^2	65.8	7.59	71.8	4.63	71.1	4.91	83.3	1.80
3	Truck, 125 lb/NHP, 300 lb/ft^2	80.7	2.22	82.7	1.89	85.1	1.55	85.2	1.54
4	Low Performance Camper	78.5	2.67	80.3	2.30	80.5	2.26	83.9	1.71
5	Low Performance Travel Trailer Combination	81.4	2.10	83.6	1.75	84.6	1.62	85.1	1.55
6	Low Performance Motor Home	81.3	2.12	83.2	1.81	84.1	1.68	84.9	1.58
7	Medium Performance Camper	82.8	1.87	84.1	1.68	84.7	1.60	85.1	1.55
8	Medium Motor Home	82.9	1.86	84.2	1.67	84.8	1.59	85.1	1.55
9	Medium Performance Travel Trailer Combination	83.2	1.81	84.5	1.63	85.3	1.53	85.3	1.53
10	High Performance Travel Trailer Combination	84.6	1.62	85.2	1.54	85.5	1.00	85.5	1.00
Alternate 2	Heavy Modular House Combination 300 lb/NHP, 350 lb/ft^2	62.1	10.29	68.1	6.28				

a/ Values for passenger and recreational vehicles are based on driver restraint which limits long period performance demands to 70% of maximum available horsepower. All vehicles attempt to maintain a speed of 85.49 ft/sec for this zero-traffic speed.

b/ The NCSU (North Carolina State University) site 3-1969 is a rugged rolling terrain with grade lengths of 1,000-1,700 ft and magnitudes up to 7%. The number one direction traffic climbs the 7% grade. There are no downgrade crawl regions. The Pacheco Pass site is a less rugged rolling terrain with an overall upgrade of about 0.6 for eastbound traffic.

TABLE 20

STEADY, ZERO-TRAFFIC SPEEDS (FT/SEC), AND EQUIVALENCE KERNELS, ν, ON LONG GRADES[a]

(From reference 43)

Vehicle		Grade Percent									
		0		2		4		6		8	
Simulation Type Number	Description	Speed	ν	Speed	ν	Speed	ν	Speed	ν	Speed	ν
1	Truck, 400 lb/NHP, 895 lb/ft^2	83.0	1.84	40.0	63.4	26.3	196.0	17.3	410.0	13.4	566.0
2	Truck, 300 lb/NHP, 580 lb/ft^2	86.0	1.44	50.0	27.8	34.5	100.0	22.9	259.0	17.8	394.0
3	Truck, 125 lb/NHP, 300 lb/ft^2	97.0	1.00	83.0	1.84	66.4	7.22	50.7	26.3	41.0	58.4
4	Low Performance Camper	81.9	2.02	72.4	4.41	62.9	9.63	53.4	21.0	43.9	46.0
5	Low Performance Travel Trailer Combination	93.6	1.00	80.3	2.30	67.0	6.87	53.7	20.5	40.4	61.3
6	Low Performance Motor Home	90.0	1.04	78.7	2.62	67.3	6.71	56.0	17.0	44.7	43.1
7	Medium Performance Camper	90.0	1.04	82.1	1.98	74.1	3.83	66.2	7.34	58.3	14.1
8	Medium Motor Home	90.0	1.04	82.4	1.94	74.8	3.62	67.1	6.82	59.5	12.7
9	Medium Performance Travel Trailer Combination	93.6	1.0	84.6	1.62	75.7	3.36	66.7	7.05	57.7	14.8
10	High Performance Travel Trailer Combination	99.0	1.0	91.7	1.00	84.5	1.63	77.2	2.97	69.9	5.4

a/ The steady on-grade speeds for the passenger and recreational vehicles are based on driver restraint to 70% of maximum available horsepower.

TABLE 21

RECREATIONAL VEHICLES GROUPED INTO SIMILAR PERFORMANCE STRATA
(Tabulated Values are Equivalence Kernels)1/
(From reference 43)

	Rolling Terrain								
	Severe		Moderate		Sustained Grades				
Vehicle Type	Overall Upgrade	Overall Downgrade	Overall Upgrade	Overall Downgrade	0%	2%	4%	6%	8%
Low Performance Camper	2.70	2.30	2.30	1.78	1.05	4.40	9.70	21.5	48.0
Low Performance Travel Trailer	2.15	1.80	1.65	1.58	1.00	2.30	7.00	21.3	61.0
Low Performance Mobile Home	2.15	1.85	1.70	1.60	1.05	2.65	6.85	17.3	44.0
Medium Performance Camper	1.90	1.70	1.65	1.58	1.05	2.00	3.90	7.40	14.0
Medium Performance Mobile Home	1.90	1.70	1.62	1.58	1.05	1.95	3.65	6.96	13.0
Medium Performance Travel Trailer	1.85	1.65	1.55	1.55	1.00	1.65	3.50	7.05	15.3
High Performance Travel Trailer	1.65	1.58	1.00	1.00	1.00	1.00	1.65	3.05	5.6
High Performance Camper	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.0

1/ The equivalence kernel values are applicable to nearly balanced flows on a 65 mph highway where percent no passing falls in range of 46 to 80%.

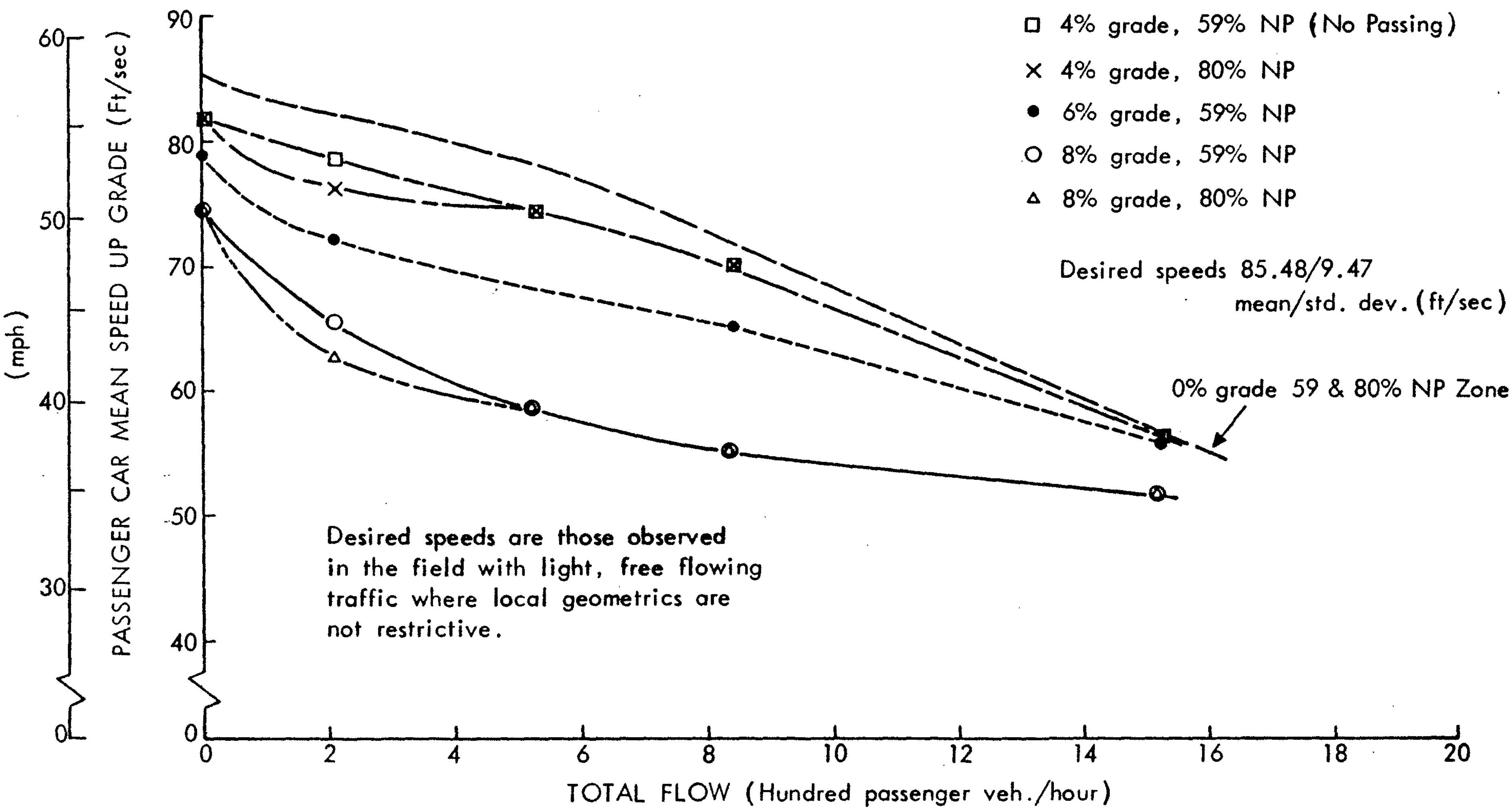

Figure 7 - Passenger Car Overall Mean Speeds Up Various Grades, Vehicle Population 100% Passenger Cars
(From Reference 43)

