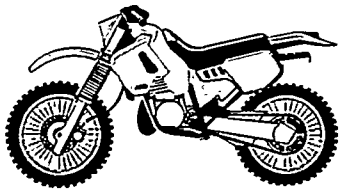

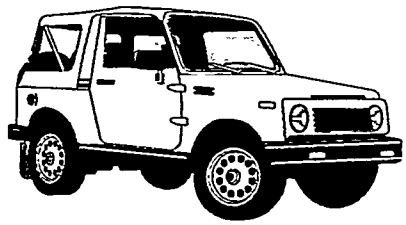

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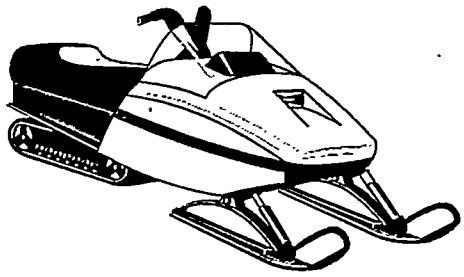

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Fuel Used for Off-Road Recreation: A Reassessment of the Fuel Use Model

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July 1999

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LIST OF ACRONYMS AND ABBREVIATIONS

ATV	All-terrain vehicle
ACSA	American Council of Snowmobile Associations
BLM	Bureau of Land Management
CARB	California Air Resources Board
cc	Cubic centimeter
CPSC	Consumer Product Safety Commission
DMV	Department of Motor Vehicles
DOT	Department of Transportation
EPA	Environmental Protection Agency
F	Fahrenheit
FMVSS	Federal Motor Vehicle Safety Standards
FHWA	Federal Highway Administration
FVE	Full vehicle equivalent
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ISIA	International Snowmobile Industry Association
ISMA	International Snowmobile Manufacturers Association
MIC	Motorcycle Industry Council
mpg	Miles per gallon
NASPD	National Association of State Park Directors
NCDC	National Climatic Data Center
NFS	National Forest Service
ORNL	Oak Ridge National Laboratory
se	Standard error
SVIA	Specialty Vehicle Institute of America
TEA-21	Transportation Equity Act for the 21st Century
TIUS	Truck Inventory and Use Survey
VIUS	Vehicle Inventory and Use Survey
vmt	Vehicle miles traveled
USDA	U.S. Department of Agriculture

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EXECUTIVE SUMMARY

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) established a National Recreational Trails Funding Program and the National Recreational Trails Trust Fund. ISTEA required that certain tax revenue generated from the sales of motor fuel used for off-road recreation be transferred from the Highway Trust Fund to the Trails Trust Fund for recreational trail and facility improvements. In order to apportion the Trails Trust Fund to individual States equitably, the Federal Highway Administration (FHWA) asked the Oak Ridge National Laboratory (ORNL) in 1993 to estimate the amount of motor fuel used for off-road recreation at the State level by different vehicle types. A modification of the methodology developed by ORNL has been used to apportion funds to the States since that time.

The recent surface transportation reauthorization act, the Transportation Equity Act for the 21st Century (TEA-21), extends the funding for the Recreational Trails Program for six years (from 1998 to 2003) with significant increases[1]. To ensure that the current method benefits from recent, more accurate data than those available in 1993–1994 and to investigate the concern that light truck recreational fuel usage is overestimated, the model previously designed by ORNL was re-evaluated, and the results of the analysis are documented in this report.

For this estimation procedure, off-road recreational fuel use is defined as Federally-taxed gasoline, gasohol, diesel fuel, or special fuel used in recreational motorized vehicles on recreational trails or back country terrain. Fuel used in outdoor non-engine recreational equipment, such as camp stoves, heaters, and lanterns, was excluded from the analysis because this fuel is not subject to the Federal motor fuel

[1]TEA-21 eliminated the National Recreational Trails Trust Fund, but funding apportionments to the States still require an estimate of off-highway recreational fuel use.

excise tax. Vehicle types included in the study are light trucks (pickups and sport utility vehicles), motorcycles, all-terrain vehicles (ATVs), and snowmobiles.

As in the previous study, it was determined that a standardized estimation procedure for all States using easily obtainable and understandable data would be preferred over State-submitted reports. Reasons for this decision include incompatibility of State-submitted estimates, along with the fact that an estimation procedure would still be required at the Federal level for States which did not submit estimates. For this reason, individual State surveys were not heavily investigated during this effort.

A methodology for fuel use estimation was determined for each vehicle type based on the previous study and any new data sources available. Fuel use estimates rely on the population of vehicles within a State and an estimate of the average annual fuel used per vehicle. Every effort was made to include registered and non-registered vehicles. The amount of time a vehicle is used for recreational pursuits as opposed to non-recreational off-road travel was also taken into consideration.

Once the estimate of total off-road recreational fuel use was determined, the State shares were adjusted by a factor determined by the amount of rural land in the State. The adjustment was deemed necessary since vehicle registration data can be misleading for estimating fuel use by State if a vehicle travels in a different State than that in which it is registered.

After the adjustment for land usage potential was incorporated, a percentage of total fuel usage, by State, was computed. This percentage will be used in the final apportionment of funds. ORNL recommends that updated data be incorporated annually into the apportionment formula and that the percentage be recalculated each year based on these updated data.

1 INTRODUCTION

1.1 Background

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) established a National Recreational Trails Funding Program and the National Recreational Trails Trust Fund. ISTEA required that certain motor fuel tax revenues generated from the sales of motor fuel for off-road recreational purposes be transferred from the Highway Trust Fund to the Trails Trust Fund for recreational trail and facility improvements. The motivation behind the Program was that while taxes were generated from sales of motor fuel used primarily for off-road recreational purposes, no commensurate benefits were received by those who made those purchases[2].

Under the ISTEA, the Federal Highway Administration (FHWA) was charged with the development of State by State estimates of the amount of fuel used for off-road recreational purposes. These estimates would then be used to apportion funds available through the National Recreational Trails Funding Program to individual States. Charged with this mission, FHWA in 1993 asked the Oak Ridge National Laboratory (ORNL) to develop a method that estimates the amount of motor fuel used for off-road recreational purposes at the State level. The methodology developed by ORNL is documented in the report *Fuel Used for Off-Highway Recreation* (ORNL, 1994). A modification of the ORNL model was used by the FHWA from 1996 to 1999.

The recent surface transportation reauthorization act, the Transportation Equity Act for the 21st Century (TEA-21), replaced the original Trails Program with a new Recreational Trails Program. TEA-21 significantly increased the amount of funding

[2]The Congress never appropriated Funds through the National Recreational Trails Trust Fund. However, funding was provided for the program from the FHWA's administrative funds in 1993, 1996, and 1997.

available for the program over its six years (from 1998 to 2003). To ensure that the method for distributing program funds benefits from recent, more accurate data than those available in 1993–1994, FHWA asked ORNL to re-evaluate this model with particular emphasis on light truck recreational fuel usage because of concerns that the representation in the previous model was overestimated.

1.2 General Approach

For this study, as with the previous study, off-road recreational fuel use is defined as Federally-taxed gasoline, gasohol, diesel fuel, or special fuel used in recreational motorized vehicles on recreational trails or back country terrain. Both registered and unregistered recreational motorized vehicles are included insofar as the number of unregistered vehicles can be determined. Fuel used in outdoor non-engine recreational equipment, such as camp stoves, heaters, and lanterns is excluded because these fuels are not subject to the Federal motor fuel excise tax.

With a fixed amount of funding, the challenge is how to *equitably* apportion these funds to individual States based on the level of fuel used for off-road recreation. Two options are available to address this challenge. The first one is to rely on the individual States to submit their annual estimates on off-road recreational fuel use. The advantage of this option is that individual States could devote more resources to this activity, and can receive more cooperation in obtaining the data, than FHWA could. As a result, individual States might be able to produce more reliable estimates than FHWA could. However, more resources and more data do not guarantee more reliable estimates. The burden is then on the FHWA to verify the estimation methods employed by the individual States. This leads to three possible drawbacks if the first option is used. First, individual States may over-estimate their off-road recreational fuel use. Second, the compatibility among States in estimating off-road recreational fuel use becomes an enormous issue in trying to apportion the funds equitably. The

third drawback of this option is that every State may not submit the required estimate. In the 1992–1993 period, only 23 States submitted data, and some of the estimates are for 1987 while others are for 1989 or 1990. Consequently, an estimation procedure would need to be developed for the remaining 22 States that failed to submit data, adding further complexity to the compatibility issue.

To overcome the disadvantages of the first option, a second option to meet the challenge is to "standardize" the estimation procedure and develop a **common** tool which can objectively apportion the Recreational Trails Program funds on an annual basis. Two factors characterize this option: ❶ individual State shares of the total program funds need to be developed using a uniform approach, and ❷ data needed for the estimation purpose should be publicly available and easily obtainable so that these estimates can be generated for all subsequent years. It is these two factors that govern the development of ORNL's estimation procedures, both in 1994 and in the current re-evaluation. It is also because of these two factors that ORNL's estimates are recommended over individual States' estimates. Of course, this option is not without its drawbacks. One major drawback is the failure to take advantage of more detailed State-specific information. Nonetheless, this methodology was used under ISTEA and is recommended for use under TEA-21.

In the previous methodology, as in this re-evaluation of the approach, fuel use estimates rely heavily on the population of vehicles within a State. State vehicle registration can be used in some cases, such as for light trucks (pickups and sport utility vehicles). All light trucks are required to register with each State. This is not the case with other vehicle types, such as snowmobiles, off-road motorcycles, and all-terrain vehicles (ATVs). Some States require registration, some allow optional registration, and still others require no registration of these vehicle types at all (Table 1.1 and Appendix A). In this study, every attempt was made to include

Table 1.1. States which require some form of registration of off-highway vehicles[1]

State	Light trucks	Off-highway motorcycles	ATVs	Snowmobiles
Alabama	✔			
Alaska	✔			✔
Arizona	✔			
Arkansas	✔		✔	
California	✔	✔	✔	✔
Colorado	✔	✔	✔	✔
Connecticut	✔	✔	✔	✔
Delaware	✔	✔	✔	✔
District of Columbia	✔			
Florida	✔	✔	✔	
Georgia	✔			
Hawaii	✔			
Idaho	✔	✔	✔	✔
Illinois	✔			✔
Indiana	✔	✔	✔	✔
Iowa	✔	✔	✔	✔
Kansas	✔			
Kentucky	✔			
Louisiana	✔	✔	✔	
Maine	✔	✔	✔	✔
Maryland	✔	✔	✔	✔
Massachusetts	✔	✔	✔	✔
Michigan	✔	✔	✔	✔
Minnesota	✔	✔	✔	✔
Mississippi	✔			
Missouri	✔		✔	
Montana	✔	✔	✔	✔
Nebraska	✔			✔
Nevada	✔			
New Hampshire	✔	✔	✔	✔
New Jersey	✔		✔	✔
New Mexico	✔	✔	✔	✔
New York	✔	✔	✔	✔
North Carolina	✔			
North Dakota	✔		✔	✔
Ohio	✔	✔	✔	✔
Oklahoma	✔			
Oregon	✔	✔	✔	✔
Pennsylvania	✔		✔	✔
Rhode Island	✔	✔	✔	✔
South Carolina	✔			
South Dakota	✔			✔
Tennessee	✔			
Texas	✔		✔	
Utah	✔	✔	✔	✔
Vermont	✔	✔	✔	✔
Virginia	✔			
Washington	✔	✔	✔	✔
West Virginia	✔			
Wisconsin	✔		✔	✔
Wyoming	✔			✔
Total number of States	51	24	31	31

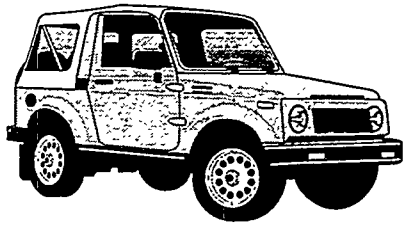
Source: Light trucks: Federal Highway Administration, 1998. Motorcycles: Motorcycle Industry Council, 1998. ATVs: Specialty Vehicle Institute of America, 1998. Snowmobiles: International Snowmobile Manufacturers Association and Table 5.2.

[1] Many conditions may apply to the registration, such as type of vehicle, ownership of land the vehicle is using, and length of time between registrations. See Appendix A for details on State registrations by vehicle type.

registered as well as unregistered vehicles. Another factor considered was the amount of time these vehicles are used for recreational pursuits as opposed to non-recreational off-road travel. In particular, light trucks, snowmobiles, and ATVs are sometimes used off-road for purposes other than recreation. And in the case of light trucks and motorcycles, adjustments are necessary for the amount of time spent off-road as opposed to on-road.

Once the recreational off-road vehicle population by State was determined for each vehicle type, estimates of annual fuel use per vehicle were used to arrive at an estimate of the total fuel used annually for each vehicle type by State. Details on the estimation of fuel use by vehicle type are contained in this report: Chapter 2 - Light Trucks; Chapter 3 - Motorcycles; Chapter 4 - ATVs; and Chapter 5 - Snowmobiles. Chapter 6 contains information on other relevant data which were investigated for inclusion in the model. Conclusions are discussed in Chapter 7. Appendix A contains information on State registration details of the different vehicle types and Appendix B contains programs used for extracting information from the 1992 Truck Inventory and Use Survey.

2 LIGHT TRUCKS



2.1 Introduction

Light trucks are growing in popularity for personal travel use, evidenced by a 39% growth in sales of pickups and sport utility vehicles from 1993 to 1997 (ORNL, 1999). (In this study the term light trucks refers to pickup trucks and sport utility vehicles less than 10,000 pounds gross vehicle weight.) Though many of those vehicles never leave the street, some are used to travel off-road for recreation. There are many clubs and organizations all over the nation that promote off-roading, and there is a lot of information made available about the "sport" in general. The trucks often travel over rocky, mountainous terrain, sometimes using a winch to overcome natural obstacles such as trees or rocks. In many areas there are designated trails for light trucks to use for off-road recreation.

2.2 Investigation into Light Truck Fuel Use Estimation

Some States have raised concerns that the light truck fuel use is overestimated in the previous off-road fuel use estimations. Light trucks represented 90% of all off-road fuel use in the latest FHWA estimates. Also, there were concerns that the fuel economy of off-road trucks as estimated by the 1987 Truck Inventory and Use Survey (TIUS) (Bureau of the Census, 1990) was too high. The light truck fuel use methodology was examined and changes were made to make use of newly available data whenever possible.

The FHWA began publishing registration data for light trucks in *Highway Statistics 1966* (FHWA, 1967). Pickup trucks and sport utility vehicles could not be distinguished from other light trucks because all light trucks were reported in one category. However, beginning with *Highway Statistics 1994* (FHWA, 1995), the FHWA improved the light truck registration data to include registrations by truck

type (pickup, sport utility, van, and other). Also, the 1992 TIUS data (Bureau of the Census, 1995) are now available instead of the 1987 TIUS, which was used in the previous study.

During the investigation into the previous light truck methodology, it was discovered that there was some misleading information in the TIUS documentation, both for 1987 and 1992 data, concerning the amount of personal use of the vehicle. This was important because the amount of personal use of a truck was used to determine whether a vehicle was traveling off-road for recreational purposes as opposed to business use.

On the TIUS questionnaire (Bureau of the Census, 1992), there was a question "Which of the following best describes the way this vehicle was most often operated?" Following were five boxes which could be checked as the answer – Business Use, Personal Transportation, For-Hire, Daily Rental, or Mixed. If the box marked "Mixed" was checked, there were blanks to be filled in for "Percent business use," "Percent personal use," and "Percent for-hire." Though the documentation makes no mention of it, ORNL discovered that the Census Bureau reclassified records which had an answer of "Mixed" into the other categories. The Census Bureau confirmed that only records which were exactly 50 percent personal use and 50 percent business use were left as "Mixed" in the final dataset; all other records were reclassified into whichever category had the greatest percentage (Bureau of the Census, personal communication with Stacy Davis, October 8, 1998). For instance, if someone marked "Mixed" as the answer, and wrote 40% business use and 60% personal use, the record was re-coded as "Personal Transportation" instead of "Mixed." Without this knowledge, the previous study used all records marked "Personal Transportation" to be 100% personal use. This would have included some portion of business use and excluded the personal use which was re-coded into the "Business Use" or "For-Hire" categories.

For this study a slightly different methodology was used to determine the amount of recreational use of a light truck as opposed to business use. Because of the new understanding of the TIUS coding, the data in this study more accurately reflect the recreational use of light trucks.

The 1987 TIUS data indicated that off-road light truck fuel economy was 10% lower than that of on-road trucks. Using 1992 data the results were the same – light trucks traveling 100% off-road had a fuel economy which was 10% lower than light trucks traveling 100% on-road. In a further attempt to validate the fuel economy of off-road light trucks, the Environmental Protection Agency (EPA) Office of Mobile Sources was contacted. Unfortunately, they have no data whatsoever on off-road light trucks (EPA, Office of Mobile Sources, personal communication with R. G. Boundy, ORNL, October 1998). ORNL also contacted people from off-road organizations around the nation. As suspected, these organizations could give specific examples from their own experience but were not able to provide any national sources of information about the off-road recreation of light trucks. In the absence of any other data on the fuel economy of off-road light trucks, the 1992 TIUS data are used in this analysis.