Truck type 2 - 2 percent
Truck type 3 - 4 percent
RV type 5 - 5 percent
RV type 6 - 4 percent
RV type 8 - 3 percent
RV type 10 - 5 percent

Using the tabulated equivalence kernels, ν_i, corresponding to the 4 percent grade in the equation for the adjustment factor, F, yields

$$F = 0.3836$$

This factor gives an equivalent volume of

$$V_{eq} = 600 \text{ vph}/F = 1{,}564 \text{ vph}$$

For this equivalent volume, Figure 7 yields an average upgrade speed for the passenger vehicles of about 38 mph (52 km/h).

5. Other Implications: The research discussed above also indicates that to characterize terrain (alignment) as level, rolling, or mountainous is not sufficient, especially the distinction between rolling and mountainous. The capability of calculating vehicle speeds (isolated vehicles) over specified alignment with a computer program may help to resolve this problem.

Historically, traffic engineering attention has been directed primarily to the average speeds of passenger cars, or to an above average speed such as operating speed or 85th percentile speed. For recreational traffic planning it may also be desirable to estimate the overall travel speeds of some of the low performance RVs. The MRI results[43/] may offer some guidelines on this aspect.

The MRI results[43/] have also been applied to estimate the safety effects of low performance vehicles in the traffic stream. RVs do create more situations likely to generate instabilities in platoons, they increase the speed differences between vehicles in a traffic stream, and they increase acceleration noise. However, RVs cause fewer of these undesirable effects than do equal numbers of trucks.

The effects of vehicle lengths on passing behavior have not been well established. The National Swedish Road and Traffic Research Institute has made investigations in this area. The reports are presently being acquired and translated by FHWA.

B. Multilane Highways

1. Currently Used Procedures: Like two-lane highways, the current procedures and practices are based primarily on several earlier documents.[30,31,32] The influence of the vehicle population is accounted for by an adjustment factor based on the percent of trucks (or buses) and the alignment. The form of the adjustment factor is the same as for two-lane highways. However, the passenger car equivalents for trucks and buses differ from the two-lane cases. Tables 22, 23, 24, and 25 were obtained from the Highway Capacity Manual.[30] How these equivalents and resulting adjustment factors were obtained is not well documented, and there is no clear-cut procedure to make extensions to RVs.

2. Additions to Current Procedures: Gwynn et al.,[36] derived truck equivalents for a steep grade from field data, but the extension to other vehicle types is not apparent.

A simulation traffic model was used by Hoffman in a dissertation.[45,46] The value of this work is diminished by some very approximate representations of vehicle performance and traffic behavior. Also, traffic regulations that appear to play a significant role are not clear from the translation.

An ingenious conceptual model by Newman and Moskowitz[47] deals with one level of service on sustained grades. The model, which is described in the Highway Capacity Manual,[30] was adjusted with a few field observations. It is not readily extendable to RVs.

A simulation model was developed, adjusted, validated, and exercised in a series of contracts for the FHWA.[48,49] The results have been summarized in a set of graphs[50] that can be used to estimate operating speeds and service levels for mixed flows of passenger cars and trucks on two or three unidirectional lanes. A user's manual has also recently been completed.[51] The basic graphs apply to a reference truck population. However, a second set of graphs employs the local speed of the lowest performance vehicle. This set together with weight factors for vehicle population elements can be used to estimate traffic characteristics for mixtures of passenger cars, trucks, buses, and RVs. A comparison with field data was reported for a case with only passenger cars and RVs; the speed-suppressing effect of the RVs was slightly underestimated. This may be because the entire procedure was designed to estimate the effects of trucks, whereas RVs are driven differently.

These findings and procedures[51] have not yet been employed and accepted by traffic engineers. However, these procedures probably offer the most nearly substantiated way to estimate the effects of RVs in mixed traffic on multilane highways.

Implicit safety and driver work load measures were also obtained.[48,49] Trucks in the traffic streams on sustained upgrades slightly increase implicit hazard and work load measures.

TABLE 22

AVERAGE GENERALIZED PASSENGER CAR EQUIVALENTS OF TRUCKS AND BUSES ON FREEWAYS AND EXPRESSWAYS, OVER EXTENDED SECTION LENGTHS (INCLUDING UPGRADES, DOWNGRADES, AND LEVEL SUBSECTIONS)
(From reference 30)

LEVEL OF SERVICE		EQUIVALENT, E, FOR:		
		LEVEL TERRAIN	ROLLING TERRAIN	MOUNTAINOUS TERRAIN
A		Widely variable; one or more trucks have same total effect, causing other traffic to shift to other lanes. Use equivalent for remaining levels in problems.		
B through E	E_T, for trucks	2	4	8
	E_B, for buses[a]	1.6	3	5

[a] Separate consideration not warranted in most problems; use only where bus volumes are significant.

TABLE 23

PASSENGER CAR EQUIVALENTS OF TRUCKS ON FREEWAYS AND EXPRESSWAYS, ON SPECIFIC INDIVIDUAL SUBSECTIONS OR GRADES
(From reference 30)

GRADE (%)	LENGTH OF GRADE (MI)	PASSENGER CAR EQUIVALENT, E_T									
		LEVELS OF SERVICE A THROUGH C FOR:					LEVELS OF SERVICE D AND E (CAPACITY) FOR:				
		3% TRUCKS	5% TRUCKS	10% TRUCKS	15% TRUCKS	20% TRUCKS	3% TRUCKS	5% TRUCKS	10% TRUCKS	15% TRUCKS	20% TRUCKS
0–1	All	2	2	2	2	2	2	2	2	2	2
2	¼–½	5	4	4	3	3	5	4	4	3	3
	¾–1	7	5	5	4	4	7	5	5	4	4
	1½–2	7	6	6	6	6	7	6	6	6	6
	3–4	7	7	8	8	8	7	7	8	8	8
3	¼	10	8	5	4	3	10	8	5	4	3
	½	10	8	5	4	4	10	8	5	4	4
	¾	10	8	6	5	5	10	8	5	4	5
	1	10	8	6	5	6	10	8	6	5	6
	1½	10	9	7	7	7	10	9	7	7	7
	2	10	9	8	8	8	10	9	8	8	8
	3	10	10	10	10	10	10	10	10	10	10
	4	10	10	11	11	11	10	10	11	11	11
4	¼	12	9	5	4	3	13	9	5	4	3
	½	12	9	5	5	5	13	9	5	5	5
	¾	12	9	7	7	7	13	9	7	7	7
	1	12	10	8	8	8	13	10	8	8	8
	1½	12	11	10	10	10	13	11	10	10	10
	2	12	11	11	11	11	13	12	11	11	11
	3	12	12	13	13	13	13	13	14	14	14
	4	12	13	15	15	14	13	14	16	16	15
5	¼	13	10	6	4	3	14	10	6	4	3
	½	13	11	7	7	7	14	11	7	7	7
	¾	13	11	9	8	8	14	11	9	8	8
	1	13	12	10	10	10	14	13	10	10	10
	1½	13	13	12	12	12	14	14	13	13	13
	2	13	14	14	14	14	14	15	15	15	15
	3	13	15	16	16	15	14	17	17	17	17
	4	15	17	19	19	17	16	19	22	21	19
6	¼	14	10	6	4	3	15	10	6	4	3
	½	14	11	8	8	8	15	11	8	8	8
	¾	14	12	10	10	10	15	12	10	10	10
	1	14	13	12	12	11	15	14	13	13	11
	1½	14	14	14	14	13	15	16	15	15	14
	2	14	15	16	16	15	15	18	18	18	16
	3	14	16	18	18	17	15	20	20	20	19
	4	19	19	20	20	20	20	23	23	23	23

TABLE 24

PASSENGER CAR EQUIVALENTS OF INTERCITY BUSES ON FREEWAYS AND EXPRESSWAYS, ON SPECIFIC INDIVIDUAL SUBSECTIONS OR GRADES

(From reference 30)

GRADE[a] (%)	PASSENGER CAR EQUIVALENT,[b] E_B	
	LEVELS OF SERVICE A THROUGH C	LEVELS OF SERVICE D AND E (CAPACITY)
0–4	1.6	1.6
5[c]	4	2
6[c]	7	4
7[c]	12	10

[a] All lengths.
[b] For all percentages of buses.
[c] Use generally restricted to grades over 1/2 mile long.

TABLE 25

ADJUSTMENT FACTORS[a/] FOR TRUCKS AND BUSES ON INDIVIDUAL ROADWAY SUBSECTIONS OR GRADES ON FREEWAYS AND EXPRESSWAYS (INCORPORATING PASSENGER CAR EQUIVALENT AND PERCENTAGE OF TRUCKS OR BUSES)[b/]

(From reference 30)

PASSENGER CAR EQUIVALENT, E_T OR E_B	TRUCK ADJUSTMENT FACTOR T_c OR T_L (B_c OR B_L FOR BUSES)[c/] — PERCENTAGE OF TRUCKS, P_T (OR OF BUSES, P_B) OF:														
	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
2	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.93	0.92	0.91	0.89	0.88	0.86	0.85	0.83
3	0.98	0.96	0.94	0.93	0.91	0.89	0.88	0.86	0.85	0.83	0.81	0.78	0.76	0.74	0.71
4	0.97	0.94	0.92	0.89	0.87	0.85	0.83	0.81	0.79	0.77	0.74	0.70	0.68	0.65	0.63
5	0.96	0.93	0.89	0.86	0.83	0.81	0.78	0.76	0.74	0.71	0.68	0.64	0.61	0.58	0.56
6	0.95	0.91	0.87	0.83	0.80	0.77	0.74	0.71	0.69	0.67	0.63	0.59	0.56	0.53	0.50
7	0.94	0.89	0.85	0.81	0.77	0.74	0.70	0.68	0.65	0.63	0.58	0.54	0.51	0.48	0.45
8	0.93	0.88	0.83	0.78	0.74	0.70	0.67	0.64	0.61	0.59	0.54	0.51	0.47	0.44	0.42
9	0.93	0.86	0.81	0.76	0.71	0.68	0.64	0.61	0.58	0.56	0.51	0.47	0.44	0.41	0.38
10	0.92	0.85	0.79	0.74	0.69	0.65	0.61	0.58	0.55	0.53	0.48	0.44	0.41	0.38	0.36
11	0.91	0.83	0.77	0.71	0.67	0.63	0.59	0.56	0.53	0.50	0.45	0.42	0.38	0.36	0.33
12	0.90	0.82	0.75	0.69	0.65	0.60	0.57	0.53	0.50	0.48	0.43	0.39	0.36	0.34	0.31
13	0.89	0.81	0.74	0.68	0.63	0.58	0.54	0.51	0.48	0.45	0.41	0.37	0.34	0.32	0.29
14	0.88	0.79	0.72	0.66	0.61	0.56	0.52	0.49	0.46	0.43	0.39	0.35	0.32	0.30	0.28
15	0.88	0.78	0.70	0.64	0.59	0.54	0.51	0.47	0.44	0.42	0.37	0.34	0.31	0.28	0.26
16	0.87	0.77	0.69	0.63	0.57	0.53	0.49	0.45	0.43	0.40	0.36	0.32	0.29	0.27	0.25
17	0.86	0.76	0.68	0.61	0.56	0.51	0.47	0.44	0.41	0.38	0.34	0.31	0.28	0.26	0.24
18	0.85	0.75	0.66	0.60	0.54	0.49	0.46	0.42	0.40	0.37	0.33	0.30	0.27	0.25	0.23
19	0.85	0.74	0.65	0.58	0.53	0.48	0.44	0.41	0.38	0.36	0.32	0.28	0.26	0.24	0.22
20	0.84	0.72	0.64	0.57	0.51	0.47	0.42	0.40	0.37	0.34	0.30	0.27	0.25	0.23	0.21
21	0.83	0.71	0.63	0.56	0.50	0.45	0.41	0.38	0.36	0.33	0.29	0.26	0.24	0.22	0.20
22	0.83	0.70	0.61	0.54	0.49	0.44	0.40	0.37	0.35	0.32	0.28	0.25	0.23	0.21	0.19
23	0.82	0.69	0.60	0.53	0.48	0.43	0.39	0.36	0.34	0.31	0.27	0.25	0.22	0.20	0.19
24	0.81	0.68	0.59	0.52	0.47	0.42	0.38	0.35	0.33	0.30	0.27	0.24	0.21	0.19	0.18
25	0.80	0.67	0.58	0.51	0.46	0.41	0.37	0.34	0.32	0.29	0.26	0.23	0.20	0.18	0.17

a/ Computed by $100/(100 - P_T + E_T P_T)$, or $100/(100 P_B + E_B P_B)$.

b/ Used to convert equivalent passenger car volumes to actual mixed traffic; use reciprocal of these values to convert mixed traffic to equivalent passenger cars.

c/ Trucks and buses should not be combined in entering this table where separate consideration of buses has been established as required, because passenger car equivalents differ.

VII. RECREATIONAL VEHICLE SAFETY

The preceding section, dealing primarily with operational concerns, pointed out that concomitant safety problems result directly from the lesser acceleration and speed maintenance capabilities of RVs. Thus, larger speed variances, increased passing on two-lane (and multilane) facilities, and greater acceleration noise will occur in mixed RV-passenger vehicle traffic than in purely passenger vehicle traffic. These observations are all indicative of safety problems, but do not necessarily correlate uniformly to accident rates.

A great wealth of literature exists concerning RV safety, accidents, and related matters. Many studies[52-69] bears rather directly on the subject of this project--planning and design of facilities for RVs and recreational traffic. Many other studies concentrate more on vehicle construction, integrity, etc., as they relate to RV safety; this facet is outside the direct interest of this project.

All of the literature clearly points to one fact--RVs are excessively overrepresented in the overall accident picture. Perhaps the most exhaustive research into this phenomenon is that recently performed by Hutchinson et al.[65] They indicate that RV accidents are 1.9 times more frequent than their actual numbers present in traffic would indicate. Furthermore, that research showed that 42.48 percent of all RV accidents are single vehicle accidents and 53.1 percent involve a vehicle (car or pickup truck) pulling a trailer. The types of trailers in accidents are as follows:

Boat trailers	30.6%
Travel trailers	29.5%
Utility trailers	24.3%
Camping trailers	6.4%
Towed cars	1.1%
Other	8.1%
Total	100.0%

Most accidents took place on straight and level roads--50.9 percent of all RV accidents occurred on a level road while 47.3 percent were on a grade. (The other 1.8 percent occurred on a hill crest.) A total of 76.5 percent of all accidents happened on tangent sections with the remaining 23.5 percent being on curves. Special notice should be given to the fact that 14.6 percent of all accidents occurred on combined horizontal and vertical curves. Horizontal curves on grades appear to be more dangerous than horizontal curves on level terrain. Further work has been planned relating roadway geometry to accident frequency.[65]* Special areas of concern regarding RV safety are discussed below.

* These results are from the interim report.

A. Winds and Wind Gusts (Natural)

In 4 percent of all RV accidents, sudden gusts of wind were a causal factor, and wind variations from a roadside windbreak were a causal factor in another 1.3 percent.65/ Wind forces acting on RVs are much higher in magnitude than they are on passenger vehicles56,59,66/ because of the large surface areas on RVs. Crosswind disturbances, added to the high drag forces on RVs, can create unpredictable reactions. The forces on RVs can become especially dangerous when there are strong ambient crosswinds interrupted unexpectedly.59/

For sharp edged uniform winds, the transient side forces do not develop to maximum values until the vehicle is several car lengths into the wind. Because of this, it is very difficult for a driver to predict what actions he will have to take to compensate. If the crosswinds are of large enough magnitudes, the vehicle can be displaced laterally causing it to leave the lane or the road.57/ This is of particular concern to van and motorhome drivers because such vehicles exhibit some directional sensitivity to the winds,54/ which increases the unpredictability of the RV reaction to the crosswinds.