2.3. Population of Off-Road Recreational Light Trucks

In order to know the off-road fuel use for light trucks, it is essential to know how many light trucks there are and what portion of them are used off-road for recreational purposes. Since the 1994 edition, FHWA's *Highway Statistics* publication has reported data annually on the total number of pickup truck registrations and the total number of sport utility vehicle registrations by State in Table MV-9. The task then is to determine how many of these trucks are traveling off-road and to what extent they travel off-road for recreational purposes. For this study, it is assumed that all light trucks are registered.

It was determined that the 1992 TIUS is the best source of data on the share of light trucks used off-road for recreational purposes. TIUS is conducted by the U.S. Bureau of the Census and is required by law to be conducted every five years. The latest survey data available at the present time are the 1992 data. Within the next year, the Census Bureau will release the 1997 Vehicle Inventory and Use Survey (VIUS) (name changed from "Truck" to "Vehicle" due to future possibilities of including additional vehicle types). There are several reasons that the TIUS is a good estimator for these data. TIUS respondents were asked to provide ❶ the percentage of miles that the vehicle was operated off-road, and ❷ the primary use of the truck (personal, business, or mixed). Respondents whose primary use of the vehicle was mixed (both business and personal) were asked to provide the percentage of business use vs. personal use. It is important to separate business use from personal use due to the fact that some off-road light truck travel is not for recreational purposes (i.e. vehicles used by the lumber industry). Information about the truck weight, body type, and configuration is also available so that pickup trucks and sport utility vehicles under 10,000 pounds gross vehicle weight can be identified.

Since TIUS did not specifically collect information on the vehicle miles used off-road *for recreational purposes*, ORNL assumed that the product of the percent miles used off-road and the percent personal use is a reasonable proxy of the probability that a truck will be used off-road for recreational purposes. Since light trucks travel both on-road and off-road, the number of off-road recreational light trucks is counted in full vehicle equivalents (FVE). For example, if a vehicle is driven 30 percent of its annual miles off-road for recreational purposes, then the vehicle is counted as 0.30 of a full vehicle equivalent. Thus, the number of FVE off-road recreational trucks is estimated as:

$$_{OFF}N_{jt} = [_{PU}REG_{jt} \times {}_{PUOFF}PCTTRK_{jt}] + [_{SUV}REG_{jt} \times {}_{SUVOFF}PCTTRK_{jt}] ,$$

where

$_{OFF}N_{jt}$ = the estimated number of full vehicle equivalents (FVE) used for off-road recreational purposes in State j in year t;

$_{PU}REG_{jt}$ = the number of pickup trucks registered in State j in year t;

$_{PUOFF}PCTTRK_{jt}$ = the share of pickup trucks estimated to be used off-road for recreational purposes (the product of the percent miles used off-road and the percent personal use from TIUS) in State j in year t;

$_{SUV}REG_{jt}$ = the number of sports utility vehicles registered in State j in year t; and

$_{SUVOFF}PCTTRK_{jt}$ = the share of sports utility vehicles estimated to be used off-road for recreational purposes (the product of the percent miles used off-road and the percent personal use from TIUS) in State j in year t.

See Appendix B, Program 1 for TIUS program details. Table 2.1 shows the calculation of the FVE trucks used off-road for recreational purposes. When the 1997 VIUS data become available, the light truck model should be updated by using the programs contained in Appendix B to derive new estimates.

2.4 Estimation of Fuel Usage

The fuel used for light truck off-road recreation can be estimated using the number of FVE trucks used off-road for recreational purposes, the fuel economy, and the annual miles per truck. The average fuel economy and average annual miles for light trucks traveling 100% off-road were compared to light trucks traveling 100% on-road. (Mixed use trucks were not taken into account in these comparisons.) Off-road trucks travel an average of 36% less on an annual basis than on-road trucks, according the TIUS data. Also, the data indicate that the average fuel economy for off-road trucks is 10% less than that of on-road trucks. (See Appendix B, Programs 2 and 3 for TIUS program details.) Using these percentages to discount the annual miles (vmt) and fuel economy (mpg), the annual gallons of fuel used per off-road truck can be estimated as:

Table 2.1. Number of light trucks used in off-road recreation, 1997

State	1992 Truck Inventory and Use Survey		*Highway Statistics 1997* Table MV-9		Off-road light truck full-vehicle equivalents
	Share of off-road pickup trucks	Share of off-road sport utility vehicles	All pickup truck registrations	All sport utility vehicle registrations	
	(A)	(B)	(C)	(D)	(A×C)+(B×D)
Alabama	6.02%	7.22%	835,053	157,150	61,641
Alaska	3.79%	5.25%	161,900	81,432	10,414
Arizona	5.98%	5.50%	703,564	281,453	57,516
Arkansas	8.43%	7.05%	518,807	119,544	52,141
California	5.05%	4.00%	4,416,456	2,006,271	303,404
Colorado	6.41%	5.04%	727,761	480,863	70,886
Connecticut	2.91%	3.62%	270,841	208,081	15,404
Delaware	6.05%	2.51%	82,597	49,381	6,240
District of Columbia	5.24%	5.71%	6,254	10,056	901
Florida	6.04%	4.68%	1,412,274	732,726	119,584
Georgia	6.08%	5.23%	1,271,362	490,589	102,993
Hawaii	4.78%	4.55%	120,823	52,487	8,167
Idaho	9.12%	8.89%	338,585	111,479	40,771
Illinois	4.91%	7.10%	1,030,661	514,444	87,079
Indiana	4.17%	2.05%	1,036,008	308,834	49,536
Iowa	4.93%	5.55%	623,961	167,711	40,088
Kansas	6.32%	5.15%	528,951	147,083	41,011
Kentucky	6.81%	4.35%	651,379	165,141	51,527
Louisiana	6.86%	11.67%	881,956	211,784	85,175
Maine	4.56%	5.60%	227,122	77,615	14,697
Maryland	4.15%	3.94%	438,562	274,946	29,030
Massachusetts	3.38%	5.68%	464,122	327,652	34,304
Michigan	3.98%	4.63%	1,208,774	587,089	75,303
Minnesota	4.79%	3.50%	741,294	316,849	46,592
Mississippi	9.93%	14.70%	644,007	135,658	83,919
Missouri	6.88%	4.94%	950,552	285,954	79,564
Montana	6.98%	12.66%	308,211	88,822	32,747
Nebraska	3.50%	5.52%	344,923	108,672	18,080
Nevada	4.77%	5.51%	237,167	124,347	18,179
New Hampshire	2.99%	2.34%	171,061	87,986	7,170
New Jersey	8.40%	6.91%	412,466	484,496	68,123
New Mexico	7.80%	13.21%	427,714	143,775	52,339
New York	3.36%	6.78%	901,588	804,034	84,845
North Carolina	5.21%	5.14%	1,166,351	415,183	82,131
North Dakota	5.51%	4.78%	177,169	47,399	12,028
Ohio	5.09%	4.82%	1,467,370	580,869	102,697
Oklahoma	6.91%	4.96%	802,621	178,028	64,258
Oregon	5.72%	5.89%	700,454	266,552	55,755
Pennsylvania	3.77%	3.83%	1,008,489	695,670	64,660
Rhode Island	4.01%	7.17%	74,898	47,988	6,442
South Carolina	6.05%	5.18%	570,856	193,748	44,584
South Dakota	5.17%	3.85%	175,269	54,617	11,160
Tennessee	4.37%	7.81%	1,001,666	307,214	67,788
Texas	5.90%	4.65%	3,074,108	1,115,665	233,116
Utah	5.67%	5.59%	320,608	172,618	27,836
Vermont	4.95%	3.20%	101,313	43,164	6,400
Virginia	7.52%	4.93%	968,970	458,267	95,506
Washington	5.30%	6.03%	1,033,962	424,302	80,359
West Virginia	6.86%	4.19%	324,211	105,806	26,663
Wisconsin	3.98%	5.60%	715,432	300,450	45,291
Wyoming	10.70%	11.41%	199,701	71,859	29,576
Total			**36,980,204**	**15,623,803**	**2,905,618**

$$_{OFF}ANNGAL_t = \frac{[_{ON}VMT_t \times (1 - 0.36)]}{[_{ON}MPG_t \times (1 - 0.10)]} \quad ,$$

where

$_{OFF}ANNGAL_t$ = the average annual fuel use per truck for off-road recreation in year t;

$_{ON}VMT_t$ = the average annual miles per on-road truck in year t;

$_{ON}MPG_t$ = the average fuel economy per on-road truck in year t;

0.36 = the discount factor to adjust for off-road annual miles; and

0.10 = the discount factor to adjust for off-road fuel economy.

Highway Statistics Table VM-1, contains annual estimates for the average fuel economy and the average annual miles per truck for on-road light trucks. (See Table 2.2.) When the 1997 VIUS data become available, the light truck discount factors should be updated by using the programs contained in Appendix B to derive new estimates. *Highway Statistics* data was used for deriving average annual gallons per truck because it is updated annually, generally accepted, and easily understood; one drawback, however, is that they are not State-specific data.

Table 2.2. Estimation of off-road recreational light truck annual fuel use per truck, 1997

	Annual vehicle miles per truck	Fuel economy per truck	Gallons per truck
	(A)	(B)	(A÷B)
1997 on-road light truck data from VM-1	12,108	17.2	703.95
1992 TIUS off-road discount percentages	36%	10%	
Estimated off-road light truck data	7,749.12	15.48	500.59

Once the annual gallons of fuel used per truck is estimated, it can be multiplied by the number of off-road recreational truck FVE's from Table 2.1 to produce estimates

of fuel use by State. Thus, the estimated annual fuel used by light trucks for off-highway recreational purposes is calculated as:

$$_{OFF}GAL_{j,t} = {}_{OFF}N_{j,t} \times {}_{OFF}ANNGAL_t \quad ,$$

where

$_{OFF}GAL_{j,t}$ = total fuel used by light trucks in off-road recreation in State j in year t;

$_{OFF}N_{j,t}$ = the estimated number of FVE light trucks used for off-road recreational purposes in State j in year t; and

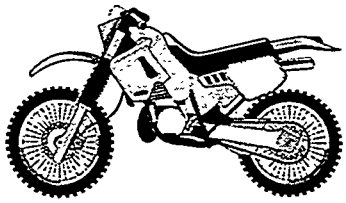
$_{OFF}ANNGAL_t$ = the average annual fuel use per truck in year t.

Table 2.3 shows the estimated fuel used by light trucks in off-road recreation in 1997.

Table 2.3. Estimated off-road recreational light truck fuel use, 1997

State	Gallons of fuel
Alabama	30,856,673
Alaska	5,212,941
Arizona	28,791,650
Arkansas	26,101,369
California	151,880,913
Colorado	35,484,731
Connecticut	7,711,202
Delaware	3,123,599
District of Columbia	451,235
Florida	59,862,296
Georgia	51,556,948
Hawaii	4,088,072
Idaho	20,409,470
Illinois	43,590,877
Indiana	24,797,028
Iowa	20,067,856
Kansas	20,529,419
Kentucky	25,793,937
Louisiana	42,637,561
Maine	7,357,339
Maryland	14,531,934
Massachusetts	17,172,042
Michigan	37,695,980
Minnesota	23,323,683
Mississippi	42,009,091
Missouri	39,828,793
Montana	16,392,660
Nebraska	9,050,538
Nevada	9,100,192
New Hampshire	3,589,391
New Jersey	34,101,851
New Mexico	26,200,256
New York	42,472,485
North Carolina	41,113,992
North Dakota	6,021,267
Ohio	51,408,831
Oklahoma	32,166,929
Oregon	27,910,158
Pennsylvania	32,367,925
Rhode Island	3,224,605
South Carolina	22,318,066
South Dakota	5,586,413
Tennessee	33,934,051
Texas	116,695,478
Utah	13,934,165
Vermont	3,203,522
Virginia	47,809,066
Washington	40,226,989
West Virginia	13,347,241
Wisconsin	22,672,433
Wyoming	14,805,589
Total	**1,454,520,733**

3 MOTORCYCLES



3.1 Introduction

The Motorcycle Industry Council (MIC) represents manufacturers and distributors of motorcycles, scooters, and ATVs as well as members of allied trades. The MIC conducts periodic owner surveys to determine usage characteristics. The most recent survey was conducted in 1997/1998. The information collected by the MIC survey is considered proprietary and survey results are confidential. Their reproduction in this report, therefore, is limited.

The MIC also publishes an annual statistical report that lists motorcycle populations by model type, engine displacement, State, region, registrations, sales volume, etc. Registration information was obtained from the U.S. Department of Transportation, FHWA, through 1975. Though the FHWA continues to collect motorcycle registration data, the MIC statistical report has used registration data from the Motorcycle Safety Foundation, Irvine, California, since 1976. Sales information is provided by U.S. distributors. Statistics for the number of off-road bikes in the Statistical Annual are estimated from yearly sales data, from scrappage rates, and from user survey data. Additional information on estimation procedures used in the annual are provided in Section 3.2. According to the *1998 Motorcycle Statistical Annual* (MIC, 1998), the South had the highest motorcycle population, approximately 28% of all motorcycles in use. The West had the highest penetration with 2.9 motorcycles per 100 persons. The average penetration over the entire United States is 2.5 bikes per 100 persons.

3.2 Population of Off-Road Recreational Motorcycles

Since 1985, the MIC has reported estimates of the numbers of motorcycles, by State, in the *Motorcycle Statistical Annual*. In this report, the MIC records off-road

motorcycle usage for three vehicle model categories – on-highway, dual purpose, and off-highway (off-road). Off-road motorcycles, by definition, are not certified by the manufacturer to be in compliance with Federal Motor Vehicle Safety Standards (FMVSS). Off-road motorcycles include competition motorcycles, as well as motorcycles that are ridden "just for fun" – that is, not for competition; the population of off-road motorcycles does not include ATVs. According to the MIC, about a third of all motorcycles (including those classified as "on-highway" or "dual") are used off-road at some time.

Table 3.1 provides the numbers of motorcycles used off-road at some time for 1992 and for 1994-1997 according to data supplied by the MIC. (The 1993 population of motorcycles is not included because the MIC numbers also included ATVs that year.) These State totals include all models that are classified as off-road, a percentage of those models classified as dual purpose, and a smaller percentage of those models classified as on-road. [These percentages, which are provided by the MIC in the annual report, are updated each year. For example, in 1997, 76% of dual-purpose motorcycles and 11% of on-road motorcycles were ridden off-road at some time (MIC, 1998, p. 13).]

It should be noted that the number of motorcycles ridden off-road (Table 3.1) is assumed to equal the number of motorcycles ridden off-road at some time for recreational purposes. ORNL recognizes that this number assumes that **all** of these motorcycles are ridden off-road **all** the time, which is not true for the dual and on-road motorcycles. However, due to data limitations, the numbers given in Table 3.1 provide the best available estimation of the population of off-road motorcycles.

It is also assumed that, because the total number of motorcycles reported by the MIC is a function of retail sales and has been adjusted for unregistered vehicles, the numbers given in Table 3.1 need no further adjustment for unregistered vehicles.

Table 3.1. Numbers of motorcycles used off-road at some time, 1992 and 1994–1997[1]

State	1992[2]	1994[3]	1995[4]	1996[5]	1997[6]
Alabama	23,700	18,900	16,400	15,100	38,400
Alaska	5,300	4,700	4,300	4,200	9,200
Arizona	22,200	19,200	17,200	16,800	38,900
Arkansas	15,400	12,500	10,800	9,800	22,800
California	229,800	198,400	161,800	148,000	357,600
Colorado	28,400	24,700	22,700	22,500	52,000
Connecticut	16,100	13,900	12,300	11,700	29,000
Delaware	3,100	2,800	2,700	2,500	5,400
District of Columbia	500	600	700	700	1,000
Florida	64,100	56,400	50,700	47,700	103,500
Georgia	40,200	33,500	29,800	28,100	70,900
Hawaii			Data are not available		
Idaho	21,300	17,600	15,600	14,400	34,400
Illinois	40,600	36,400	33,500	32,300	68,500
Indiana	27,300	23,800	21,800	20,900	47,800
Iowa	13,800	11,400	10,000	9,500	21,600
Kansas	10,400	8,600	7,700	7,200	16,600
Kentucky	17,400	15,200	13,800	13,200	32,000
Louisiana	14,300	11,600	10,600	10,500	25,400
Maine	8,400	6,800	5,800	5,300	13,000
Maryland	22,700	20,300	18,200	17,100	38,400
Massachusetts	26,400	22,100	19,400	18,000	46,600
Michigan	47,300	42,800	40,300	39,400	90,100
Minnesota	23,200	20,400	18,100	16,900	37,500
Mississippi	8,700	7,200	6,500	6,300	14,700
Missouri	19,800	16,700	15,000	14,700	35,800
Montana	12,200	9,600	8,300	7,500	18,400
Nebraska	6,800	4,800	4,300	4,000	10,100
Nevada	12,600	11,500	11,000	10,900	23,500
New Hampshire	10,000	8,400	7,200	6,900	17,700
New Jersey	33,500	30,100	26,900	25,400	60,500
New Mexico	12,400	10,300	9,100	8,900	20,500
New York	59,200	51,100	44,700	41,600	94,800
North Carolina	39,400	34,600	31,600	30,700	75,500
North Dakota	4,100	3,100	2,600	2,400	5,600
Ohio	48,100	44,700	41,200	39,900	92,300
Oklahoma	21,900	15,900	13,600	12,600	30,500
Oregon	27,700	22,900	19,900	19,100	48,000
Pennsylvania	56,800	50,000	45,200	43,100	100,200
Rhode Island	4,400	3,700	3,200	2,800	7,400
South Carolina	17,500	15,300	13,800	13,300	33,200
South Dakota	4,700	3,900	3,300	3,000	7,100
Tennessee	28,900	23,600	20,700	19,400	47,400
Texas	81,900	67,800	55,500	51,500	134,100
Utah	20,000	14,800	12,500	11,900	32,100
Vermont	3,500	2,900	2,600	2,400	5,900
Virginia	32,400	26,900	23,200	21,200	52,800
Washington	46,500	40,400	35,800	33,500	78,100
West Virginia	14,600	11,600	10,100	9,300	24,500
Wisconsin	23,600	20,900	18,800	17,900	38,500
Wyoming	5,900	4,700	4,200	4,000	9,700
Total	1,379,000	1,180,000	1,035,000	976,000	2,319,500

[1]The Motorcycle Industry Council did not supply separate numbers for motorcycles and ATVs in the 1994 report (which reported 1993 usage data).

[2]Motorcycle Industry Council, "1993 Motorcycle Statistical Annual," p. 28.

[3]Motorcycle Industry Council, "1995 Motorcycle Statistical Annual," p.12.

[4]Motorcycle Industry Council, "1996 Motorcycle Statistical Annual," p.13.

[5]Motorcycle Industry Council, "1997 Motorcycle Statistical Annual," p.13.

[6]Motorcycle Industry Council, "1998 Motorcycle Statistical Annual," p.13.

3.3 Estimation of Fuel Usage

In the analysis conducted in 1993–1994, ORNL examined fuel use estimates provided by four States (California, Colorado, Oregon, and Washington) and the MIC (ORNL, 1994, pp. 33-59). These fuel use estimates and the methodologies for deriving them varied widely. Using these available estimates, in 1994, ORNL gave a subjective weight to each fuel use estimate and derived low, medium, and high values for average annual fuel use. An explanation of these weights and the rationale for their selection is provided in ORNL-6794 (ORNL, 1994). This weighted average fuel consumption ranged from a low of 54 gallons per vehicle per year to a high of 64 gallons per vehicle per year for off-road consumption.

Because the MIC completed a usage survey in 1998, the current analysis looked at that data. Although summaries and summary tables will be publicly available, specific data are considered confidential and are not reported in their entirety in this report. According to MIC personnel, the questions in the survey were asked from several perspectives in order to check the consistency of the responses. Unfortunately, repeating the question from different perspectives results in large discrepancies in values for annual mileage estimates and annual fuel usage, which can be calculated in multiple ways from the survey responses.

3.3.1 Annual mileage estimates

For example, as shown in Table 3.2, median and mean annual mileage estimates can be derived (Method A) from a single survey question asking for an approximate number of miles ridden off-road annually. These estimates could also be derived (Method B) from responses to three different questions that request the ❶ approximate number of miles ridden off-road per day, ❷ approximate number of days ridden per month, and ❸ approximate number of months during which off-road

Table 3.2. Annual mileage and fuel usage estimates for motorcycles

❶	❷	❸	❹	❺	❻	❼	❽
	Annual mileage estimate: Method A[1]	Annual mileage estimate: Method B[2]	Annual mileage: average of A and B	Days ridden off-road annually	Miles per day when riding off-road	Gallons of gas used per day of riding off-road	Annual fuel usage (col. 5 times col. 7)
Median	100 miles	560 miles	330 miles	28 days	20 miles/day	3.0 gal/day	84 gallons
Mean	270 miles	1,372 miles	821 miles	50.4 days	27.2 miles/day	4.25 gal/day	214 gallons

Source: MIC, electronic communication with L. F. Truett, ORNL, March 16, 1999; data derived from the 1997/1998 MIC usage survey.

[1]Method A uses the responses from a single question asking how many miles were ridden in the last 12 months.

[2]Method B is a calculation based on responses to questions concerning the number of miles ridden per day, number of days ridden each month, and months ridden in past year; columns 5 and 6 of this table are partial components of these questions.

recreation takes place. The mean annual mileage estimates range from 270 miles (Method A) to 1,372 miles (Method B). The median annual mileage estimates range from 100 miles (Method A) to 560 miles (Method B). MIC recommends that an average of the median estimates be used. [That is, average the median value of Method A (100 miles) and the median value of Method B (560 miles).] According to MIC personnel, "These seem to be the most 'reasonable' and 'consistent' numbers from each of the surveys" (MIC, electronic communication with L. F. Truett, ORNL, March 16, 1999). The MIC recommendation results in an average of 330 miles per year ridden off-road. (The average of the mean values of the two approaches results in 821 miles.) It should be noted that this methodology is not consistent with past practices, in which the MIC used the mean annual mileage estimate using Method A (270 miles).

3.3.2 Fuel economy

According to the MIC (MIC, 1998, p. 1), most **on-road** bikes have engine displacements of over 750 cc, but most **dual-purpose** and **off-road** bikes are smaller. In fact, almost 90% of off-road motorcycles in use in 1997 had engine displacements under 350 cc. In the *1994 Motorcycle Statistical Annual* (MIC, 1994, p. 31 – the latest year in which motorcycle fuel economy was included), the MIC estimated that the larger bikes have an average fuel economy of about 43 mpg and that dual-purpose motorcycles averaged between 119 mpg (engine displacement under 125 cc) and 85 mpg (engine displacement of 125-349 cc). The MIC does not publish fuel economy numbers for motorcycles used entirely off-road, and it cannot be assumed that their fuel economy would be as high as dual-purpose motorcycles, which are sometimes ridden on-road. [If one **DID** assume that motorcycles ridden off-road had a fuel economy of 85 mpg and assumed that the MIC estimate of annual mileage is correct (i.e., 330 miles ridden off-road each year), then the fuel usage would be only 3.9 gallons per year (330 miles ÷ 85 mpg = 3.9 gallons)!] However,

a fuel economy of 85 mpg for off-road bikes is very uncertain, and this methodology is not recommended.

In the 1997/1998 usage survey, the MIC asked a survey question about the gallons of gas used per day. The median response was 3.0 gallons/day and the mean response was 4.25 gallons/day (see Table 3.2). Combining this response with responses to usage questions about the number of days ridden per year, the annual fuel usage would equate to a median value of 84 gallons of fuel used and a mean value of 214 gallons of fuel used annually. It should be noted that the fuel economy would compute to between 3.9 mpg (median) and 3.8 mpg (mean) for off-road motorcycle fuel consumption if these rates are combined with the median and mean annual mileage averages given above:

330 miles ÷ 84 gallons = 3.9 mpg;

821 miles ÷ 214 gallons = 3.8 mpg.

There is a great difference between 84 (or 214) gallons and the 3.8 gallons discussed previously. In addition, the MIC acknowledges that people responding to the survey may not really know how much fuel they use each day; they may buy fuel for more than one bike or use the fuel to clean parts or dispose of the fuel in other ways. Because of the problems with the MIC survey results, ORNL does not recommend using either 3.8, 84, or 213 gallons as the annual fuel use for off-road motorcycles. Instead, because the amount of fuel used annually in the 1994 ORNL report was well documented and seemed to be generally acceptable, ORNL recommends using the annual fuel usage estimates from the 1994 report.

Table 3.3 shows the low, medium, and high estimates for total gallons of fuel, by State, used annually for off-road recreation by motorcycles during 1997 on the basis of a fuel usage each year of 54, 59, and 64 gallons per vehicle. Until more precise data are collected on average annual fuel use of off-road motorcycles, it is

recommended that the "medium" estimate of 59 gallons per year be used. Thus the estimated fuel use for off-road recreational motorcycles is:

$$_{OFF}Gal_{jt} = {}_{OFF}N_{jt} \times 59\ gallons \quad ,$$

where

${}_{OFF}N_{jt}$ = the number of motorcycles used off-road some of the time in State j in year t.

Table 3.3. Estimated annual total fuel consumption for off-road motorcycles, 1997[1] (gallons of fuel)

State	Low estimate	Average estimate	High estimate
Alabama	2,073,600	2,265,600	2,457,600
Alaska	496,800	542,800	588,800
Arizona	2,100,600	2,295,100	2,489,600
Arkansas	1,231,200	1,345,200	1,459,200
California	19,310,400	21,098,400	22,886,400
Colorado	2,808,000	3,068,000	3,328,000
Connecticut	1,566,000	1,711,000	1,856,000
Delaware	291,600	318,600	345,600
District of Columbia	54,000	59,000	64,000
Florida	5,589,000	6,106,500	6,624,000
Georgia	3,828,600	4,183,100	4,537,600
Hawaii		Data are not available	
Idaho	1,857,600	2,029,600	2,201,600
Illinois	3,699,000	4,041,500	4,384,000
Indiana	2,581,200	2,820,200	3,059,200
Iowa	1,166,400	1,274,400	1,382,400
Kansas	896,400	979,400	1,062,400
Kentucky	1,728,000	1,888,000	2,048,000
Louisiana	1,371,600	1,498,600	1,625,600
Maine	702,000	767,000	832,000
Maryland	2,073,600	2,265,600	2,457,600
Massachusetts	2,516,400	2,749,400	2,982,400
Michigan	4,865,400	5,315,900	5,766,400
Minnesota	2,025,000	2,212,500	2,400,000
Mississippi	793,800	867,300	940,800
Missouri	1,933,200	2,112,200	2,291,200
Montana	993,600	1,085,600	1,177,600
Nebraska	545,400	595,900	646,400
Nevada	1,269,000	1,386,500	1,504,000
New Hampshire	955,800	1,044,300	1,132,800
New Jersey	3,267,000	3,569,500	3,872,000
New Mexico	1,107,000	1,209,500	1,312,000
New York	5,119,200	5,593,200	6,067,200
North Carolina	4,077,000	4,454,500	4,832,000
North Dakota	302,400	330,400	358,400
Ohio	4,984,200	5,445,700	5,907,200
Oklahoma	1,647,000	1,799,500	1,952,000
Oregon	2,592,000	2,832,000	3,072,000
Pennsylvania	5,410,800	5,911,800	6,412,800
Rhode Island	399,600	436,600	473,600
South Carolina	1,792,800	1,958,800	2,124,800
South Dakota	383,400	418,900	454,400
Tennessee	2,559,600	2,796,600	3,033,600
Texas	7,241,400	7,911,900	8,582,400
Utah	1,733,400	1,893,900	2,054,400
Vermont	318,600	348,100	377,600
Virginia	2,851,200	3,115,200	3,379,200
Washington	4,217,400	4,607,900	4,998,400
West Virginia	1,323,000	1,445,500	1,568,000
Wisconsin	2,079,000	2,271,500	2,464,000
Wyoming	523,800	572,300	620,800
Total	125,253,000	136,850,500	148,448,000

[1]Total annual fuel use is based on a low estimate of 54 gallons per vehicle, an average estimate of 59 gallons per vehicle, and a high estimate of 64 gallons per vehicle. See ORNL-6794, p. 54.

4 ALL-TERRAIN VEHICLES

4.1 Introduction

An all-terrain vehicle (ATV) is a three- or four-wheeled motorized vehicle designed for off-road use. In 1988, as a result of safety concerns, especially for three-wheeled ATVs, the Specialty Vehicle Institute of America (SVIA) instituted a national program to promote ATV safety (http://www.sos.state.tx.us/tac/37/I/33/33.1.html). In 1997, the Consumer Product Safety Commission (CPSC) conducted an ATV exposure survey to collect general information and to evaluate changes in usage habits pursuant to a 1989 survey on ATV safety practices (CPSC, 1998, p. 7).

The CPSC survey showed that there are approximately 3.9 million ATVs and about 5.85 million ATV drivers in the United States. Almost 60% of ATV-owning households are located in low-density areas, primarily in the midwest and south. The survey found that about 90% of ATV drivers ride on private lands at least some time and about 27% ride *only* on private lands (CPSC, 1998, pp. 10-13).

Engine sizes of ATVs range from about 50 to 400 cc; three-wheelers usually have engines of 250 cc or less, and four-wheelers have engines sizes of 250 cc or larger (CPSC, 1998, p. 16).

4.2 Population of Off-Road Recreational All-terrain Vehicles

The MIC represents manufacturers and distributors of motorcycles, scooters, and ATVs as well as members of allied trades. Between 1985 and 1991, the MIC collected data on the numbers of motorcycles and ATVs by State and reported combined population data in the *Statistical Annual* produced each year. Since 1991, the MIC has sometimes reported ATV population data separately and has sometimes

combined it with motorcycle population data. The MIC conducted its latest usage survey in 1997/1998; however, ATV questions were not included in the survey.

State population estimates for ATVs have been computed by MIC from the annual retail sales of ATVs in conjunction with the vehicle scrappage rates, based on user survey information. In addition, the 1997 CPSC user survey information has been used to produce the current numbers of ATVs by State. This methodology for estimating State populations of ATVs is not flawless; for example, it does not consider the migration of vehicles from one State to another. It is, however, the best estimate available. Only 17 State Department of Motor Vehicles (DMVs) require registration of ATVs (see Appendix A; note that some States require registration through Recreation Management Agencies rather than through the DMVs), and there is no other survey of the population of ATVs which encompasses the entire United States. Therefore, the ATV population estimates from the MIC are used for the purposes of this report. Unfortunately, because these data are not released to the public, they cannot be printed for external circulation; therefore, they are not reproduced in this report. They were provided, however, to ORNL and to the FHWA Recreational Trails Program Office and were used to derive the ATV fuel usage, by State, for this report.

It is assumed that the numbers of ATVs, by State, as provided by the MIC are all used off-road. However, the numbers of ATVs must be adjusted for recreational use. According to the 1997 CPSC ATV exposure survey, 73.7% [standard error (se) = 4.0] of ATV drivers use ATVs for at least one nonrecreational activity (e.g., farming or ranching, household chores, occupation, or commercial tasks). The mean time spent on non-recreational activities is 4.42 hours out of every 10 hours (se = 0.30).

4.3 Estimation of Fuel Usage

The 1997 CPSC ATV exposure survey also contained information about annual ATV driving time in hours per year. The mean annual driving time is 252.3 hours per year (se = 35.3) and the median annual driving time is 110.9 hours (se = 17.5). When records for ATV drivers reporting more than 1,000 hours per year of riding time are excluded, the mean annual riding time equals 170.9 hours (se = 21.2) per year (CPSC, 1998, p. 12). Unfortunately, ORNL has not found a method to convert driving time to fuel use.

In the analysis conducted in 1993–94, ORNL examined fuel use estimates provided by four States (California, Colorado, Oregon, and Washington) and the MIC (ORNL, 1994, pp. 33-59). These fuel use estimates and the methodologies for deriving them varied widely. Using these available estimates, in 1994, ORNL gave a subjective weight to each fuel use estimate and derived low, medium, and high values for average annual fuel use. An explanation of these weights and the rationale for their selection is provided in ORNL-6794 (ORNL, 1994). This weighted average fuel consumption ranged from a low of 46 gallons per vehicle per year to a high of 65 gallons per vehicle per year for off-road consumption.

According to the California Air Resources Board (CARB; personal communication with Stacy Davis, ORNL, February 26, 1999), most ATVs have a fuel economy ranging between the high 40s and low 50s (i.e., 45 mpg to 55 mpg).

Because the MIC did not produce new fuel economy estimates for ATVs based on the results of the 1997/1998 MIC usage survey and because the CARB values are very similar to the values used by ORNL in the previous report, ORNL used the same annual fuel estimates that were used in the previous analysis.

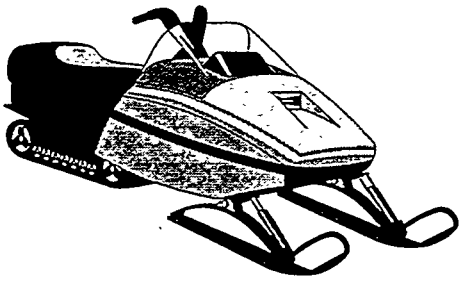
Table 4.1 shows the low, medium, and high estimates for total gallons of fuel, by State, used annually for off-road recreation by ATVs during 1997. These results have considered the non-recreational usage factor.