A driver of a vehicle towing a trailer, particularly a large trailer, must respond to winds and wind gusts in a manner quite different than he would be accustomed to without the trailer. With a steady crosswind, the driver of a single vehicle (passenger car, motorhome, pickup truck, etc.) must steer into the wind to maintain his lateral placement within the lane. With a large trailer, however, the aerodynamic side forces create, through the hitch, a moment on the towing vehicle tending to turn it into the wind. The driver must correct by steering in the opposite direction--down wind.

Design considerations bearing on this problem are given in the next subsection, in conjunction with design considerations for other types of wind gust problems.

B. Wind Gusts from Passing Trucks and Buses

When a large vehicle (truck or bus) passes another vehicle, lateral aerodynamic forces are created on the passed vehicle from the bow wave and from the following turbulence of the passing vehicle. such forces were a causal factor in 6.2 percent of all RV accidents.65/

With no crosswind present, when a truck or bus passes another vehicle, the other vehicle is first forced away from the passing vehicle by the bow wave, and then forced back toward the passing vehicle because of the turbulence and vacuum behind the passing vehicle.68/ Under these situations, the lateral forces involved, although discomforting, should usually not lead to any real problem. However, if the passed vehicle is pulling a large trailer, the forces and force reversals are more severe and can lead to control difficulties.[57] And, all such passing situations result in greatly magnified forces in the presence of crosswinds, particularly crosswinds which place the recreational vehicle downwind of the passing truck or bus.[56] Large path deviations can result, even though oscillations of the passed vehicle are stable.[63]

The aerodynamic disturbances created from a truck or bus passing another vehicle depend on other factors as well. The magnitude of the forces depends on the square of the speed of the truck or bus.[56] The forces are also aggravated by headwinds but are moderated by tailwinds. (In effect, the relative air speed of the truck or bus is important.) The speed of the truck or bus relative to the passed vehicle is also of concern. If the relative speed between the two vehicles is large, the disturbing aerodynamic forces act for a short time and create only a modest lateral displacement. On the other hand, as the relative speed is diminished, the forces act for a longer period with greater effects.[68] Degradation of control due to these forces is noticeable at a relative speed of 10 mph (16 km/h).[56]

The aerodynamic forces are essentially independent of lane width (lateral distance between truck and recreational vehicle).[57] However, with narrower lanes the disturbances are more likely either to force the recreational vehicle off the road to the right or into the passing truck to the left. Detailed simulations[57] actually produced collisions (on paper) in situations with large (20 to 40 mph) crosswinds and narrow (8 to 10 ft) lanes.

Thus, there are several variables that affect RV safety on the road where aerodynamic disturbance may create a problem: (1) ambient winds; (2) lateral separation of vehicles; (3) absolute speed of passing vehicle; (4) relative (overtaking) speed of vehicles, (5) driver reaction.[68] These are the variables that should be examined if the highway design is to incorporate safety countermeasures.

Ambient winds cannot be eliminated in a practical manner. In extreme cases, windbreaks could be constructed. At other times, signing could be used to warn the driver of potentially windy areas. The designer could also consciously attempt to avoid a design incorporating unnecessary short windbreaks alternated with open areas, such as may happen in rolling terrain with cuts and fills.

On highway sections where passing maneuvers are most likely (e.g., the first few hundred feet of a passing zone), consideration should be given to providing increased lane width, to absorb the lateral displacements of vehicles being passed. Similarly, increased lane width in localized areas subject to wind gusts should also be considered. In lieu of increased lane width, the planner should consider wide stabilized shoulders.

As a traffic control measure, reduced speed warnings could be imposed during periods of high winds.

Finally, the designer should minimize the presence of distracting features and signs in areas where wind gusts and/or passing maneuvers are most likely. By eliminating these distractions, the drivers will be able to devote more attention to the unusual demands of the driving task.

C. Trailer Instability

While RVs as a whole are overrepresented in accidents, vehicles pulling trailers account for nearly 75 percent of this representation.65/ Hitch loading, trailer length, and mass and moment of inertia and pulling vehicle tire pressure can influence the trailer's stability.

That trailer towing possesses certain hazards is recognized by the drivers of towing vehicles, although they may not agree on the reasons. In a survey,66/ drivers of articulated vehicles were asked to rate various potential problem areas. Although 99 percent of the drivers felt that their trailer was well balanced and safe to drive, they nevertheless thought that lack of power and crosswind and gust stability were the major problems. High speed stability received the best rating (was the least problem). The respondents were also asked to identify sources of control or stability problems. The following were mentioned most often:

1. Being passed by a large vehicle traveling at excessive speeds (203 responses).

2. Strong gusty winds and crosswinds (180).

3. Traveling at speeds above 55 mph (58).

4. Road irregularities (45).

5. Improperly balanced trailer (40).

6. Making a sudden turn or lane change (29).

7. Going downhill on a steep grade (24).

Maneuvering at speeds higher than at 55 mph can easily cause jackknifing.63/ A computer simulation indicated that at a speed of 50 mph with a pulse or step steering input (simulating a sharp turn or lane change) the articulated vehicle could not return to a parallel path, and at 70 mph jackknifing occurred.67/ Braking in a turn at 30 mph also caused the trailer to jackknife in the simulation. Accident data indicate that jackknifing accidents are more likely to occur on downgrades.

It is suggested[57/] that single-axle trailers are less stable dynamically than tandem-axle trailers of comparable size. Accident data[57/] seemingly indicate otherwise--that tandem-axle trailers are less safe. However, these comparisons do not control for trailer size; the tandem axle trailers may be in accidents more frequently than single-axle trailers because they are bigger and more unwieldy, not because they have more axles. These studies also indicate that accident risk increased rapidly with decreasing size of the towing vehicle. Moreover, installation of sway control devices could have a significant impact on the reduction of accidents, although most trailers involved in accidents (72.2 percent) did not have such devices.[65/]

The highway planner and designer can probably do very little to control trailer stability other than provide reminders in recreational areas, etc., about such key elements as the proper tongue weight or hitch load, reasonable speeds, and proper tire pressures. Other than that, the highway planner/designer can only recognize that such instabilities exist, and follow the suggestions of the previous subsection to help alleviate the consequences of these instabilities.

D. RV Overloading

Overloading of recreational vehicles is commonplace. In many instances space available is assumed to be load capacity.[62/] The problem is compounded by manufacturers applying unusable or inaccurate GVWR (gross vehicle weight rating) information with the RVs.[64,69/]

An NHTSA survey[64/] showed that 54 percent of the motorhomes on the road had front-end loads that exceeded recommended capacities, and 43 percent even exceeded the recommended capacity in the unloaded condition with just two front seat occupants. About one-fourth of the motor homes had overloaded rear suspensions.

Another NHTSA survey[59/] found gross mismatching of pickup trucks to camper bodies, causing overloading and improper load distribution. Still other surveys[64,69/] have found that nearly two-thirds of the pickup campers had their rear suspensions overloaded, and slightly over half had overloaded front suspensions, although the most recent data indicate some improvement in this respect (40.5 percent overloaded rear suspensions, 22 percent overloaded front suspensions). Generally speaking, travel trailers and towing vehicles are not as frequently overloaded.[65,69/]

Again, the highway planner/designer can do little to control such overloading, but can recognize that it is commonplace, especially with motorhome and pickup campers, and that such overloading will tend to cause control problems, as well as reduce the vehicle acceleration capabilities.

E. Trailer Hitches

Hitch failures or separations were causal factors in 5.7 percent of all RV accidents and accounted for 40 percent of all mechanical malfunctions.65/ These malfunctions ranged from ball and socket separation, with or without safety chains, to accidents in which the trailer did not become separated from the towing vehicle, with the result that the towing vehicle was overturned by the trailer.

Proper hitch loading appears to be the major consideration regarding trailer hitch failures. Simulation studies have found that about 10 percent of the total trailer weight should be on the hitch.58/ Field measurements have shown that average loads are slightly higher than this; among travel trailers the average hitch load was 13 percent, and among camper trailers it was 12 percent.69/

Trailer hitch problems cannot be attacked directly by highway planners and designers. Rather, they must be recognized as a potential causal factor of accidents in situations where severe braking or lateral maneuvering is required. Thus, the planner should take pains to minimize design situations which would require an excessive amount of such maneuvers.