Table 4.1. Annual fuel consumption of ATVs used for off-road recreation, 1997[1] (gallons of fuel)

State	Low estimate	Average estimate	High estimate
Alabama	3,233,963	3,901,846	4,569,730
Alaska	1,268,179	1,530,085	1,791,992
Arizona	1,646,140	1,986,104	2,326,068
Arkansas	3,522,599	4,250,093	4,977,586
California	6,324,595	7,630,762	8,936,928
Colorado	1,177,956	1,421,229	1,664,503
Connecticut	486,717	587,234	687,752
Delaware	178,033	214,801	251,569
District of Columbia	1,566	1,889	2,212
Florida	2,889,062	3,485,716	4,082,370
Georgia	3,606,200	4,350,959	5,095,717
Hawaii		Data are not available	
Idaho	1,203,188	1,451,672	1,700,156
Illinois	2,511,254	3,029,883	3,548,512
Indiana	2,214,917	2,672,346	3,129,775
Iowa	1,200,210	1,448,079	1,695,949
Kansas	890,936	1,074,934	1,258,932
Kentucky	2,763,263	3,333,937	3,904,611
Louisiana	3,451,140	4,163,875	4,876,610
Maine	921,456	1,111,756	1,302,057
Maryland	842,398	1,016,372	1,190,345
Massachusetts	759,105	915,877	1,072,649
Michigan	4,683,255	5,650,449	6,617,643
Minnesota	2,733,616	3,298,168	3,862,719
Mississippi	2,864,472	3,456,047	4,047,623
Missouri	2,996,842	3,615,755	4,234,668
Montana	877,563	1,058,799	1,240,035
Nebraska	938,448	1,132,258	1,326,067
Nevada	571,010	688,936	806,862
New Hampshire	584,332	705,009	825,687
New Jersey	1,193,023	1,439,408	1,685,793
New Mexico	672,117	810,923	949,730
New York	3,656,689	4,411,875	5,167,060
North Carolina	3,343,719	4,034,270	4,724,820
North Dakota	438,435	528,981	619,528
Ohio	3,688,030	4,449,688	5,211,346
Oklahoma	1,523,806	1,838,506	2,153,205
Oregon	1,746,091	2,106,697	2,467,303
Pennsylvania	4,422,519	5,335,866	6,249,212
Rhode Island	76,337	92,102	107,867
South Carolina	1,375,676	1,659,784	1,943,891
South Dakota	511,384	616,995	722,607
Tennessee	3,512,948	4,238,448	4,963,948
Texas	5,539,462	6,683,482	7,827,501
Utah	1,903,411	2,296,506	2,689,602
Vermont	380,810	459,456	538,102
Virginia	1,851,741	2,234,166	2,616,590
Washington	1,568,007	1,891,834	2,215,662
West Virginia	2,309,581	2,786,560	3,263,538
Wisconsin	2,729,509	3,293,212	3,856,916
Wyoming	576,170	695,161	814,153
Total	**100,361,880**	**121,088,790**	**141,815,700**

[1]Total annual fuel use is based on a low estimate of 46 gallons per vehicle, an average estimate of 55.5 gallons per vehicle, and a high estimate of 65 gallons per vehicle. See ORNL-6794, p. 54.

5 SNOWMOBILES



5.1 Introduction

Snowmobiling is a popular recreational activity both in the United States and worldwide. More than half of the snowmobiles sold in 1998 were sold in the U.S, which has over 230,000 miles of groomed and marked snowmobile trails (International Snowmobile Manufacturers Association, "Snow Facts," 1998).

5.2 Population of Off-Road Recreational Snowmobiles

Prior to 1995, thirty-one States submitted their snowmobile registration data to the International Snowmobile Industry Association (ISIA) in response to ISIA's annual North American Snowmobile Registration Survey. In 1995, the ISIA was dissolved into two separate organizations. The American Council of Snowmobile Associations (ACSA) is a national organization for snowmobile users, and the International Snowmobile Manufacturers Association (ISMA) is an organization representing the snowmobile manufacturing industry. Since 1995, both the ACSA and the ISMA have collected registration data from the States. This collection is accomplished through phone calls to the individual States. Snowmobile registration data for 1993–1998 were obtained from ISMA.

Table 5.1 reports snowmobile registration data by State for 1981–1998 based on data supplied by ISIA (prior to 1993) and ISMA (1993 and later). Although ISIA collected data for all States, ACSA and ISMA only gather data for States that have snowmobile associations that participate in international events. Therefore, registration data previously reported for a few States with small snowmobile counts are not included in Table 5.1. These States include Connecticut, Delaware, Maryland,

Table 5.1. Number of registered snowmobiles by State, 1981–1998

State	1981	1982	1983	1984	1986	1987	1988	1989
Alabama								
Alaska	1,102	2,522	1,602	2,522	2,632	3,593	1,812	2,671
Arizona								
Arkansas								
California	5,542	5,048	5,120	4,816	5,837	5,729	6,283	6,847
Colorado	12,832	14,087	13,959	13,788	14,250	13,600	14,234	15,060
Connecticut	2,700	2,577	2,266	2,379	3,239	3,667	3,626	3,503
Delaware	290	290	290	290	290	280	263	328
District of Columbia								
Florida								
Georgia								
Hawaii								
Idaho	19,961	18,552	21,785	20,200	23,000	18,000	20,000	21,024
Illinois	70,822	72,682	69,439	66,863	65,591	60,490	59,163	62,047
Indiana	44,760	46,361	32,037	32,651	23,539	23,695	26,643	19,206
Iowa	60,000	56,000	60,291	65,329	55,091	55,090	49,033	45,000
Kansas								
Kentucky								
Louisiana								
Maine	51,511	57,178	42,177	47,862	49,722	56,391	57,481	58,148
Maryland	786	896	639	1,200	400	420	450	450
Massachusetts	18,696	23,000	16,500	15,000	15,000	15,000	15,000	22,000
Michigan	368,858	386,391	282,274	271,221	287,524	200,773	206,544	200,854
Minnesota	228,764	220,100	207,564	202,944	202,944	198,212	181,598	192,647
Mississippi								
Missouri								
Montana	10,944	14,046	16,074	13,261	16,569	12,068	50,589	50,000
Nebraska	1,500	1,016	1,664	1,858	994	1,095	1,095	918
Nevada								
New Hampshire	26,679	35,490	21,154	29,658	30,586	32,974	38,332	30,000
New Jersey	5,392	4,015	4,109	4,000	6,000	6,000	6,000	2,600
New Mexico	2,543	3,077	5,900	4,500	6,000	6,000	6,000	7,029
New York	86,907	85,639	73,244	67,346	67,346	60,701	54,321	56,172
North Carolina								
North Dakota	14,900	13,660	14,739	10,976	13,532	10,823	6,415	9,361
Ohio	32,045	32,045	24,048	31,971	15,417	6,388	25,456	18,782
Oklahoma								
Oregon	7,544	7,682	4,113	8,134	7,813	8,597	8,767	9,349
Pennsylvania	55,763	56,459	55,000	47,000	46,700	47,000	46,500	43,785
Rhode Island	400	451	395	395	395	2,700	395	395
South Carolina								
South Dakota	4,695	6,986	7,839	9,617	9,066	5,163	6,459	6,433
Tennessee								
Texas								
Utah	14,984	17,016	16,355	11,741	13,480	12,951	11,884	16,481
Vermont	22,223	28,827	19,971	21,288	11,953	19,566	23,573	27,953
Virginia								
Washington	14,194	15,161	14,959	14,959	17,020	15,813	17,922	20,032
West Virginia								
Wisconsin	162,600	175,334	159,561	164,124	154,000	145,609	149,839	150,963
Wyoming	9,468	12,715	12,972	12,197	11,136	11,868	13,736	14,958
Total	**1,359,405**	**1,415,303**	**1,208,040**	**1,200,090**	**1,177,066**	**1,060,256**	**1,109,413**	**1,114,996**

Table 5.1. Number of registered snowmobiles by State, 1981–1998 (continued)

State	1990	1991	1992	1993	1994	1995	1996	1997	1998
Alabama									
Alaska	2,756	4,427	4,231	7,181	7,254	12,366	9,678	9,678	12,997
Arizona				0	0	0	0	0	0
Arkansas									
California	7,989	8,849	9,646	10,807	11,684	12,117	13,397	13,500	13,500
Colorado	16,026	17,142	18,396	19,803	21,831	22,000	24,704	27,300	28,000
Connecticut	3,062	2,635	2,600						
Delaware	307	290	176						
District of Columbia									
Florida									
Georgia									
Hawaii									
Idaho	15,356	21,000	22,790	27,255	27,255	27,005	31,000	30,861	35,027
Illinois	60,510	58,891	58,276	58,112	58,676	58,676	60,035	60,000	58,116
Indiana	22,941	21,509	18,178	19,179	17,440	21,341	18,503	18,506	19,193
Iowa	22,020	22,000	29,300	27,000	31,510	27,000	26,416	34,594	33,000
Kansas									
Kentucky									
Louisiana									
Maine	63,190	61,641	63,471	64,985	70,043	70,043	75,000	76,000	83,000
Maryland	333	235	235						
Massachusetts	23,110	13,000	8,253	7,265	8,000	10,000	12,200	20,693	13,271
Michigan	205,772	202,368	180,340	214,874	225,921	253,093	256,267	270,266	292,407
Minnesota	194,339	191,838	192,926	205,049	216,928	216,621	233,433	270,000	274,913
Mississippi									
Missouri									
Montana	14,500	14,500	11,300	18,099	18,572	19,100	20,252	20,328	14,361
Nebraska	902	767	828	1,182	1,392	1,392	1,354	2,000	1,382
Nevada									
New Hampshire	33,000	32,430	27,330	32,325	37,761	37,761	44,291	54,000	35,283
New Jersey	3,641	2,991	3,000						
New Mexico	1,100	1,246	1,246						
New York	46,324	51,239	51,723	54,755	62,110	62,110	82,600	102,000	110,000
North Carolina									
North Dakota	10,893	8,200	9,200	9,849	10,393	14,284	13,095	17,819	16,201
Ohio	17,947	18,040	15,421	17,083	19,783	19,783	22,153	22,376	23,000
Oklahoma									
Oregon	9,533	9,675	10,078	11,114	11,635	11,169	11,648	12,000	13,426
Pennsylvania	43,000	39,449	42,354	34,976	35,300	35,300	39,658	45,000	43,000
Rhode Island	432	375	353						
South Carolina									
South Dakota	3,200	4,028	3,480	4,662	4,983	8,500	4,464	19,628	12,536
Tennessee									
Texas									
Utah	12,706	14,034	9,683	13,436	20,550	19,920	22,363	25,706	24,498
Vermont	33,961	32,762	31,515	26,337	27,021	35,996	32,000	32,600	26,736
Virginia				0	0	0	0	0	0
Washington	17,280	19,631	20,414	23,179	27,323	27,323	24,558	27,539	27,833
West Virginia									
Wisconsin	151,000	155,632	156,062	164,941	178,624	179,000	180,216	200,000	202,216
Wyoming	14,683	14,506	14,208	17,398	17,205	17,000	17,253	18,461	18,964
Total	**1,051,813**	**1,045,330**	**1,017,013**	**1,090,846**	**1,169,194**	**1,218,900**	**1,276,538**	**1,430,855**	**1,432,860**

New Jersey, New Mexico, and Rhode Island. Explanation for snowmobile counts for these six States as well as for Alaska, Arizona, and Nevada are provided below. Table 5.2 provides the numbers of snowmobiles in States for which registration data was not available but for which snowmobile counts have been determined.

Table 5.2. Number of snowmobiles in States not reporting snowmobile registration data to ISMA or ACSA

State	1998 data	Source of data
Alaska	60,000	ISMA estimate for **total** number of snowmobiles, both registered and unregistered
Arizona	10,000	ACSA estimate for **total** number of snowmobiles (all unregistered)
Connecticut	1,315	Connecticut DMV number of **registered** snowmobiles in 1997 (does not include unregistered vehicles)
Delaware	271	Delaware Park Resource Office number of **registered** snowmobiles (does not include unregistered vehicles)
Maryland	235	ISIA estimate provided for 1992 (does not include unregistered vehicles)
Nevada	0	Nevada DMV and State Recreational Trails Office
New Jersey	2,513	New Jersey Commissioner's Correspondence Unit
New Mexico	1,246	ISIA estimate provided for 1992 (does not include unregistered vehicles)
Rhode Island	174	Rhode Island Boat Registration and Licensing

The DMV and/or the State Trails Coordinators in Connecticut, Delaware, New Jersey, and Rhode Island were contacted to obtain snowmobile counts. These States were able to provide the numbers of snowmobile registrations and/or licenses (see Table 5.2).

Maryland DMV was also contacted but was unable to provide any data on the numbers of snowmobiles. New Mexico DMV stated that, in October 1998, there were 6,502 registered off-road vehicles, including off-road motorcycles, ATVs, and snowmobiles; however, New Mexico DMV could not determine how many vehicles

belonged in each category. Since the number of off-road motorcycles as estimated by the Motorcycle Industry Council (see Chapter 4) exceeds the "total" number of off-road vehicles supplied by the New Mexico DMV, the number of registered off-road vehicles as provided by the New Mexico DMV was not used. Because current numbers of snowmobiles could not be obtained for Maryland and New Mexico, ORNL examined the growth rates of other States to see if a growth factor could be applied to the number of snowmobiles in Maryland and New Mexico based on the last known number (the value from 1992). The "growths," however, spread from -15% (Vermont) to 260% (South Dakota). Therefore, ORNL used the last-known source of verified information – the numbers supplied by the ISIA for 1992 and set the number of snowmobiles in each of these States to the 1992 values (see Table 5.2).

Alaska has just begun requiring snowmobile registration. Although the number of **registered** snowmobiles for Alaska in 1998 is less than 13,000, the ISMA estimates that there is a total of 60,000 snowmobiles in Alaska and that the share that are registered will increase dramatically in the next few years. ORNL followed the guideline provided by ISMA for the total number of snowmobiles in Alaska (see Table 5.2).

Neither ISMA nor ACSA has data for Arizona, which does not require snowmobile registration. For the estimation procedure used in the 1994 allocation formula, snowmobile counts were based on surveys conducted by the State of Arizona in 1990. According to the Arizona survey, the average estimated number of snowmobiles ridden off-road in 1990 was 1,088. No new survey of off-road recreational use has been conducted in Arizona since that time; however, the ACSA estimates that there are about 10,000 snowmobiles in Arizona (all of which are unregistered; see Table 5.2).

Nevada has apparently never submitted registration data to ISMA or ACSA. According to the Nevada DMV, there are no requirements to register snowmobiles, and no data is available which could provide vehicle counts. Therefore, the number of snowmobiles for Nevada was set to 0. Nevada plans to conduct a survey of off-road vehicle usage in the near future. The results of this survey should be supplied to the Federal Recreational Trails Program office for use in determining total fuel consumption for off-road recreation in future years (see Table 5.2).

Even in States that require registration, not all snowmobiles are registered. According to ISMA, the number of unregistered, usable snowmobiles in the United States is no more than 5% of the total number of snowmobiles in any State for which they have registration data, except for Alaska, which has just begun requiring registration. Most of the snowmobiles in Alaska are unregistered at this time. All snowmobiles in Arizona are unregistered. For the purpose of this analysis, the number of snowmobiles in each State (except for Alaska and Arizona, which remain constant) is increased by 5% to include unregistered usable snowmobiles. Table 5.3 provides the total number of snowmobiles by State for 1998.

5.3 Estimation of Fuel Usage

In the fuel estimation procedure for snowmobiles, all snowmobiles are assumed to be used exclusively off-the-road. According to the ISMA, snowmobiles are used 80% of the time for recreation, about 15% for ice fishing, and about 5% for work purposes. Although snowmobiles do not traverse established trails to go ice fishing, this sport is a recreational activity and the fuel use will be included within the formula calculation. The annual mileage accumulated by ice fishers, however, is much lower than that of recreational trail users. This difference is accounted for in the formula.

Table 5.3. Total number of snowmobiles, registered and unregistered, in each State, 1998

State	Registered (source: ISMA)[1]	Registered (other source)[2]	Unregistered or estimated[3]	Total
Alabama				0
Alaska	12,997		60,000	60,000
Arizona	0		10,000	10,000
Arkansas				0
California	13,500		675	14,175
Colorado	28,000		1,400	29,400
Connecticut		1,315	66	1,381
Delaware		271	14	285
District of Columbia				0
Florida				0
Georgia				0
Hawaii				0
Idaho	35,027		1,751	36,778
Illinois	58,116		2,906	61,022
Indiana	19,193		960	20,153
Iowa	33,000		1,650	34,650
Kansas				0
Kentucky				0
Louisiana				0
Maine	83,000		4,150	87,150
Maryland		235	12	247
Massachusetts	13,271		664	13,935
Michigan	292,407		14,620	307,027
Minnesota	274,913		13,746	288,659
Mississippi				0
Missouri				0
Montana	14,361		718	15,079
Nebraska	1,382		69	1,451
Nevada				0
New Hampshire	35,283		1,764	37,047
New Jersey		2,513	126	2,639
New Mexico		1,246	62	1,308
New York	110,000		5,500	115,500
North Carolina				0
North Dakota	16,201		810	17,011
Ohio	23,000		1,150	24,150
Oklahoma				0
Oregon	13,426		671	14,097
Pennsylvania	43,000		2,150	45,150
Rhode Island		174	9	183
South Carolina				0
South Dakota	12,536		627	13,163
Tennessee				0
Texas				0
Utah	24,498		1,225	25,723
Vermont	26,736		1,337	28,073
Virginia				0
Washington	27,833		1,392	29,225
West Virginia				0
Wisconsin	202,216		10,111	212,327
Wyoming	18,964		948	19,912
Total	**1,432,860**			**1,566,898**

[1]See Table 5.1.

[2]See Table 5.2.

[3]See Table 5.2. In States where snowmobiles are registered, it is assumed that an additional 5% are unregistered. This additional factor is not added to Alaska and Arizona.

In February 1992, a survey by ISIA ("February 1992 International Snowmobile Industry Association Survey of Snowmobile Owners," data supplied to Ms An Lu, ORNL, January 13, 1993), indicated that most snowmobiles average 12.5 miles per gallon (mpg) of fuel and that the annual amount of fuel used per snowmobile is about 63 gallons. Since that time, however, snowmobiles have become more fuel efficient. In addition, because of better trails, improved machines, and warmer clothing, snowmobilers are riding further. Currently, the ISMA estimates that most snowmobiles average 15 mpg and that the average snowmobiler riding for recreational purposes uses the snowmobile about 1,520 miles/year (ISMA, electronic communication to L. F. Truett, ORNL, November 30, 1998). Thus, the average snowmobiler uses about 101 gallons of fuel annually for "typical" off-road recreational purposes. The ISMA estimates that individuals who use their snowmobiles to go ice fishing ride for about 200 miles per year (with the same fuel economy) for a total annual fuel usage of 13.3 gallons.

Snowmobiles obviously can only travel when there is snow on the ground. Thus, snowmobile usage is a function of the amount of snow accumulated on the ground. Since there are no available data on average snow accumulation by State, average annual amount of snowfall and normal winter temperature data were used to categorize each State (Table 5.4). The snowfall ranges are a derivative of the snowfall adjustment factors from the original study, which were based on the map of mean annual snowfall published in the *National Atlas of the United States of America*. The temperatures are based on data from the National Climactic Data Center (NCDC) which show the maximum normal temperature in January. The NCDC derived the maximum normal temperature based on 30 years of temperature data. Maximum normal temperatures in January from the weather stations in each State were categorized as either ❶ freezing and below (≤ 32° Fahrenheit) or ❷ above freezing (> 32° Fahrenheit). If there were data from two stations within one State, the temperatures from the stations were averaged and then classified into the

Table 5.4. Categories of average annual snowfall and normal winter temperatures

< 8 inches of snow	8-16 inches of snow	16-32 inches of snow	
above 32° F	above 32° F	above 32° F	below 32° F
Category 1	Category 2	Category 3	Category 4
Alabama	Arizona	California	Illinois
Arkansas	Kentucky	Dist. of Columbia	Iowa
Florida	Missouri	Indiana	Ohio
Georgia	North Carolina	Delaware	
Hawaii	Oklahoma	Kansas	
Louisiana		Maryland	
Mississippi		New Jersey	
South Carolina		New Mexico	
Tennessee		Rhode Island	
Texas		Virginia	
		West Virginia	

32-64 inches of snow		64-96 inches of snow		> 96 inches of snow
above 32° F	below 32° F	above 32° F	below 32° F	below 32° F
Category 5	Category 6	Category 7	Category 8	Category 9
Nebraska	Minnesota	Washington	Maine	Alaska
Connecticut	North Dakota	Utah	Vermont	
Colorado	Michigan	Oregon	Montana	
Pennsylvania	Wisconsin	New York	Wyoming	
Massachusetts	South Dakota	Idaho	New Hampshire	
Nevada				

Source: Mean annual snowfall was derived from the map of mean annual snowfall published in the *National Atlas of the United States of America*. Maximum normal winter temperature was derived using data from the National Climactic Data Center, Asheville, NC.

corresponding category. During the process of determining the snowfall ranges and temperatures, ORNL reviewed data from the National Climatic Data Center, the National Snow and Ice Data Center, the National Weather Service, and the USDA National Water and Climate Center.

Snowmobile fuel use adjustments were made by category to account for the difference in snowmobile usage due to the difference in opportunity for snowmobile use in the State (Table 5.4). There are ten States in category 1 which have limited opportunity for snowmobile use because of the light snowfall and warm temperatures

(such as in Hawaii or Florida). Category 5, which is the middle category, has potential for some snowmobile use due to the amount of snowfall (32–64 inches), but warmer temperatures can prevent snow from staying for long periods. Alaska is in category 9 with the heaviest amount of snowfall and freezing winter temperatures.

The estimated annual fuel used by snowmobiles for off-highway recreational purposes is calculated by

$$_{OFF}Gal_{j,t} = [(N_{j,t} \times C_{rec}) \times 101\ gallons\ \times \xi_j] + [(N_{j,t} \times C_{ice}) \times 13.3\ gallons\ \times \xi_j],$$

where

$N_{j,t}$ = the number of snowmobiles, registered and unregistered, in State j in year t;

C_{rec} = 0.8 (the percentage of the time when a snowmobile is used for "typical" recreational purposes),

$(N_{j,t} \times C_{rec})$ = the number of snowmobiles (in full vehicle equivalents) used for off-road recreation,

C_{ice} = 0.15 (the percentage of the time when a snowmobile is used for ice fishing),

$(N_{j,t} \times C_{ice})$ = the number of snowmobiles (in full vehicle equivalents) used for ice fishing, and

ζ_j = the adjustment factor for State j in terms of the difference in the amount of snowfall and temperature (Table 5.4).

The resulting fuel use estimates are in Table 5.5.

Table 5.5. Estimated total fuel consumption for snowmobiles, 1998

State	Number of snowmobiles[1]	Average annual fuel use for recreation (gal.)	Average annual fuel use for ice fishing (gal.)	Total fuel used (gal.)
Alabama	0	0	0	0
Alaska	60,000	7,376,941	182,141	7,559,082
Arizona	10,000	153,686	3,795	157,481
Arkansas	0	0	0	0
California	14,175	435,701	10,758	446,458
Colorado	29,400	1,807,350	44,625	1,851,975
Connecticut	1,381	84,881	2,096	86,977
Delaware	285	8,746	216	8,962
District of Columbia	0	0	0	0
Florida	0	0	0	0
Georgia	0	0	0	0
Hawaii	0	0	0	0
Idaho	36,778	3,391,396	83,736	3,475,132
Illinois	61,022	2,813,464	69,466	2,882,930
Indiana	20,153	619,437	15,294	634,731
Iowa	34,650	1,597,569	39,445	1,637,014
Kansas	0	0	0	0
Kentucky	0	0	0	0
Louisiana	0	0	0	0
Maine	87,150	9,375,631	231,490	9,607,120
Maryland	247	7,584	187	7,772
Massachusetts	13,935	856,620	21,150	877,770
Michigan	307,027	23,592,943	582,524	24,175,467
Minnesota	288,659	22,181,435	547,673	22,729,108
Mississippi	0	0	0	0
Missouri	0	0	0	0
Montana	15,079	1,622,210	40,053	1,662,263
Nebraska	1,451	89,206	2,203	91,408
Nevada	0	0	0	0
New Hampshire	37,047	3,985,547	98,406	4,083,952
New Jersey	2,639	81,105	2,003	83,107
New Mexico	1,308	40,214	993	41,206
New York	115,500	12,425,534	306,794	12,732,328
North Carolina	0	0	0	0
North Dakota	17,011	1,307,182	32,275	1,339,457
Ohio	24,150	1,113,457	27,492	1,140,949
Oklahoma	0	0	0	0
Oregon	14,097	1,299,937	32,096	1,332,033
Pennsylvania	45,150	2,775,574	68,531	2,844,104
Rhode Island	183	5,616	139	5,754
South Carolina	0	0	0	0
South Dakota	13,163	1,011,471	24,974	1,036,445
Tennessee	0	0	0	0
Texas	0	0	0	0
Utah	25,723	2,371,954	58,565	2,430,519
Vermont	28,073	3,020,083	74,568	3,094,650
Virginia	0	0	0	0
Washington	29,225	2,694,856	66,538	2,761,394
West Virginia	0	0	0	0
Wisconsin	212,327	16,315,856	402,848	16,718,704
Wyoming	19,912	2,142,162	52,891	2,195,053
Total	**1,566,898**	**126,605,346**	**3,125,961**	**129,731,307**

[1]Includes both registered and unregistered vehicles.

6 OTHER POTENTIAL FACTORS

6.1 Introduction

Off-road vehicles use recreational trails or back country terrain. Off-road clubs, associations, and other organizations abound and include enthusiasts for motorcycles, ATVs, snowmobiles, 4x4s, sand cars, quads, etc. According to the Environmental Protection Agency (EPA), "Increasing numbers of Americans are taking to the back country, and more and more are doing so on wheels. Use of off-road motorcycles and all-terrain vehicles nearly tripled between 1980 and 1990" (http://www.epa.gov/owowwtr1/info/NewsNotes/issue40/nps40nat.html).

In earlier chapters of this report, we provided rationale for deriving the population of each type of off-road recreational vehicle (light trucks, motorcycles, ATVs, and snowmobiles) by State and also for calculating the total fuel used for off-road recreational purposes. The end result of each of these chapters was the number of gallons of off-road fuel used for recreational purposes, by State, for each type of off-road vehicle. The process included counting the number of vehicles within each category and multiplying that number by the annual fuel usage for one vehicle of that category.

It has been suggested that calculating fuel consumption based on a count of off-road recreational vehicles in a State is not necessarily a fair measure since, for example, a light truck (or a motorcycle, ATV, or snowmobile) might be registered in (or belong to a resident of) one State but ridden off-road in a different State. To address this concern, ORNL considered other possible factors.

6.2 A Discussion of Other Factors

Additional factors that could impact the calculation of the amount of off-road recreational fuel used include the following:

- Visitation to Federal recreation areas, as measured in number of visitors, visitation hours, or visitor days,
- Recreational use of public land for off-road vehicle travel, as measured in visitor hours,
- Miles of trail available for off-road usage by motorized vehicles,
- Private land available for off-road usage by motorized vehicles,
- State land available for off-road usage by motorized vehicles,
- Federal land available for off-road usage by motorized vehicles, and
- Rural land available for off-road usage by motorized vehicles.

Each of these potential factors is discussed below.

The *Statistical Abstract of the United States 1997* (Bureau of the Census, 1997) provides data on visitations to Federal recreational areas (in number of visitors, visitor hours, or visitor days) and lists the recreational use of public lands for off-road vehicle travel (in visitor hours). In addition, the Bureau Recreation Management Information System Report #22 provides information of visitor use activities based on participant, visitor hours, and visitor days. One category that is measured is "Trail activities." These measures of recreational use seem to be potential factors for inclusion in the formula for recreational fuel use. Unfortunately, the measurement of off-road vehicle travel is provided for only a few individual States and groupings of the remaining States. When event participation is measured and provided for every individual State, the measurement includes activities other than just off-road vehicle recreation. Therefore, because of these limitations, these potential factors are not recommended for use at this time.

The existence of trails and/or the accessibility of acreage definitely encourages recreational participation. Arriving at a fair and equitable measure of length of trails and/or acreage is not simple, however.

For example, although some States have very precise measurements of miles of established trails, other States have not calculated the miles of trail available to off-road vehicles. In some areas, ATVs are used by hunters, and many of their trails are logging roads on private land. Therefore, a source of data which measures the miles of "trail" in each State in an equitable manner is difficult or perhaps impossible to obtain. For this reason, using miles of trail as a proxy for off-road recreation is not recommended at this time.

Measuring acreage that allows use of ORVs is another potential option for calculating off-road recreational activities.

One type of land that is made available for off-road recreational use is privately owned property (e.g., large tracts of land belonging to timber companies). Sometimes this land is leased and managed by a State; sometimes it is just made available to individual off-road clubs and associations. A few States have estimates of the amount of land that is available; however, there is little or no consistency on how the information is obtained by the States, on how long the private lands are available for off-road vehicle usage, or on specific restrictions that are applied (e.g., only available during hunting season). Because there is no verifiable, stable data source for the amount of private land available for off-road recreation, this factor is not recommended at this time.

ORNL attempted to obtain acreages for State-owned properties available in each State for recreational purposes. Land totals were calculated from information obtained from the National Association of State Park Directors (NASPD). These

acreages included recreation areas, State forests, and fish/wildlife areas but excluded State parks, natural areas, historic areas, environmental education areas, scientific areas, and other miscellaneous areas, because these areas generally prohibited off-road vehicles. The total acreages were sent to the Recreational Trails Coordinators in each State for validation. Although a few States verified these numbers, most States rejected them as incorrect and supplied other numbers (almost always greater). In addition, some States never responded to the request to supply better numbers. Because there is no central valid source of data for State land that is accessible to off-road vehicles, use of State acreage is not recommended at this time.

Table 6.1 provides a total acreage of Federal lands available in each State. This acreage is a sum of all non-wilderness land managed by either the U.S. National Forest Service (NFS) or the Bureau of Land Management (BLM). Because there are valid central sources of NFS and BLM data and because the existence of public land that permits off-road vehicle usage is an indication of the potential for off-road recreational fuel use, using Federal, non-wilderness acreage within the formula seems to be a valid practice. This land measure, however, does not include all available recreational areas (e.g., State and private lands that allow motorized recreation are excluded). Therefore, it is incomplete.

The final factor examined is that of net rural land area. Table 6.2 shows this measurement for square miles (as given in *Highway Statistics 1997*, Table PS-1). The rationale for selecting net rural land area as a proxy for availability of land for off-road recreational fuel use includes the following: ❶ it is a number supplied by the States to FHWA, ❷ the definitions for "rural" and "urban" areas are clearly defined, easily understood, and consistently applied, ❸ it includes Federal, State, and private rural lands, and ❹ the data are from a stable, accessible source that is updated regularly.

Table 6.1. Federal lands acreage by State based on U.S. National Forest Service (NFS) and Bureau of Land Management (BLM) acreage, 1997

State	NFS land	NFS wilderness land	BLM land	BLM wilderness land	Total NFS +BLM non-wilderness land
Alabama	664,889	32,167	3,117	0	635,839
Alaska	21,969,321	5,752,298	86,908,060	0	103,125,083
Arizona	11,251,701	1,345,008	11,609,999	1,405,750	20,110,942
Arkansas	2,576,852	116,578	2,059	0	2,462,333
California	20,647,142	4,432,634	9,088,886	3,587,381	21,716,013
Colorado	14,508,108	3,147,101	7,262,065	59,255	18,563,817
Connecticut	24	0	0	0	24
Delaware	0	0	0	0	0
District of Columbia	0	0	0	0	0
Florida	1,147,246	74,495	1,512	0	1,074,263
Georgia	864,942	114,537	0	0	750,405
Hawaii	1	0	0	0	1
Idaho	20,460,774	3,961,578	11,155,662	802	27,654,056
Illinois	277,506	25,638	3	0	251,871
Indiana	195,625	12,945	0	0	182,680
Iowa	0	0	0	0	0
Kansas	108,175	0	0	0	108,175
Kentucky	693,126	16,779	0	0	676,347
Louisiana	604,138	8,679	4,351	0	599,810
Maine	53,040	12,000	0	0	41,040
Maryland	0	0	0	0	0
Massachusetts	0	0	0	0	0
Michigan	2,857,019	91,891	47	0	2,765,175
Minnesota	2,837,488	809,772	6,044	0	2,033,760
Mississippi	1,158,172	6,046	1,240	0	1,153,366
Missouri	1,494,217	63,198	67	0	1,431,086
Montana	16,877,005	3,371,881	6,089,123	6,000	19,588,247
Nebraska	352,133	7,794	6,580	0	350,919
Nevada	5,823,676	787,085	47,633,965	6,435	52,664,121
New Hampshire	724,740	102,932	0	0	621,808
New Jersey	0	0	0	0	0
New Mexico	9,326,935	1,388,262	12,402,742	145,425	20,195,990
New York	16,068	0	0	0	16,068
North Carolina	1,243,520	102,634	0	0	1,140,886
North Dakota	1,105,752	0	59,536	0	1,165,288
Ohio	227,187	0	0	0	227,187
Oklahoma	392,211	14,543	2,142	0	379,810
Oregon	15,656,351	2,072,494	13,040,775	6,788	26,617,844
Pennsylvania	513,264	8,938	0	0	504,326
Rhode Island	0	0	0	0	0
South Carolina	612,390	16,671	0	0	595,719
South Dakota	2,013,124	9,826	272,277	0	2,275,575
Tennessee	634,073	66,349	0	0	567,724
Texas	754,983	38,483	0	0	716,500
Utah	8,112,730	773,818	21,155,026	26,630	28,467,308
Vermont	366,406	59,421	0	0	306,985
Virginia	1,656,986	87,064	0	0	1,569,922
Washington	9,177,071	2,572,977	366,921	6,900	6,964,115
West Virginia	1,032,625	80,852	0	0	951,773
Wisconsin	1,521,104	42,294	2,521	0	1,481,331
Wyoming	9,247,742	3,111,232	15,184,488	0	21,320,998
Total	191,757,582	34,738,894	242,259,208	5,251,366	394,026,530

Sources:

NFS acreage - "Land Areas of the National Forest System, as of September 1997," Table 4, Areas by States, http://www.fs.fed.us/database/lar/97. **NFS Wilderness acreage** - "Land Areas of the National Forest System, as of September 1997," Table 9, National Wilderness Areas Summary, http://www.fs.fed.us/database/lar/97. **BLM acreage** - *Public Land Statistics 1997,* Table 1-4, Public Lands Under Exclusive Jurisdiction of the Bureau of Land Management, Fiscal Year 1997, http://www.blm.gov/natacq/pls97. **BLM Wilderness acreage** *Public Land Statistics 1997,* Table 5-10, Bureau of Land Management lands designated as wilderness by Congress as of September 30, 1997, http://www.blm.gov/natacq/pls97.