F. Center of Gravity

Recreational vehicles with high centers of gravity and with low ratios of weight-to-wind pressure are overrepresented in the accident data.65/ There is a slight indication that where turning movements are a contributing factor, pickup campers are at fault more often than are other recreational vehicles.52/ Such vehicles seem particularly prone to single vehicle accidents on sharp curves.66/

Computer simulations show that vehicles of this type will roll over rather than skid under certain conditions.54/ These conditions include combinations of lateral maneuvering, such as during a passing maneuver or on a sharp curve, with a high frictional coefficient or skid number.62/

The highway planner/designer should pay special attention to the elimination of sharp turns, and to providing proper super-elevation on curves.

G. Braking

Braking characteristics are important in recreational vehicles in two ways--inadequate braking may result in longer than acceptable stopping distances[63] or undesirable transient behavior,[67] and they can also lead to problems of brake fading on long downgrades.[53,66] Accident studies have found that most car-trailer combinations involved in accidents did not have operational brakes on the trailer.[55] Pickup campers often have brakes that are inadequate from a standpoint of brake fading.[53] Travel trailers are over involved in single vehicle accidents on downgrades.[66]

The implications of braking problems for the highway planner/designer are of two types. First of all, the highway planner/designer should reconsider carefully the stopping sight distance criteria and their application to vehicles such as RVs that may have degraded stopping abilities. Secondly, special treatment may be required on long downgrades, such as providing adequate driver warnings, special slow lanes, and emergency off ramps for vehicles experiencing brake fade. The downgrade considerations are similar to those faced by truck drivers except that (1) truck drivers as a group may be more experienced in utilizing engine drag or other means of maintaining speed control, and (2) trucks generally are more capable than passenger vehicles with trailers of dissipating energy through engine braking or through their service brakes.

H. Vehicle Breakdowns

Equipment malfunction, such as tire failures, hitch failures, broken axles, etc., are a contributing factor in some RV accidents.[52,54,65] The literature does not indicate whether such problems are more frequent with recreational vehicles than with other vehicles. Nevertheless, the implications of such problems can be minimized by providing wide shoulders or frequent vehicle turnouts for drivers who have had an equipment malfunction, or for periodic checking of such things as tires, hitch, etc.

I. Driver Characteristics

Drivers of recreational vehicles usually do not have any special training for the operation of such vehicles, other than through experience.[52,62] Accident data indicate that inexperience is a frequent contributing factor in accidents.[62] From a highway planning and design viewpoint, it is important to recognize this inherent limitation of some drivers which probably cannot be dealt with directly. Instead, the planner/designer should do whatever he can to (1) provide pertinent information to the drivers, (2) avoid design situations that place unusual demands on the drivers, and (3) provide a forgiving highway environment for such drivers when they encounter difficulties.

VIII. SUMMARY AND CONCLUSIONS

A. Recreational Travel

Growth in visitation to federally administered recreational areas has been phenomenal. For example, between 1950 and 1975, recorded visits to the national forests, national parks, and national wildlife refuges increased more than 600 percent, while attendance at Corps of Engineers lakes increased by more than 2,250 percent. Most of this growth has occurred in the East-South Central and West-South Central census divisions.

The growth in visitation to federally administered recreational areas continued to increase through the period of the energy crisis, although at a somewhat diminished rate. That hesitation in the growth rate is now past, and recreational travel in the last year or two has continued to increase strongly. As an average, visitation to federally administered recreational areas has increased 5 percent per year over the last 10 years.

Usage of private campgrounds, in contrast, has been increasing at an average rate of about 15 percent per year over the last half dozen years. This average growth rate has been exceeded most years except for 1974 when, in response to the energy crisis, the growth rate was only about 5 percent.

Based on recreational area visitations, by 1990 there will be between about 1.55 times as much recreational travel as in 1975. In other words, recreational travel, as measured by visits to major outdoor recreational resources, will grow about 3 percent per year, a lower rate than observed over the past 10 to 20 years. This projection is for a "no surprise" future in which no major catastrophic events or changes in our way of life occur. This projection recognizes, for example, that even with a doubling of price for petroleum products in the last few years, there has been essentially no lasting impact on recreational travel--the response of the American public has been to virtually ignore the price change.

Linear projections of traffic (vehicle counts) on selected routes known to be serving primarily recreational traffic suggests a higher growth rate--about 5.5 percent per year. Moreover, using travel survey data from 1972 and 1976 implies a growth of about 16 percent per year in personal long distance mileage (100 miles or more one way) by auto and truck.

These widely varying projections, based on independent data bases, illustrate the difficulty of making such projections even with a no-surprise future. Nevertheless, all projections agree on one thing. Highway travel for recreational purposes will grow more rapidly than total highway travel. Discounting the survey-based projection as the most likely erroneous, recreational travel will probably grow 1.5 to 2 times as rapidly as total highway travel.

B. Recreational Vehicle Ownership

Recreational vehicle ownership has experienced strong and steady growth over the past 25 years, except for a major drop in sales during the energy crisis and economic recession period of 1973-1975. Recreational vehicle ownership is expected to continue to grow in the future, but at a gradually declining rate such that, within about a decade, ownership will essentially stabilize. This phenomenon has been seen in the past in regard to boat ownership and, more recently, with respect to snowmobile ownership. A point will be reached when virtually everyone who wants to own a recreational vehicle will own one. After that time, recreational vehicle usage will continue to grow, but more slowly than in the past.

While total production of RVs has increased steadily (with the exception of the 1973-1975 period) there have also been shifts in the mix of the types of vehicles produced. Historically, the production of travel trailers dominated the industry. However recent figures indicate that motorhomes have become the production leader, followed by pickup covers. In the future, it is expected that motor homes (especially of the "mini" variety) will become ever more dominant and that travel trailers will remain popular, continuing a recent trend away from the large truck campers.

Of the number of events which could result in major changes in the American way of life, two seem most likely. One is an increasing shortage of petroleum energy; the other is a shift to the 4-day workweek.

It is expected that consumers will modify their behavior in such a way as to maximize the opportunity for a continued high level of recreation participation regardless of changing energy policies. As previously indicated, the historical public approach to substantial increases in petroleum prices has largely been to ignore that price increase. If, however, changes occur which can no longer be ignored, several possibilities are apparent. One obvious response is a shift toward more fuel-efficient RVs and passenger vehicles with essentially no change in travel patterns. Beyond that there may be a shift toward using smaller, more efficient vehicles for long distance travel, and purchase or lease of larger recreational vehicles within major destination areas. It is also conceivable that mass transit could be more effectively utilized, although there are a number of reasons to believe that this will not be a major factor in recreational travel.

A shift to a 4-day workweek, which has been predicted by many for some time although it has not yet come to pass in large measure, would have tremendous implications on recreational travel. On the one hand, such travel would tend to be redistributed over a much larger period of the week--Thursday evening through Monday night as opposed to the typical weekend travel period from Friday evening to Sunday night. In addition, many workers will probably decide to maintain their permanent residence near a recreational area, and commute for a 4-day, 3-night period to more minimum accommodations near their work location. In such a case, the traveler would utilize smaller, more fuel efficient vehicles, and the presence of recreational vehicles on the highways would be lessened.

C. Operational Effects of RVs

Currently used procedures provide adjustments for the effects of trucks and buses in the traffic flow. Tables, figures and the associated procedures are available in standard references. The procedures are similar for two-lane and multilane facilities, although the numerics are different.

In recent Canadian investigations, field data were collected and analyzed to quantify the influence of RVs employing the currently accepted procedure. These data, and related work by others, caused the validity of the procedures to be questioned.

A new procedure that employs results from a traffic simulation model has been developed by MRI and applied to mixed flows with trucks and RVs on two-lane highways. The new procedure views vehicle equivalency in a more general framework, and results are now available for one highway design or average speed (65 mph). The MRI work provides methods for estimating vehicle performance characteristics from associated engineering attributes, as well as methods to estimate the overall speeds of vehicles on specified alignments. This combination of capabilities suggests that vehicle populations projected for future years can be evaluated for their traffic characteristics.

The same basic vehicle equivalency concept can be carried over to multilane flow. However, the means of incorporating low performance vehicles is somewhat different. Recent work (again, by MRI) has developed graphical procedures for estimating speeds and service levels of mixed flows of cars and trucks on grades. It appears that the procedures can also be applied to flows containing RVs, although it will be necessary to account for the different driving habits of truck and RV drivers.