Table 6.2. Rural land by State, 1997

State	1997 Rural net land area (square miles)
Alabama	47,561
Alaska	569,444
Arizona	110,757
Arkansas	51,096
California	146,692
Colorado	101,942
Connecticut	3,287
Delaware	1,677
District of Columbia	0
Florida	45,477
Georgia	54,389
Hawaii	6,159
Idaho	82,284
Illinois	51,484
Indiana	34,004
Iowa	54,761
Kansas	80,642
Kentucky	38,340
Louisiana	41,428
Maine	30,383
Maryland	8,114
Massachusetts	4,788
Michigan	53,250
Minnesota	77,778
Mississippi	45,856
Missouri	66,884
Montana	145,290
Nebraska	76,444
Nevada	108,943
New Hampshire	8,506
New Jersey	5,040
New Mexico	120,810
New York	41,761
North Carolina	45,488
North Dakota	68,841
Ohio	36,474
Oklahoma	66,650
Oregon	95,056
Pennsylvania	40,869
Rhode Island	517
South Carolina	28,686
South Dakota	75,648
Tennessee	38,484
Texas	253,449
Utah	81,301
Vermont	9,020
Virginia	37,118
Washington	64,359
West Virginia	23,656
Wisconsin	52,869
Wyoming	96,625
Total	3,430,381

Source: Federal Highway Administration, *Highway Statistics 1997*, Table PS-1, Washington, DC, 1998.

It should be noted, however, that the availability of land for off-road recreation does not ensure off-road recreational fuel use. Therefore, ORNL does not recommend that this factor be incorporated *directly* into the formula. The methodology that ORNL recommends for applying this land-based data is explained in Chapter 7.

6.3 Summary and Recommendations

In this chapter, we examined several new potential factors that might impact the amount of fuel used for off-road recreation. These factors included time-based and land-based measures.

While researching the existence of data sets that are believable, dependable, stable, updated on a reasonable basis, accessible by FHWA, and consistently applied across all States, ORNL requested information from State DOTs, State Trails Coordinators, and other agencies and organizations. In responding to a request for information, one State recommended that a scientifically designed study be conducted among all States. While surveys on recreational fuel use have been conducted within individual States in the past, they have used various survey methodologies. Surveys that are not applied consistently across all States can not serve the same purpose as a single survey that is statistically designed and universally applied. A survey collecting data consistently over all States could ascertain off-road fuel usage with undeniable results. Such a survey, designed with the specific purpose of determining off-road fuel use, has not been conducted as of this time.

On the basis of using valid and consistent data that obviously relates to off-road vehicles, ORNL determined that the only new data set that is reasonable in terms of this analysis is that of rural net land area, as provided in *Highway Statistics1997*. A methodology for using this data is explained in the following chapter.

7 SUMMARY AND CONCLUSIONS

Since 1994, FHWA has been using a modification of the model developed by ORNL to estimate the fuel used for off-road recreation in order to apportion funds to each State under the Recreational Trails Program. To ensure that the method for distributing program funds benefits from recent, more accurate data than those available in 1993–1994, this effort re-evaluated the methodology. As in the previous study (ORNL, 1994), it was determined that a standardized estimation procedure for all States using easily obtainable and understandable data would be preferred over State-submitted reports. Reasons for this rationale include incompatibility of State-submitted estimates, along with the fact that an estimation procedure would still be required at the Federal level for States which did not submit estimates. For this reason, individual State surveys were not heavily investigated during this effort.

In this report ORNL has examined off-road recreational fuel use by four vehicle types – light trucks, motorcycles, ATVs, and snowmobiles. Fuel use estimates rely on the population of vehicles within a State and an estimate of the average annual fuel used per vehicle. The amount of time a vehicle is used for recreational pursuits as opposed to non-recreational off-road travel was also taken into consideration, as well as opportunity for recreational use (e.g., snowfall). A summary of fuel use for all vehicle types by State is provided in Table 7.1.

The FHWA had concerns that light truck fuel use was overestimated in their previous off-road fuel use estimates. Table 7.1 shows that, when the updated data and revised methodologies are incorporated, light trucks represent approximately 79% of the total off-road fuel use. The most recent FHWA estimations prior to this study estimated that off-road fuel consumption by light trucks represented 90% of the total off-road fuel usage.

Table 7.1. Off-road fuel use estimates by vehicle type, 1997[1] (gallons)

State	Light trucks	Motorcycles	ATVs	Snowmobiles	Total	Percentage
Alabama	30,856,673	2,265,600	3,901,846	0	37,024,120	2.010%
Alaska	5,212,941	542,800	1,530,085	7,559,082	14,844,908	0.806%
Arizona	28,791,650	2,295,100	1,986,104	157,481	33,230,335	1.804%
Arkansas	26,101,369	1,345,200	4,250,093	0	31,696,662	1.721%
California	151,880,913	21,098,400	7,630,762	446,458	181,056,533	9.828%
Colorado	35,484,731	3,068,000	1,421,229	1,851,975	41,825,936	2.270%
Connecticut	7,711,202	1,711,000	587,234	86,977	10,096,413	0.548%
Delaware	3,123,599	318,600	214,801	8,962	3,665,962	0.199%
District of Columbia	451,235	59,000	1,889	0	512,125	0.028%
Florida	59,862,296	6,106,500	3,485,716	0	69,454,512	3.770%
Georgia	51,556,948	4,183,100	4,350,959	0	60,091,007	3.262%
Hawaii	4,088,072	0	0	0	4,088,072	0.222%
Idaho	20,409,470	2,029,600	1,451,672	3,475,132	27,365,874	1.486%
Illinois	43,590,877	4,041,500	3,029,883	2,882,930	53,545,190	2.907%
Indiana	24,797,028	2,820,200	2,672,346	634,731	30,924,306	1.679%
Iowa	20,067,856	1,274,400	1,448,079	1,637,014	24,427,349	1.326%
Kansas	20,529,419	979,400	1,074,934	0	22,583,753	1.226%
Kentucky	25,793,937	1,888,000	3,333,937	0	31,015,874	1.684%
Louisiana	42,637,561	1,498,600	4,163,875	0	48,300,036	2.622%
Maine	7,357,339	767,000	1,111,756	9,607,120	18,843,216	1.023%
Maryland	14,531,934	2,265,600	1,016,372	7,772	17,821,678	0.967%
Massachusetts	17,172,042	2,749,400	915,877	877,770	21,715,090	1.179%
Michigan	37,695,980	5,315,900	5,650,449	24,175,467	72,837,796	3.954%
Minnesota	23,323,683	2,212,500	3,298,168	22,729,108	51,563,458	2.799%
Mississippi	42,009,091	867,300	3,456,047	0	46,332,439	2.515%
Missouri	39,828,793	2,112,200	3,615,755	0	45,556,747	2.473%
Montana	16,392,660	1,085,600	1,058,799	1,662,263	20,199,323	1.096%
Nebraska	9,050,538	595,900	1,132,258	91,408	10,870,103	0.590%
Nevada	9,100,192	1,386,500	688,936	0	11,175,628	0.607%
New Hampshire	3,589,391	1,044,300	705,009	4,083,952	9,422,653	0.511%
New Jersey	34,101,851	3,569,500	1,439,408	83,107	39,193,867	2.128%
New Mexico	26,200,256	1,209,500	810,923	41,206	28,261,886	1.534%
New York	42,472,485	5,593,200	4,411,875	12,732,328	65,209,888	3.540%
North Carolina	41,113,992	4,454,500	4,034,270	0	49,602,762	2.693%
North Dakota	6,021,267	330,400	528,981	1,339,457	8,220,106	0.446%
Ohio	51,408,831	5,445,700	4,449,688	1,140,949	62,445,167	3.390%
Oklahoma	32,166,929	1,799,500	1,838,506	0	35,804,934	1.944%
Oregon	27,910,158	2,832,000	2,106,697	1,332,033	34,180,888	1.855%
Pennsylvania	32,367,925	5,911,800	5,335,866	2,844,104	46,459,695	2.522%
Rhode Island	3,224,605	436,600	92,102	5,754	3,759,061	0.204%
South Carolina	22,318,066	1,958,800	1,659,784	0	25,936,650	1.408%
South Dakota	5,586,413	418,900	616,995	1,036,445	7,658,753	0.416%
Tennessee	33,934,051	2,796,600	4,238,448	0	40,969,099	2.224%
Texas	116,695,478	7,911,900	6,683,482	0	131,290,860	7.127%
Utah	13,934,165	1,893,900	2,296,506	2,430,519	20,555,090	1.116%
Vermont	3,203,522	348,100	459,456	3,094,650	7,105,728	0.386%
Virginia	47,809,066	3,115,200	2,234,166	0	53,158,432	2.886%
Washington	40,226,989	4,607,900	1,891,834	2,761,394	49,488,117	2.686%
West Virginia	13,347,241	1,445,500	2,786,560	0	17,579,300	0.954%
Wisconsin	22,672,433	2,271,500	3,293,212	16,718,704	44,955,850	2.440%
Wyoming	14,805,589	572,300	695,161	2,195,053	18,268,103	0.992%
Total	1,454,520,733	136,850,500	121,088,790	129,731,307	1,842,191,331	
Percentage by type	79.0%	7.4%	6.6%	7.0%	100.0%	

[1]Snowmobile population data as of 1998.

Vehicle registration data can be misleading for estimating fuel use by State if a vehicle travels in a different State than that in which it is registered. This is the case with the small amounts of fuel use shown in the District of Columbia (Table 7.1), because there are no areas available for off-road recreation within the District (FHWA, Recreational Trails Program Office, personal communication with S. C. Davis, ORNL, October 13, 1998). Since the fuel use estimations recommended in this report rely heavily on vehicle registrations, ORNL investigated other factors which might impact the amount of fuel used for off-road recreation and could be used in conjunction with fuel use to derive the most equitable apportionment of funds. It was concluded in Chapter 6 that the acreage of net rural lands is a valid measure that relates to off-road recreational vehicle use.

Although the *availability* of rural land is a proxy for an *opportunity* to participate in off-road recreational activities, it is not apparent that there is a direct correlation between the number of square miles of land and the numbers of gallons of fuel consumed. ORNL examined the possibility of classifying the States into broad categories on the basis of how much rural land is available (Table 7.2). These categories are defined as follows. Category 1 includes 10 States (including the District of Columbia) that have either very little or no rural land, which implies that there is limited opportunity for off-road recreation. Category 2, with eight States, includes all States with rural lands of 20–40,000 square miles available for off-highway riding. Category 3 includes 13 States with 40–60,000 rural square miles. Category 4 includes seven States, all of which have 60–80,000 square miles of rural land. Category 5 includes five States, all of which have 80–100,000 square miles of rural land. Categories 6 and 7 contain three and five States, respectively, with 100–120,000 square miles and over 120,000 square miles of land classified as rural. If a State is in category 1, with little or no Federal land available, the estimation of fuel usage for that State remains constant (i.e., unchanged from the totals given in Table 7.1). If a State is in category 2 (a greater opportunity to ride off-road because

Table 7.2. Categories of rural land availability for off-road recreation (square miles of net rural land)

Category 1: < 20,000	Category 2: 20–40,000	Category 3: 40–60,000	Category 4: 60–80,000	Category 5: 80–100,000	Category 6: 100–120,000	Category 7: >120,000
Connecticut	Indiana	Alabama	Minnesota	Idaho	Arizona	Alaska
Delaware	Kentucky	Arkansas	Missouri	Kansas	Colorado	California
DC	Maine	Florida	Nebraska	Oregon	Nevada	Montana
Hawaii	Ohio	Georgia	N. Dakota	Utah		New Mexico
Maryland	S. Carolina	Illinois	Oklahoma	Wyoming		Texas
Massachusetts	Tennessee	Iowa	S. Dakota			
New Hampshire	Virginia	Louisiana	Washington			
New Jersey	W. Virginia	Michigan				
Rhode Island		Mississippi				
Vermont		N. Carolina				
		New York				
		Pennsylvania				
		Wisconsin				

Based on data from Table 6.2.

of the greater amount of rural land available), that State will receive a bonus of 5%; if in category 3, the State will receive a bonus of 10%; if in category 4, the State will receive a bonus of 15%; if in category 5, the State will receive a bonus of 20%; States in categories 6 and 7 receive bonuses of 25% and 30%, respectively. This methodology is similar to that described in Chapter 5, when applying the adjustment factor for average annual snow fall and normal winter temperature. After applying this adjustment factor to the total off-road recreational fuel use, the final apportionment of State funding is shown on Table 7.3.

Table 7.3 provides the percentages of off-road fuel use, by State, at this time (March 1999). The most recent data available (1997 for light trucks, motorcycles, and ATVs; 1998 for snowmobiles) have been used for these calculations.

Table 7.3. Final allocation using rural land factor adjustment

State	Total off-road recreational fuel use (gallons)	Rural land factor adjustment	Final allocation (percentage)
Alabama	37,024,120	10%	1.929%
Alaska	14,844,908	30%	0.914%
Arizona	33,230,335	25%	1.967%
Arkansas	31,696,662	10%	1.651%
California	181,056,533	30%	11.147%
Colorado	41,825,936	25%	2.476%
Connecticut	10,096,413	0%	0.478%
Delaware	3,665,962	0%	0.174%
District of Columbia	512,125	0%	0.024%
Florida	69,454,512	10%	3.618%
Georgia	60,091,007	10%	3.131%
Hawaii	4,088,072	0%	0.194%
Idaho	27,365,874	20%	1.555%
Illinois	53,545,190	10%	2.790%
Indiana	30,924,306	5%	1.538%
Iowa	24,427,349	10%	1.273%
Kansas	22,583,753	20%	1.284%
Kentucky	31,015,874	5%	1.542%
Louisiana	48,300,036	10%	2.516%
Maine	18,843,216	5%	0.937%
Maryland	17,821,678	0%	0.844%
Massachusetts	21,715,090	0%	1.028%
Michigan	72,837,796	10%	3.795%
Minnesota	51,563,458	15%	2.808%
Mississippi	46,332,439	10%	2.414%
Missouri	45,556,747	15%	2.481%
Montana	20,199,323	30%	1.244%
Nebraska	10,870,103	15%	0.592%
Nevada	11,175,628	25%	0.662%
New Hampshire	9,422,653	0%	0.446%
New Jersey	39,193,867	0%	1.856%
New Mexico	28,261,886	30%	1.740%
New York	65,209,888	10%	3.397%
North Carolina	49,602,762	10%	2.584%
North Dakota	8,220,106	15%	0.448%
Ohio	62,445,167	5%	3.105%
Oklahoma	35,804,934	15%	1.950%
Oregon	34,180,888	20%	1.943%
Pennsylvania	46,459,695	10%	2.420%
Rhode Island	3,759,061	0%	0.178%
South Carolina	25,936,650	5%	1.290%
South Dakota	7,658,753	15%	0.417%
Tennessee	40,969,099	5%	2.037%
Texas	131,290,860	30%	8.083%
Utah	20,555,090	20%	1.168%
Vermont	7,105,728	0%	0.337%
Virginia	53,158,432	5%	2.644%
Washington	49,488,117	15%	2.695%
West Virginia	17,579,300	5%	0.874%
Wisconsin	44,955,850	10%	2.342%
Wyoming	18,268,103	20%	1.038%
Total	1,842,191,331		100.000%

Based on Tables 7.1 and 7.2.

In order to get the most accurate estimates from the model, it is important to update the input data as often as new data become available. Below is a summary of the ORNL recommendations for these updates.

- Light trucks: ❶ update the number of FVE trucks annually, using Table MV-9 from *Highway Statistics*, ❷ update annual miles and fuel economy annually, using Table VM-1 from *Highway Statistics*, ❸ update the percentages of trucks used for off-road recreation every five years, using TIUS data and the programs provided in Appendix B, and ❹ use TIUS data and the programs provided in Appendix B to determine the off-road fuel economy and annual miles discounts;
- Motorcycles: update the number of motorcycles ridden off-road each year, using the data supplied by the MIC in the Statistical Annual;
- ATVs: contact the MIC annually to determine whether an update has been calculated;
- Snowmobiles: update the number of registered snowmobiles annually (in late Spring), based on registration material supplied by the ACSA; for States that require registrations but do not report snowmobile populations to ACSA, contact the responsible State agency for updated numbers;
- Rural land: update the square miles of rural land each year using the *Highway Statistics* Table PS-1.

Outdoor recreational activities are becoming more and more popular every year. Participants, including men, women, and children, are active in maintaining trails and protecting the environment. In this report, we show that the enthusiasm for off-road vehicle recreation requires a substantial quantity of fuel each year – almost 2 billion gallons, based on currently available data! This fuel usage represents a 27% increase over the 1992 estimated fuel use. Although there are differences among the off-road vehicles considered in this study (e.g., the snowmobile riding season is not equal to

the motorcycle riding season), every single vehicle type saw an increase in the total amount of annual fuel use.