D. Safety Effects of RVs

A number of safety-related features of RVs have been identified, in addition to those associated with their operational effects on traffic (performance). These fall into the following categories:

- Winds and wind gusts (natural)
- Wind gusts from passing trucks and buses
- Trailer hitches
- Recreational vehicle loading
- Trailer instability
- Vehicle breakdowns
- Driver characteristics
- Center of gravity
- Braking

Perhaps the most important, from the standpoint that it is a rather unique and severe problem for RVs, is the effect of wind gusts, natural or caused by passing maneuvers.

Many of the safety considerations are out of the hands of the highway planner/designer. At best, he must recognize their existence and plan his facilities so as not to aggravate any problems, or to be accommodating (or forgiving) to driver errors or vehicle problems. Particular concern should be placed on providing adequate (or extra) lane width, good shoulders, large radius curves with proper super-elevation and appropriate signing. He should attempt to minimize terrain-induced wind gusts and long, steep downgrades.

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APPENDIX A

ANNUAL VISITATION TO PUBLIC RECREATION AREAS

TABLE A-1

ANNUAL VISITATION TO STATE PARKS 1950-1975
(thousands)

Year	Visits
1950	114,290
1951	120,722
1952	149,255
1953	159,115
1954	166,427
1955	183,187
1956	200,705
1957	a/
1958	237,328
1959	255,309
1960	259,001
1961	273,484
1962	284,795
1963	a/
1964	a/
1965	a/
1966	a/
1967	391,062
1968	a/
1969	a/
1970	482,536
1971	a/
1972	a/
1973	a/
1974	a/
1975	565,714

Source: State Park Statistics, The National Conference on State Parks, (a branch of the National Recreation and Park Association) Washington, D.C.

a/ Visitation data were not collected by National Recreation and Park Association.

TABLE A-2

ANNUAL VISITATION FOR THE NATIONAL PARK SYSTEM
(thousands)

Year	Visits
1950	33,252 a/
1951	37,106 a/
1952	47,379
1953	52,288
1954	54,210
1955	56,573
1956	61,602
1957	68,016
1958	65,461
1959	68,901
1960	79,229
1961	86,663
1962	97,044
1963	102,710
1964	111,385
1965	121,312
1966	133,081
1967	139,675
1968	150,835
1969	163,990
1970	172,004
1971	200,500
1972	211,600
1973	215,500
1974	217,400
1975	238,800
1976	267,800

Source: National Park Service.
a/ Does not include National Capital Park System.

TABLE A-3

ANNUAL VISITATION TO NATIONAL FOREST RECREATION AREAS[a] 1950-1976
(thousands)

Year	Visits
1950	27,367
1951	29,950
1952	33,006
1953	35,403
1954	40,304
1955	45,712
1956	52,556
1957	60,957
1958	68,449
1959	81,521
1960	92,594
1961	101,912
1962	112,762
1963	122,582
1964	133,762
1965	160,336
1966	150,728
1967	149,647
1968	156,665
1969	162,838
1970	172,554
1971	178,109
1972	183,958
1973	188,174
1974	192,915
1975	199,200
1976	199,928

Source: U.S. Forest Service

a/ Includes of campgrounds, picnic grounds, winter sports sites, hotels and resorts, recreation residences and use of other forest areas.

TABLE A-4

ANNUAL VISITATION TO CORPS OF ENGINEERS RECREATION AREAS
(millions)

Year	Visits
1950	16
1951	21
1952	30
1953	41
1954	54
1955	63
1956	71
1957	85
1958	95
1959	106
1960	109
1961	120
1962	127
1963	147
1964	156
1965	169
1966	194
1967	204
1968	227
1969	254
1970	276
1971	310
1972	328
1973	344
1974	352
1975	376

Source: U.S. Army Corps of Engineers.

TABLE A-5

ANNUAL VISITATION TO RECLAMATION PROJECT RECREATION AREAS 1958-1975[a/]

(thousands)

Year	Visits[b/]
1958	19,500
1959	22,700
1960	24,300
1961	25,500
1962	27,000
1963	34,700
1964	34,300
1965	36,600
1966	44,900
1967	47,900
1968	49,500
1969	54,500
1970	54,200
1971	55,700
1972	56,200
1973	56,400
1974	63,800
1975	64,700

Source: Bureau of Reclamation.

a/ Data before 1958 are not available.

b/ Visits are the same as the recreation days as defined by the Corps of Engineers.

TABLE A-6

ANNUAL VISITATION TO BUREAU OF LAND MANAGEMENT AREAS 1964-1975
(thousands)

Year[a]	Visits
1964	17,500
1965	27,239
1966	37,836
1967	48,547
1968	56,933
1969	64,760
1970	67,238
1971	91,240
1972	84,566
1973	95,359
1974	89,359
1975	79,529

Source: Bureau of Land Management.
a/ Visitation data not available before 1964.

TABLE A-7

ANNUAL VISITATION TO NATIONAL WILDLIFE REFUGES AND FISH HATCHERIES 1951-1975
(thousands)

Year	National Wildlife Refuge Visits	Fish Hatchery Visits	Total Visits
1951	3,442	--	--
1952	4,261	--	--
1953	4,687	--	--
1954	5,202	--	--
1955	6,974	--	--
1956	7,555	--	--
1957	8,669	--	--
1958	9,114	--	--
1959	9,936	--	--
1960	10,754	--	--
1961	11,121	--	--
1962	10,871	--	--
1963	12,435	--	--
1964	14,020	a/	--
1965	12,906	2,031	14,937
1966	13,803	2,180	15,983
1967	14,200	2,177	16,377
1968	14,500	2,031	16,531
1969	16,300	2,276	18,576
1970	17,872	2,543	20,415
1971	19,000	2,802	21,802
1972	21,000	3,005	24,005
1973	19,588	3,046	22,634
1974	21,538	3,021	24,559
1975	24,121	2,938	27,059

Source: U.S. Fish and Wildlife Service.
a/ Visitation data for fish hatcheries were not available before 1965.

TABLE A-8

ANNUAL VISITATION TO TVA DAMS AND STEAM PLANTS 1950-1976
(thousands)

Year	Visits
1950	6,408
1951	5,683
1952	5,748
1953	6,730
1954	7,463
1955	8,671
1956	9,635
1957	11,495
1958	10,676
1959	11,005
1960	10,441
1961	10,677
1962	11,231
1963	10,963
1964	11,707
1965	11,387
1966	11,847
1967	12,237
1968	11,755
1969	12,653
1970	12,193
1971	12,943
1972	13,714
1973	12,892
1974	12,297
1975	13,488
1976	13,256

Source: Tennessee Valley Authority.

APPENDIX B

SELECTED SOCIOECONOMIC CHARACTERISTICS
OF RECREATION VEHICLE OWNERS

TABLE B-1

HOUSEHOLD INCOME CHARACTERISTICS OF RECREATION VEHICLE OWNERS - 1976

Income ($)	Percent
5,000-Less	2.80
5,000-9,999	8.03
10,000-14,999	20.13
15,000-24,999	45.23
25,000-Over	23.73

Source: Recreation Vehicle Industry Association, unpublished report, Woodall Publishing Company (1976).

TABLE B-2

OCCUPATIONS HELD BY RECREATION VEHICLE OWNERS - 1976

Ocupation	Percent	Mileage[a/]
Professional/Executive Manager	36.25	14.6
Retired	25.00	6.6
Blue Collar/Semiskilled	15.53	10.9
Clerical/Sales/Service	5.89	13.3
Laborer/Unskilled Labor	2.85	10.9
Farmer	1.96	8.6
Military	0.53	
Student	0.17	10.0
Other	11.78	

Source: Recreation Vehicle Industry Association, unpublished report, Woodall Publishing Company (1976).

a/ Total average annual mileage (in thousands) per vehicle by persons in this category, from 1972 Nationwide Personal Transportation Study.

TABLE B-3

EDUCATION CHARACTERISTICS OF RECREATION VEHICLE OWNERS - 1976

Education Level	Percent
No High School	15.35
High School Graduate	32.14
Some College	23.39
College Graduate	15.17
Post Graduate Work	13.92

Source: Recreation Vehicle Industry Association, unpublished report, Woodall Publishing Company (1976).