Recognizing the importance of recreational trail funds to the States, ORNL examined various information sources and analyzed the available data. ORNL then calculated a fair and equitable distribution that is based on the vehicles within each State, the fuel economy of each type of vehicle, and the opportunity for usage within each State. This formula for apportionment, in spreadsheet format, was provided to FHWA.

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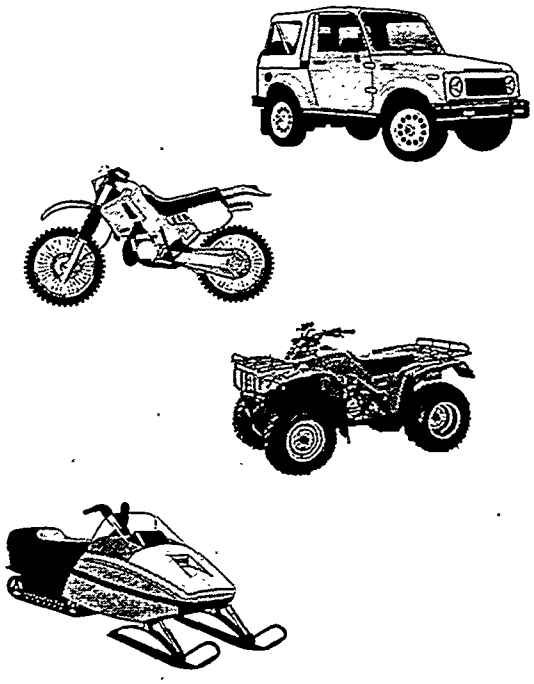
Appendix A

Detailed Registration Information



A DETAILED REGISTRATION INFORMATION

A.1 Light Trucks

All light trucks which travel on-road are required to be registered with the State Department of Motor Vehicles (DMV). Pickup trucks and sports utility vehicles which are specifically used for off-road recreation are almost always driven at some point on-road, and, therefore, would be registered with the State. Only vehicles which **always** recreate off-road in the same location as they are stored or vehicles which are **always** trailered to recreational locations could avoid State registration.

A.2 Motorcycles

Each year the Motorcycle Industry Council (MIC) collects information concerning the registration of off-road motorcycles and publishes it in the *Motorcycle Statistical Annual.* Since there is no Federal requirement for registering off-road motorcycles, the States set their own policies and have many different requirements concerning registration of these vehicles. Some States register off-road motorcycles with the motor vehicle registration agency and others register with the recreation management agency. Some States only register the vehicles if they use certain State lands. There are also exceptions for off-road motorcycles used in competitive events. Each State maintains its own records on off-road motorcycles according to its own registration conditions; thus, there is no central location of all off-road motorcycle registration data. The chart "State Off-Highway Motorcycle Requirements" (MIC, 1998) which lists the specific requirements for each State follows the text of Appendix A.

A.3 All-Terrain Vehicles (ATVs)

The Government Relations Office of the Specialty Vehicle Institute of America compiles data each year on State ATV registration requirements. Like off-road

motorcycles, each State provides rules concerning ATV registration. ATVs may be required to register only if they travel on public lands; they may be required to register either through the motor vehicle registration agency or the recreation management agency; they may have registration exclusions for authorized events; and there is no central location of nationwide registration data. The chart "State All-Terrain Vehicle Requirements" (SVIA, 1998) which lists the specific registration requirements of each State is found at the end of Appendix A.

A.4 Snowmobiles

Snowmobile registration requirements are also not consistent across States. Nor is there a Federal requirement or central repository for registrations. The two snowmobile associations, the ISMA and the ACSA, both collect population numbers. Neither organization collects registration information from the States which have registration requirements but very small numbers of snowmobiles. In addition, the numbers of snowmobiles reported by the two organizations are not consistent. The inconsistency is easily explained. Since there is no central data repository, data collection is by phone calls to the State DMVs. Because the States have different requirements for the length of time that a registration is valid, the two organizations may collect the number of registered snowmobiles at different times in the registration cycle. Other problems with collecting the numbers of snowmobiles include the number of vehicles that are not registered, the fact that Alaska (which has a large snowmobile population) has only recently required registration, the problem with combining snowmobiles with other off-road vehicles in a common registration category, and the fact that Arizona has a large snowmobile population and does not require registration.

State Off-Highway Motorcycle Requirements

August, 1998

State	Off-Highway Registration	Vehicle Title	Operator License	Minimum Age to Operate	OFF-HIGHWAY EQUIPMENT REQUIREMENTS: Lighting	Brakes	Muffler	Spark Arrester	Approved Helmet	Other	Rider Education
Alabama											
Alaska				14BH							
Arizona		•					•-f				X
Arkansas											
California	•-Ad	•			•-K	•	•-Mf	•-N			X
Colorado	•-Se				•-KU	•-f	•-Mf	•-f			
Connecticut	•-Ed				•	•	•				
Delaware	•-Dd			12B	•-K	•	•-Mf	•	•		X
Dist. of Columbia		•									
Florida	•-EeH										
Georgia						•	•				
Hawaii											
Idaho	•-e	•-T					•-M	•-N			X
Illinois											
Indiana	•-UDe	•-I		14B	•-K	•-L	•				
Iowa	•-Ue			12UR, 18Ua	•-K	•	•-M				•-CU
Kansas											
Kentucky				12j, 16k &B			•		•		
Louisiana	•-d	•									
Maine	•-Fe			10, 16B	•-f		•-Mf	•	•-C		•-C
Maryland	•-eH		•-BH	12H	•-KH	•-H	•-MH				
Massachusetts	•-Ee			12, 14B, 10g	•-	•	•-M	•	•		
Michigan	•-e	•		16B & a	•-K	•-L	•-Mf	•	•	•-P	•-O
Minnesota	•-UFd	•-I		16aUh, 12BU		•			•-CU	•-P	•-OU
Mississippi		•-I									
Missouri		•									
Montana	•-d	•-U									X
Nebraska											
Nevada		•-I						•			
New Hampshire	•-Fe		•-CB or a	18B, b or J	•-K	•-L	•-M	•	•-C	•-PC	•-GB or b
New Jersey											
New Mexico	•-Ed	•									
New York	•-Fd			16B, 10W	•-Kf	•	•-Mf	•-N	•		•-c
North Carolina											
North Dakota							•-MH				
Ohio	•-Ed		•-U	16B, 12V	•	•	•				
Oklahoma					•-KH		•-H	•-H	•-H		
Oregon	•-Hd		•-U, a or h	7U, 12UB & a	•-K	•	•-M	•-H	•-C		•-i
Pennsylvania							•-H	•-NH			
Rhode Island	•-Ee	•		12, 16BH	•-K	•	•-Mf			•-Q	
South Carolina		•-I									
South Dakota		•					•				
Tennessee		•					•-H	•-H	•-H	•-PH	
Texas		•					•-H	•-NH	•-H		
Utah	•-UEd	•-Z	•-a	8U, 16a	•-K	•	•		•-C		•-b
Vermont	•-UEd			12B	•-f	•-f	•-Mf				
Virginia											
Washington	•-Dd				•-K	•	•-M	•			X
West Virginia											
Wisconsin											
Wyoming											

• Requirement in law

A. Except street-registered OHMs. Identification sticker required to transport competition OHM.
B. Unless supervised.
C. Under age 18.
D. Except street-registered OHMs or OHMs in races.
E. Except street-registered OHMs.
F. Except OHMs in races.
G. For ages 12-17.
H. Applies only on certain state lands.
I. Only if lien exists.
J. Unless at least age 12 & have safety certificate.
K. Night operation only.
L. Specific performance requirements.
M. Decibel sound limit specified.
N. Approved by U.S. Forest Service.
O. Under age 16,
P. Eye protection.
Q. 16 sq. in. reflective material each side of OHM and approved helmet.
R. Unless taking a safety course.
S. Except OHMs used only for agriculture or in authorized events.
T. For transfer of ownership.
U. On public lands.
V. On DNR lands if accompanied by parent.
W. With safety certificate.
X. Safety education & info program available.
Y. Helmet and eye protection if under 18.
Z. For 1988 model year or newer.
a. Unless in possession of safety certificate.
b. Unless operator's license possessed.
c. Ages 10-15 unless supervised.
d. By motor vehicle registration agency.
e. By recreation management agency.
f. Except in authorized competitive events.
g. In authorized events.
h. Unless accompanied by person at least 18 who holds license or operator permit.
i. Ages 7-12.
j. For OHM's over 70cc
k. For OHM's over 90cc

OHM SOUND LEVEL LIMITS		TEST PROCEDURES
CA	Manuf'd before 1973 92 dBA; 1973-1974 88 dBA, 1975-1985 86 dBA, after 1985 82 dBA; or 101 dBA.	a,d
CO	Manuf'd 1971-1972 86 dBA; after 1972 84 dBA; different local limits also permitted.	a
DE	Manuf'd 1978 and after 88 dBA or EPA limit.	b
IA	86dBA.	e
ID	92 dBA; Effective 7/94 96 dBA (+ 3 dBA correction factor)	c,d
MD	Manuf'd after 6/76 86 dBA; 1979 and after 84 dBA.	a
MA	103 dBA.	d
ME	Must meet Federal EPA Standards.	
MI	Model year 1983 and after - EPA limit; additional limits specified in law.	
NH	Manuf'd 1973-74 88 dBA, 1975-1982 86 dBA, after 1982 EPA limit.	a
NY	Must meet Federal EPA Standards.	
ND	85 dBA.	a
OR	In use: model year 1975 and before 102 dBA, after 1975 99 dBA. Certification: 170cc & under: model year after 1985 80 dBA; over 170cc: model year after 1985 82 dBA. Racing: 105 dBA.	d,a,d
RI	Manuf'd after 5/72 82 dBA; after 5/74 73 dBA.	a
VT	82 dBA.	e
WA	86 dBA or 105 dBA.	a,d

TEST PROCEDURE KEY
a— Acceleration test 50 feet incorporating SAE J331a or similar test method.
b— Passby test 50 feet.
c— Passby test 20 feet.
d— Stationary test 20 inches.
e— Measured at 50 feet. Test procedure not prescribed.

Although the chart represents information from the most authoritative sources available as of the date shown above, the Motorcycle Industry Council is not responsible for accuracy or completeness. Many of the provisions summarized herein have exceptions and may require further explanation. It is necessary to refer to the actual laws and regulations for specific details.

Source: Compiled by Motorcycle Industry Council, Inc., Arlington, VA, August 1998.

STATE ALL-TERRAIN VEHICLE REQUIREMENTS

SEPTEMBER 1998

This chart is compiled by SVIA's Government Relations Office. It will be updated annually as state legislatures enact or amend ATV requirements. Please contact SVIA for additional information concerning ATVs or for additional copies of this chart.

State	REGISTRATION	TITLE	M/V OPERATOR'S LICENSE	MINIMUM AGE	SAFETY EDUCATION CERTIFICATE	EQUIPMENT REQUIREMENTS: LIGHTING	BRAKES	MUFFLER	SPARK ARRESTER	OTHER	ON-ROAD USE	CLASSIFIED AS	WEIGHT/WIDTH LIMITS
Alabama													
Alaska				14DS								OHV	
Arizona		•						•+C			Q	OHV/ATV	≤800lbs/≤50"
Arkansas	•A	•		12D		•G		•	•C		X, Z	ATV	≤800lbs/≤75"
California	•A	•		14EM, 18En or s	•Ein	•G	•	•IC	•	•KE	Z	OHMV/ATV	≤600lbs/≤50"
Colorado	•BCE					•EG	•CHE	•ICE	•CE		X, Z	OHV	
Connecticut	•A		•F	12E, 16Es & n	•vE	•p	•	•			Z	ATV	≤600lbs/≤50"
Delaware	•AC			12D		•G	•	•IC	•	•K+	J	OHV	
Dist. of Col.													
Florida	•BE									•hd		ORV/ATV	≤600lbs/≤50"
Georgia							•	•			g+	ORV/ATV	
Hawaii													
Idaho	•B	•						•I	•		X	ATV	<650lbs/<48"
Illinois		•									Z	ATV/OHV	≤600lbs/≤50"
Indiana	•BCE		•F	14		•G	•H	•			Z	ORV	
Iowa	•BE			12E, 18s	•iE	•G	•	•I			Z, (ge)	ATV	<750lbs/none
Kansas		•									gV	ATV	≤650lbs/≤45"
Kentucky				12R, 16u & D				•		•Kz	J	ATV	
Louisiana	•A	•									s	ORV	
Maine	•AC			10, 16D & F, 18s	•i	•p		•IC	•	•Ki	Z	ATV	
Maryland	•BS		•PS	12S		•GS	•S	•IS				ORV	
Massachussetts	•B			12, 14D, 16½F		•	•	•(I+)	•	•K	Z	RV	
Michigan	•B	•		12z, 16t & D & s	•d	•G	•H	•IC	•	•h	Z	ORV/ATV	
Minnesota	•BC			12E,16Es & D	•beE	•FG	•	•IC	•	•KiE	Q	ATV	<600lbs/none
Mississippi													
Missouri	•A	•		16D		•C	•C	•C	•C	•Ki	o	ATV	≤600lbs/≤50"
Montana	•A	•E							•S		Z	OHV	
Nebraska						•F & G	•	•	•C		Z, (ge)	ATV	≤600lbs/≤50"
Nevada								•	•				
New Hampshire	•B		•iD or s	18D, m or q	•rD or m	•p	•H	•(I+)C	•	•hi	Z	OHRV/ATV	≤1000lbs/≤50"
New Jersey	•ACE			x,14E, 16uE	•izCE	•C	•	•		•KL	Z	ATV	
New Mexico	•A	•									Z	OHMV	
New York	•AC			10D, 16D or s	•cD	•GC	•	•(I+)C	•	•K	Z	ATV	≤1000lbs/≤70"
North Carolina													
North Dakota	•AC		•s	12, 16D or s	•b	•	•	•(IS)		•Ki	Z	ATV	≤600lbs/≤50"
Ohio	•A		•E	16D, 12U		•	•	•				APV	
Oklahoma						•SG		•+S	•+S	•OS		ORV	
Oregon	•A	•	•E,s or D	12FD	•D or m	•G	•	•I	•S	•(KiE),W	Z	ATV	≤800lbs/≤50"
Pennsylvania	•B	•		10E,16s	•c	•G	•H	•I	•S	•KF	Z	ATV	≤600lbs/≤50"*
Rhode Island	•B	•	•T	12S,16SD & F,w		•F & G	•	•IC		•KL	Z	RV/ATV	
South Carolina													
South Dakota		•									N	ATV/ORV	
Tennessee		•						•+S	•+S	•+hS	Z	OHMV	
Texas	•AE	•		14D	•nE	•EG	•E	•E	•EC	•hE	Z	ATV	
Utah	•BE	•k	•eE	8E, 16s	•mE	•G	•	•		•Y	Z	ATV/OHV	≤700lbs/≤50"
Vermont	•AE			12D, 16FD, 18s	•i	•C	•C	•IC	•C		Z	ATV	
Virginia				16, 12j						•K	X, Z	ATV	
Washington	•AC					•G	•	•I	•			NHV/ORV	
West Virginia		•											
Wisconsin	•BC	•		12z & D(y),16D or s	•bD	•F & G	•	•	•	•Kiz	X, Z	ATV	≤650lbs/≤48"
Wyoming											X	ORRV	≤900lbs/≤50"

- • Required by law or regulation
- \+ Applies to 3-wheel ATVs only
- A. By motor vehicle registration agency
- B. By recreation management agency
- C. Except in authorized events
- D. Unless supervised
- E. Applies only on public lands
- F. To cross highway
- G. For night operation only
- H. Specific performance requirements
- I. Decibel limit specified
- J. Prohibited
- K. Approved helmet
- L. 16 sq. in. reflective material on each side of ATV
- M. Unless supervised by parent or his designee and either has safety certificate or is supervised by adult with certificate
- N. Prohibited except to cross highway & by registered ATVs with 4 or more wheels & 200 cc or more
- O. Helmet (for 3-wheelers); flag on whip, as specified (on all ATVs)
- P. Must have license or learner's permit, or be accompanied by licensee or by parent
- Q. Allowed as specified in law
- R. For ATV over 70cc
- S. Applies only on specified public lands
- T. For ages 16-18 to cross highway
- U. On DNR lands if accompanied by parent
- V. Lights required at night
- W. Red flag (on sand), chain guard (if equipped with chain)
- X. Prohibited except for agricultural purposes
- Y. Helmet under age 18 & safety flag as specified on certain sand dunes
- Z. Prohibited except to cross highway
- a. Unless safety certificate is possessed
- b. For ages 12-15
- c. For ages 10-15
- d. Under age 16
- e. During daylight hours only
- f. If issued to persons age 12-15, not valid for ATVs over 90cc
- g. Allowed for agricultural purposes
- h. Helmet and eye protection
- i. For persons under age 18
- j. For ATVs 70-90cc
- k. For 1988 models and newer
- m. Unless motor vehicle operator's license possessed
- n. Unless supervised by adult with safety certificate
- o. Prohibited except for agricultural/industrial purposes or with special permit
- p. Except ATVs of 90cc or less
- q. Unless at least age 12 & have safety certificate
- r. For ages 12-17
- s. Special provisions for operation on shoulders for farm use
- t. For 3-wheel ATVs
- u. For ATVs over 90cc
- v. For all ages; under age 18 must complete safety course
- w. Sale to under age 16 prohibited
- x. Sale of ATV over 90cc for use under age 16 prohibited
- y. Additional provisions apply; law too complex to summarize completely
- z. Except if engaged in agricultural activities
- * ≤700lbs/≤58" if equipped with bench seat

CLASSIFICATION ABBREVIATIONS

- APV - All-purpose vehicle
- ATV - All-terrain vehicle
- NHV - Non-highway vehicle
- OHV - Off-highway vehicle
- OHMV - Off-highway motor vehicle
- OHRV - Off-highway recreation vehicle
- ORV - Off-road vehicle
- ORRV - Off-road recreational vehicle
- RV - Recreation vehicle

Although this chart represents information from the most authoritative sources available, SVIA is not responsible for accuracy or completeness. Many of the provisions summarized herein have exceptions and may require further explanation. It is necessary to refer to the actual laws and regulations for specific details.

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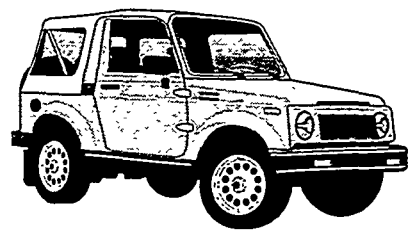
Appendix B.

Truck Inventory and Use Survey Programs



Program 1.

```
*****************************************************************;
** OFFHWY1.SAS IS TO ESTIMATE THE FULL-VEHICLE EQUIVALENT       **;
** OF VEHICLES GOING OFF OF THE ROAD FOR RECREATIONAL PURPOSES **;
** FROM THE 1992 TRUCK INVENTORY AND USE SURVEY (LATEST AVAIL.)**;
*****************************************************************;
** WHEN MAJOR USE IS 'NOT IN USE' THE RECORD WAS DELETED        **;
*****************************************************************;
** BODY TYPES USED WERE: 1-PICKUP, 24-UTILITY, 25-STATION WAGON**;
** ON TRUCK CHASSIS.  VEHICLE TYPE: STRAIGHT TRUCK, NO TRAILER **;
*****************************************************************;
** POLK GROSS VEHICLE WEIGHT RATING OF 10,000 LBS OR LESS       **;
*****************************************************************;
** NORMALIZED THE SUM OF POFFRD, PLOCAL, PSHORT, PLONG TO 100   **;
** WHEN NECESSARY (SOME RECORDS DID NOT ADD TO 100)             **;
** NORMALIZED THE SUM OF PPTRAN, PBUS, PFORHR TO 100 WHEN       **;
** NECESSARY (SOME RECORDS DID NOT ADD TO 100)                  **;
*****************************************************************;

LIBNAME T92 'E:\TIUS92';

PROC FORMAT;
VALUE STATE
 1='AL'
 2='AK'
 4='AZ'
 5='AR'
 6='CA'
 8='CO'
 9='CT'
10='DE'
11='DC'
12='FL'
13='GA'
15='HI'
16='ID'
17='IL'
18='IN'
19='IA'
20='KS'
21='KY'
22='LA'
23='ME'
24='MD'
25='MA'
26='MI'
27='MN'
28='MS'
29='MO'
30='MT'
```

```
31='NE'
32='NV'
33='NH'
34='NJ'
35='NM'
36='NY'
37='NC'
38='ND'
39='OH'
40='OK'
41='OR'
42='PA'
44='RI'
45='SC'
46='SD'
47='TN'
48='TX'
49='UT'
50='VT'
51='VA'
53='WA'
54='WV'
55='WI'
56='WY'
;

** SET UP THE TIUS FILE **;
DATA LIGHT; SET T92.TIUS1992(KEEP=EXPANF ANNMIL POFFRD PLOCAL
PSHORT PLONG BODTYP MAJUSE PPTRAN PBUS PFORHR OPCLAS VEHTYP PKGVW
BASTAT);

IF MAJUSE NE 13; ** GET RID OF 'NOT IN USE' VEHICLES **;
IF PKGVW IN (1,2); ** KEEP ONLY GVW LESS THAN 10,000 POUNDS **;
IF VEHTYP=1; ** KEEP ONLY STRAIGHT TRUCKS, NO TRAILERS **;
IF BODTYP IN (1,24,25); ** KEEP ONLY THE BODY TYPES APPLICABLE **;
IF BASTAT NE 99; **GET RID OF STATE=99(UNKNOWN)-VERY FEW RECORDS **;

TOTAL1 = SUM(POFFRD, PLOCAL, PSHORT, PLONG);
TOTAL2 = SUM(PPTRAN, PBUS, PFORHR);

** NORMALIZE PERCENTAGES TO ADD TO 100 **;
** (SOME RECORDS ADD TO SOMETHING OTHER THAN 100)**;
IF TOTAL1 NOT IN (100, 0, .) THEN DO;
 IF POFFRD NE . THEN POFFRD = (POFFRD/TOTAL1)*100;
 IF PLOCAL NE . THEN PLOCAL = (PLOCAL/TOTAL1)*100;
 IF PSHORT NE . THEN PSHORT = (PSHORT/TOTAL1)*100;
 IF  PLONG NE . THEN  PLONG = (PLONG/TOTAL1)*100;
 TOTAL1 = SUM(POFFRD, PLOCAL, PSHORT, PLONG);
END;

** NORMALIZE PERCENTAGES TO ADD TO 100 **;
** (SOME RECORDS ADD TO SOMETHING OTHER THAN 100)**;
```

```
IF TOTAL2 NOT IN (100, 0, .) THEN DO;
 IF PPTRAN NE . THEN PPTRAN = (PPTRAN/TOTAL2)*100;
 IF PBUS NE . THEN PBUS = (PBUS/TOTAL2)*100;
 IF PFORHR NE . THEN PFORHR = (PFORHR/TOTAL2)*100;
END;

** CHANGE TO PROPER CODING ACCORDING TO THE CENSUS BUREAU DATA
   INPUT METHOD **;
IF OPCLAS=2 AND PPTRAN=. THEN PPTRAN=100;
ELSE IF OPCLAS IN (1,3,4) AND PPTRAN=. THEN PPTRAN=0;
** RECALCULATE THE TOTAL **;
TOTAL2 = SUM(PPTRAN, PBUS, PFORHR);

** CHANGE TO PROPER CODING ACCORDING TO THE CENSUS BUREAU DATA
   INPUT METHOD **;
IF ROUND(TOTAL1,1) = 100 AND POFFRD=. THEN POFFRD=0;

** IF POFFRD, PLOCAL, PSHORT, AND PLONG ARE ALL MISSING **;
** THEN THE AVERAGE POFFRD BY STATE AND BODY TYPE ARE USED **;
DATA NONMISS MISS(DROP=POFFRD); SET LIGHT;
IF TOTAL1 IN (., 0) THEN OUTPUT MISS;
ELSE OUTPUT NONMISS;

** CREATE AVERAGE POFFRD BY BASE STATE AND BODY TYPE **;
PROC SUMMARY NWAY DATA=NONMISS;
CLASS BASTAT BODTYP;
VAR POFFRD;
WEIGHT EXPANF;
OUTPUT OUT=SUM1(DROP=_TYPE_ _FREQ_) MEAN=POFFRD;

PROC SORT DATA=MISS; BY BASTAT BODTYP;

** FILL IN MISSING DATA WITH THE AVERAGES JUST CREATED **;
DATA MISS2; MERGE MISS(IN=IN1) SUM1; BY BASTAT BODTYP;  IF IN1;

** GET ALL THE DATA BACK TOGETHER AGAIN **;
DATA ALL; SET NONMISS MISS2;

** SET UP THE PERCENTAGE OF RECREATIONAL OFF-ROADING **;
RECPCT = (POFFRD/100)*(PPTRAN/100);
FVETRKS = EXPANF*RECPCT;

** COMBINE SPORTS UTILITY AND STATION WAGON ON TRUCK CHASSIS **;
** TO MATCH HOW FHWA LIGHT TRUCK DATA ARE DISPLAYED **;
IF BODTYP=25 THEN BODTYP=24;

** SUM OVER STATE AND BODYTYPE FOR PICKUP TRUCKS **;
PROC SUMMARY NWAY DATA=ALL;
WHERE BODTYP=1;
CLASS BASTAT;
VAR EXPANF FVETRKS;
OUTPUT OUT=PUSET(DROP=_TYPE_ _FREQ_) SUM=PU OFFPU;
```

```
** SUM OVER STATE AND BODYTYPE FOR SPORT UTILITY TRUCKS **;
PROC SUMMARY NWAY DATA=ALL;
WHERE BODTYP=24;
CLASS BASTAT;
VAR EXPANF FVETRKS;
OUTPUT OUT=SUSET(DROP=_TYPE_ _FREQ_) SUM=SU OFFSU;

DATA TRUCKSET; MERGE PUSET SUSET; BY BASTAT;

PCTPU=OFFPU/PU;
PCTSU=OFFSU/SU;

DATA _NULL_; SET BYSTATE;
FILE 'C:\MYFILES\RV\SAS\TIUSPCT.TXT';
PUT BASTAT STATE. ',' PCTPU ',' PCTSU;

RUN;
```

Program 2

```
*************************************************************;
** OFFHWY2.SAS IS TO ESTIMATE THE FUEL ECONOMY FOR OFF-HIGHWAY **;
** LIGHT TRUCKS AS OPPOSED TO ON-HIGHWAY LIGHT TRUCKS          **;
** FROM THE 1992 TRUCK INVENTORY AND USE SURVEY (LATEST AVAIL.)**;
*************************************************************;
** WHEN MAJOR USE IS 'NOT IN USE' THE RECORD WAS DELETED       **;
*************************************************************;
** BODY TYPES USED WERE: 1-PICKUP, 24-UTILITY, 25-STATION WAGON**;
** ON TRUCK CHASIS.  VEHICLE TYPE: STRAIGHT TRUCK, NO TRAILER  **;
*************************************************************;
** POLK GROSS VEHICLE WEIGHT RATING OF 10,000 LBS OR LESS      **;
*************************************************************;
** NORMALIZED THE SUM OF POFFRD, PLOCAL, PSHORT, PLONG TO 100  **;
** WHEN NECESSARY (SOME RECORDS DID NOT ADD TO 100)            **;
** NORMAILIZED THE SUM OF PPTRAN, PBUS, PFORHR TO 100 WHEN     **;
** NECESSARY (SOME RECORDS DID NOT ADD TO 100)                 **;
*************************************************************;

LIBNAME T92 'E:\TIUS92';

PROC FORMAT;
  VALUE MPG
  1 = 5
  2 = 5.5
  3 = 7.5
  4 = 9.5
  5 = 11.5
  6 = 13.5
  7 = 15.5
  8 = 17.5
  9 = 19.5
 10 = 22.5
 11 = 27.0
 12 = 32.0
 ;

** SET UP THE TIUS FILE **;
DATA LIGHT; SET T92.TIUS1992(KEEP=EXPANF POFFRD PLOCAL PSHORT
PLONG BODTYP MAJUSE
VEHTYP PKGVW MPGCK BASTAT ANNMIL);

IF MAJUSE NE 13; ** GET RID OF 'NOT IN USE' VEHICLES **;
IF PKGVW IN (1,2); ** KEEP ONLY GVW LESS THAN 10,000 POUNDS **;
IF VEHTYP=1; ** KEEP ONLY STRAIGHT TRUCKS, NO TRAILERS **;
IF BODTYP IN (1,24,25); ** KEEP ONLY THE BODY TYPES APPLICABLE **;
IF BASTAT NE 99; **GET RID OF STATE=99(UNKNOWN)-VERY FEW RECORDS**;

TOTAL1 = SUM(POFFRD, PLOCAL, PSHORT, PLONG);
```

```
** NORMALIZE PERCENTAGES TO ADD TO 100 **;
** (SOME RECORDS ADD TO SOMETHING OTHER THAN 100)**;
IF TOTAL1 NOT IN (100, 0, .) THEN DO;
 IF POFFRD NE . THEN POFFRD = (POFFRD/TOTAL1)*100;
 IF PLOCAL NE . THEN PLOCAL = (PLOCAL/TOTAL1)*100;
 IF PSHORT NE . THEN PSHORT = (PSHORT/TOTAL1)*100;
 IF  PLONG NE . THEN  PLONG = (PLONG/TOTAL1)*100;
 TOTAL1 = SUM(POFFRD, PLOCAL, PSHORT, PLONG);
END;

** MAKE MPG CATEGORIES INTO NUMBERS USING THE MIDPOINTS WHEN
   POSSIBLE (SEE FORMAT) **;
MPG = PUT(MPGCK, MPG.);

** CREATE GALLONS TO BE USED IN HARMONIC MEAN MPG CALCULATION **;
IF MPG >0 THEN DO;
  GALLONS=ANNMIL/MPG;
END;

** DISTINGUISH BETWEEN ON-HIGHWAY AND OFF-HIGHWAY **;
IF POFFRD = 100 THEN HIGHWAY = 'OFF';
ELSE IF POFFRD = 0 OR POFFRD = . THEN HIGHWAY = 'ON';
ELSE HIGHWAY = 'MIX';

PROC SUMMARY NWAY DATA = LIGHT;
CLASS HIGHWAY;
VAR ANNMIL GALLONS;
WEIGHT EXPANF;
OUTPUT OUT=SUM1(DROP=_TYPE_ _FREQ_) SUM=MILES GALLONS;

DATA FINAL; SET SUM1;
HMPG = MILES/GALLONS;

PROC PRINT DATA=FINAL;RUN;
TITLE '1992 TIUS'
TITLE2 'HMPG FOR TRUCKS BY HIGHWAY STATUS';
RUN;
```

Program 3

```
*****************************************************************;
** OFFHWY3.SAS IS TO ESTIMATE AVG ANNUAL MILES FOR OFF-HIGHWAY **;
** LIGHT TRUCKS AS OPPOSED TO ON-HIGHWAY LIGHT TRUCKS          **;
** FROM THE 1992 TRUCK INVENTORY AND USE SURVEY (LATEST AVAIL.)**;
*****************************************************************;
** WHEN MAJOR USE IS 'NOT IN USE' THE RECORD WAS DELETED       **;
*****************************************************************;
** BODY TYPES USED WERE: 1-PICKUP, 24-UTILITY, 25-STATION WAGON**;
** ON TRUCK CHASIS.  VEHICLE TYPE: STRAIGHT TRUCK, NO TRAILER  **;
*****************************************************************;
** POLK GROSS VEHICLE WEIGHT RATING OF 10,000 LBS OR LESS      **;
*****************************************************************;
** NORMALIZED THE SUM OF POFFRD, PLOCAL, PSHORT, PLONG TO 100  **;
** WHEN NECESSARY (SOME RECORDS DID NOT ADD TO 100)            **;
*****************************************************************;

LIBNAME T92 'E:\TIUS92';

** SET UP THE TIUS FILE **;
DATA LIGHT; SET T92.TIUS1992(KEEP=EXPANF POFFRD PLOCAL PSHORT PLONG
BODTYP MAJUSE
VEHTYP PKGVW MPGCK BASTAT ANNMIL);

IF MAJUSE NE 13; ** GET RID OF 'NOT IN USE' VEHICLES **;
IF PKGVW IN (1,2); ** KEEP ONLY GVW LESS THAN 10,000 POUNDS **;
IF VEHTYP=1; ** KEEP ONLY STRAIGHT TRUCKS, NO TRAILERS **;
IF BODTYP IN (1,24,25); ** KEEP ONLY THE BODY TYPES APPLICABLE **;
IF BASTAT NE 99; ** GET RID OF STATE = 99 (UNKNOWN) - VERY FEW
RECORDS **;

TOTAL1 = SUM(POFFRD, PLOCAL, PSHORT, PLONG);

** NORMALIZE PERCENTAGES TO ADD TO 100 **;
** (SOME RECORDS ADD TO SOMETHING OTHER THAN 100)**;
IF TOTAL1 NOT IN (100, 0, .) THEN DO;
 IF POFFRD NE . THEN POFFRD = (POFFRD/TOTAL1)*100;
 IF PLOCAL NE . THEN PLOCAL = (PLOCAL/TOTAL1)*100;
 IF PSHORT NE . THEN PSHORT = (PSHORT/TOTAL1)*100;
 IF  PLONG NE . THEN  PLONG = (PLONG/TOTAL1)*100;
 TOTAL1 = SUM(POFFRD, PLOCAL, PSHORT, PLONG);
END;

** DISTINGUISH BETWEEN ON-HIGHWAY AND OFF-HIGHWAY **;
IF POFFRD = 100 THEN HIGHWAY = 'OFF';
ELSE IF POFFRD = 0 OR POFFRD = . THEN HIGHWAY = 'ON';
ELSE HIGHWAY = 'MIX';

PROC SUMMARY NWAY DATA = LIGHT;
CLASS HIGHWAY;
VAR ANNMIL;
```

```
WEIGHT EXPANF;
OUTPUT OUT=SUM1(DROP=_TYPE_ _FREQ_) MEAN=AVGMIL;

PROC PRINT DATA=FINAL;RUN;
TITLE '1992 TIUS'
TITLE2 'AVERAGE ANNUAL MILES FOR TRUCKS BY HIGHWAY STATUS';
RUN;
```

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