TABLE B-4

AGE CHARACTERISTICS OF RECREATION VEHICLE OWNERS - 1976

Age (years)	Percent
Under 25	0.53
25-34	8.00
35-44	20.64
45-54	27.22
55-64	30.42
65 and Over	13.16

Source: Recreation Vehicle, Industry Association, unpublished report Woodall Publishing Company (1976).

TABLE B-5

SELECTED COMPARISONS OF RECREATION VEHICLE OWNER CHARACTERISTICS - 1968-1976

Income ($)	1968[a]	1976[b]
5,000-Under	18.1	2.80
5,000-9,999	54.6	8.03
10,000-14,999	9.1	20.18
15,000-24,999	13.6	45.23
25,000-Over	4.5	23.73
Age (years)		
Under 25	0.7	0.53
25-34	8.5	8.00
35-44	20.6	20.64
45-54	31.9	27.22
55-64	27.7	30.42
65-Over	10.6	13.16

a/ A Profile Study of Selected Recreational Vehicle Users, Woodall Publishing Company (1968).

b/ Recreation Vehicle Industry Association, unpublished report, Woodall Publishing Company (1976).

APPENDIX C

RECREATIONAL TRAVEL TRENDS--
COMPARISON OF NATIONAL TRAVEL SURVEYS

Although availability of national travel data are limited, two comparable surveys were performed in 1972 and 1976. The 1972 survey was conducted by the U.S. Bureau of the Census,[3/] the 1976 National Travel Survey was sponsored by the U.S. Travel Data Center.[2/]

In the section that follows, the 1972 and 1976 travel statistics are compared in terms of trips, person-trips, person-miles, and person-nights. (A "trip" is defined as travel to a place 100 miles or more away from home and return, whether or not an overnight stay is involved. Every time one or more members of a household travel together, a trip is recorded. A "person-trip" is counted every time one person makes one trip. If three members of a household travel together, this is one trip but three person-trips. A "person-mile" is recorded whenever one person travels one mile. A "person-night" is counted when one person spends one night away from home.)

Overall Travel Statistics

The volume of the travel segment represented by trips of 100 miles and over in the United States has increased significantly in the last 4 years. A total of almost 706 million person-trips were taken during the year, 7 percent over the previous year's level and 54 percent above the 1972 level. The total number of person-miles traveled was 608 billion and person-nights away from home almost 2.9 billion; these were increases over 1972 of 65 and 61 percent, respectively. As indicated in the body of the report this is at the highest end of likely growth estimates.

Although the increases in total activity are significant, the individual characteristics of the average trip vary only slightly from 1972. In each case they indicate increased travel in 1976, however.

CHARACTERISTICS OF THE AVERAGE TRIP, 1976 and 1972

	1976	1972
Persons per trip	2.00 persons	1.94 persons
Miles per trip	862 miles	806 miles
Nights per trip	4.06 nights	3.88 nights

Auto/truck travel remains the most popular travel mode and is up 52 percent over 1972. Air travel, up only 42 percent during the period, also shows a significant growth. It appears that the airlines have lost a portion of their share of the total travel market to other common carriers, which show a 125 percent increase in travel over 1972.

PERCENT DISTRIBUTION OF ALL PERSON-TRIPS, PERSON-MILES AND PERSON-NIGHTS BY TRANSPORT MODE, 1976 AND 1972

Primary Transport	Person-Trips (%)		Person-Miles (%)		Person-Nights (%)	
	1976	1972	1976	1972	1976	1972
Auto/truck	84.3	85.2	71.0	69.4	72.3	71.1
Air	11.2	11.8	24.5	27.6	21.2	23.4
Other	4.5	3.0	4.5	3.0	6.5	5.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

The category of trips showing the greatest increase is pleasure travel. This includes travel for outdoor recreation, sightseeing, or entertainment. Business travel also shows slight growth. Visiting friends and relatives, while decreasing over the period, nevertheless, continues to be the main purpose of travel away from home. The combination of travel for such visits with other pleasure travel now accounts for 67.9 percent of the person-trips and 69.7 percent of the person-miles, compared with 64.1 and 63.1 percent, respectively, in 1972.

PERCENT DISTRIBUTION OF ALL PERSON-TRIPS, PERSON-MILES AND PERSON-NIGHTS BY PURPOSE OF TRIP, 1976 AND 1972

Trip Purpose	Person-Trips (%)		Person-Miles (%)		Person-Nights (%)	
	1976	1972	1976	1972	1976	1972
Visit Friends or Relatives	35.8	38.4	37.5	38.7	38.7	40.7
Other Pleasure	32.1	25.7	32.2	24.4	35.9	27.3
Business	21.3	20.2	21.0	22.0	18.0	16.2
Other	10.8	15.7	9.3	14.9	7.4	15.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

Auto/Truck Travel

Auto/truck travel involved 595 million person-trips in 1976; this represents an increase of 52 percent over 1972. Trips taken in autos/trucks during 1976 involve somewhat larger travel party sizes, and longer distances and durations than in 1972. In addition, auto/truck travel has increased 79 percent for uses such as outdoor recreation, sightseeing, and entertainment. Auto/truck travel has also grown 81 percent during the period for vacations, compared to 35 percent for nonvacational travel.

CHARACTERISTICS OF THE AVERAGE AUTO/TRUCK TRIP, 1976 AND 1972

	1976	1972
Persons per trip	2.19 persons	2.11 persons
Miles per trip	726 miles	657 miles
Nights per trip	3.48 nights	3.24 nights

During the 4-year period the portion of travel by auto/truck to visit friends and relatives has decreased slightly; both air lines and other common carriers have increased their market share.

PERCENT DISTRIBUTION OF ALL PERSON-TRIPS TO VISIT FRIENDS OR RELATIVES BY TRANSPORT MODE, 1976 AND 1972

Transport Mode	1976 (%)	1972 (%)
Auto/truck	89.1	90.2
Air	8.0	7.3
Other	2.9	2.5
Total	100.0	100.0

Although total auto/truck travel for other pleasure trips increased somewhat less than average, dramatic increases of 155 and 274 percent was experienced by airlines and other common carriers respectively during the 4-year period.

PERCENT DISTRIBUTION OF OTHER PLEASURE PERSON-TRIPS BY TRANSPORT MODE, 1976 AND 1972

Transport Mode	1976 (%)	1972 (%)
Auto/truck	82.7	88.9
Air	9.2	6.9
Other	8.1	4.1
Total	100.0	100.0

Time of Travel

Most of the pleasure trips other than visiting friends and relatives occur over weekends, although the gap between non-weekend and weekend travel is closing rapidly. Non-weekend travel showed a much faster growth rate (120 percent) than travel over weekends (67 percent) during the 4-year period. A similar pattern exists between vacation and non-vacation travel. Although vacation travel accounts for 67 percent of all other pleasure person-trips, the gap is closing rapidly. Vacation travel recorded a growth of 90 percent over 1972; this is less than the 119 percent growth in the nonvacation travel.

A total of 46 percent of all trips in the United States during 1976 (325 million person trips) was taken over weekends. During the 4-year period, this type of travel grew 49 percent over 1972. However, the characteristics of the average weekend trip have changed minimumly.

CHARACTERISTICS OF THE AVERAGE WEEKEND TRIP, 1976 AND 1972

Characteristics	1976	1972
Persons per trip	2.28 persons	2.28 persons
Miles per trip	597 miles	594 miles
Nights per trip	2.39 nights	2.24 nights

Weekend travel by automobile/truck shows a slight decrease from 1972, compared to travel by common carriers other than airliners; air travel remains about even.

PERCENT DISTRIBUTION OF ALL WEEKEND PERSON-TRIPS BY MODE OF TRANSPORTATION, 1976 AND 1972

Transport Mode	1976 (%)	1972 (%)
Auto/truck	91.7	93.0
Air	4.5	4.5
Other	3.8	2.5
Total	100.0	100.0

Vacation Travel

Almost 45 percent of all weekend travel is taken in conjunction with vacations, with this type of travel up 77 percent since 1972. Vacation travel accounts for 47 percent of all trips in the United States in 1976 and it increased 86 percent since 1972 in terms of person-trips. These trips involved smaller traveling parties, shorter durations and longer average trip distances.

CHARACTERISTICS OF THE AVERAGE VACATION TRIP, 1976 AND 1972

Characteristics	1976	1972
Persons per trip	2.24 persons	2.29 persons
Miles per trip	1,096 miles	1,056 miles
Nights per trip	5.89 nights	6.21 nights

Although the automobile/truck is the preferred mode of vacation travel, with slightly more than 82 percent of all vacation person-trips taken by this mode in 1976, it was off by nearly 7 percent since 1972. During this period, the airlines have maintained their share of the vacation travel market, but other common carriers have made notable increases. The overall use of other common carriers was up almost 200 percent over 1972.

PERCENT DISTRIBUTION OF ALL VACATION PERSON-TRIPS BY TRANSPORT MODE, 1976 AND 1972

Transport Mode	1976 (%)	1972 (%)
Auto/truck	82.3	89.5
Air	11.4	11.6
Other	6.3	3.9
Total	100.0	100.0

Regional Travel Patterns

For purposes of this discussion, the country is divided into eight travel regions.

TRAVEL REGIONS

Region	States
New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
Eastern Gateway	New Jersey, New York
G. Washington Country	Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia
South	Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee
Great Lakes Country	Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, Wisconsin
Mountain West	Colorado, Montana, Nebraska, North Dakota, South Dakota, Utah, Wyoming
Frontier West	Arizona, Kansas, Missouri, New Mexico, Oklahoma, Texas
Far West and Hawaii	Alaska, California, Idaho, Nevada, Oregon, Washington, Hawaii

Since 1972 the south region has evidenced the greatest increase in popularity as a destination. It is closely followed by the George Washington Country with an increase of 74 percent. The Frontier West Region recorded the least amount of growth, with person-trips to this destination up only 20 percent in the last 4 years.

PERCENT DISTRIBUTION OF ALL PERSON-TRIPS BY REGION OF ORIGIN AND REGION OF DESTINATION, 1976 AND 1972

Region	Region of Origin (%) 1976	1972	Region of Destination (%) 1976	1972
New England	5.1	5.6	5.5	5.5
Eastern Gateway	8.3	8.2	6.4	5.5
George Washington Country	11.7	10.0	10.7	9.4
South	19.8	16.3	22.5	19.2
Great Lakes Country	23.2	24.7	19.4	20.5
Mountain West	4.6	4.7	4.8	4.9
Frontier West	11.5	14.8	11.3	14.6
Far West	15.9	15.7	15.4	15.6
Outside U.S.	NA	NA	4.0	4.0
Total	100.0	100.0	100.0	100.0

If interregional travel is excluded, net flow patterns can be examined to determine which regions are net attractors and which are net generators of travel. In the table below, a plus figure indicates that a region attracts more visitors from other areas than it generates. Conversely a minus indicates that the region generates more visitors which travel to other parts of the country than it attracts.

NUMBER OF INTERREGIONAL PERSON-TRIPS RECEIVED AND ORIGINATED, AND DESTINATION NET FLOW
(in millions)

Region	Received	Originated	Destination Net Inflow
New England	16.0	13.5	+ 2.5
Eastern Gateway	23.9	36.9	- 13.0
George Washington Country	31.2	38.2	- 7.0
South	52.0	33.1	+ 18.9
Great Lakes Country	25.2	52.0	- 26.8
Mountain West	15.1	13.3	+ 1.8
Frontier West	24.8	26.1	- 1.3
Far West	18.1	21.7	- 3.6

APPENDIX D

MATHEMATICAL PROJECTIONS OF RECREATIONAL TRAVEL AND RV OWNERSHIP

This appendix presents the equations used for projecting future travel and ownership trends. The projections use regression analyses, and both linear and logarithmic models were tested. Independent variables examined were time, population, and personal consumption expenditures.

. State Parks: The best fit for historical state park visitation data was a linear function of population for the short-term (15-year) period:

$$V = 10.5P - 1,676$$

$$R^2 = 0.992 \qquad (1)$$

where V = visitation in millions
P = U.S. Population in millions

This equation produces an estimated 1975 value that is very close to the reported actual value; it indicates a comparatively modest rate of growth through 1990. The linear time regression resulted in quite a good fit, with an R^2 value of 0.989, and a 1990 projection about 10 percent higher than the linear population function provided. The logarithmic population forecasting function also provided a reasonably good fit, with an R^2 value of 0.987. The 1990 projection from this equation is approximately 33 percent above the value derived from the population-linear equation. Surprisingly enough, the logarithmic time correlations are generally quite poor, both in terms of correlation coefficient and agreement of calculated and actual values in 1975.

. Corps of Engineers Facilities: A linear population correlation over the 10-year period provided the best fit in terms of the correlation coefficient and agreement with 1975 actual data. The projecting equation is as follows:

$$V = 10.7P - 1,904$$

$$R^2 = 0.995 \qquad (2)$$

where V = visitation in millions
P = U.S. population in millions

The indicated growth increase is modest, with a 1990 value of about 1.7 times the 1975 value. The short-term logarithmic population correlation also gave a fairly good fit, with an R^2 equal to 0.986, and close agreement between observed and calculated 1975 values. Because this is a logarithmic forecast, however, the 1990 projection is 1.57 times the value derived by the linear relationship. Both of the linear time correlations, long-term and short-term, gave results reasonably close to the linear population correlation, although neither the numerical value of the coefficient of correlation nor agreement between observed and actual values in 1975 were as good.

. National Parks: Two projecting equations provided essentially equivalent degrees of correlation with historical data: a logarithmic correlation with population over a 20-year time span, and a logarithmic time correlation over a 25-year period. These relationships are shown as follows:

$$V = e^{(0.0332P - 1.59)} \qquad R^2 = 0.991 \tag{3}$$

or,

$$V = e^{(0.0737Y + 4.41)} \qquad R^2 = 0.994 \tag{4}$$

where V = visitation in millions
P = U.S. population in millions
Y = year, with 1960 = 0.

Despite the closeness of fit with historical data, the end results in terms of 1990 projections are quite different. The 1990 result of time series provided a result 1.4 times greater than the population function. Neither the 10-year nor the 25-year linear population functions proved a very good fit with historical data; both of these produced considerably lower 1990 visitation estimates. Since both of the equations providing the best fit with historical National Park Service data are logarithmic, the resulting projections show a 1975-1990 growth rate that is much higher than the growth rates of the linear functions that provided the best fits for the other resources. Accordingly, we have also shown national park visitation projections to 1990 by the best-fit linear relationship in Table 8; the associated Equation 5 is as follows:

$$V = 6.80P - 1{,}206 \qquad (5)$$

$$R^2 = 0.962$$

where V = visitation in millions
P = U.S. population in millions

. U.S. Forest Service: A 10-year linear population correlation provided the best fit with historical data. The projecting equation is as follows:

$$V = 3.00P - 442 \qquad (6)$$

$$R^2 = 0.994$$

where V = visitation in millions
P = U.S. population in millions

This equation indicates relatively modest future growth, with a 1990 visitation figure 1.36 times the 1975 value. A 10-year logarithmic population correlation was almost as good, with an R^2 value of 0.988; this equation yields projections approximately 10 percent higher than the linear equation.

. Boats: Since the absolute rate of growth over the last decade has been so low, there is really little choice between using a linear and logarithmic projecting relationship. Accordingly, we tested both population and time as independent variables, and found the best fit to be a linear population relationship. Because of slow growth, both logarithmic and linear time relationships are also quite good. Ownership data for outboard motors show a similar saturated market pattern in recent years. The best fit linear population relationship provides a 1990 boat ownership projection just 1.29 times the 1975 figure, which represents an extremely slow annual rate of growth. The equation is as follows:

$$B = 0.0474P - 2.45 \qquad (7)$$

$$R^2 = 0.996$$

where B = boat ownership in millions
P = U.S. population in millions

. Recreational Vehicles: For projecting equations, we tested both linear and logarithmic relationships between recreational vehicle sales and time, current dollar personal consumption expenditures aggregate, and aggregate constant dollar personal consumption expenditures, for both 8-year and 16-year periods. As might be expected, the two best-fitting projecting equations were a logarithmic time correlation and a linear correlation with aggregate current dollar personal consumption expenditures; for both series, the 16-year period was superior to the 8-year period. The two projecting equations are as follows:

$$S = 7.57C - 3{,}759 \qquad R^2 = 0.934 \qquad (8)$$

and

$$S = e^{(0.248Y + 1.92)} \qquad R^2 = 0.950 \qquad (9)$$

where S = sales in millions of dollars
C = current dollar PCE in billions of dollars
Y = year, with 1950 = 0.