AN ESTIMATE OF THE ENERGY CONSUMPTION OCCURRING BECAUSE OF PARTICIPATION IN SELECTED OUTDOOR RECREATION ACTIVITIES

Submitted to

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by

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Introduction and Objectives

The continuing escalation in the price of energy and the often uncertainty about the availability of gasoline has served to focus on strategies to reduce energy consumption. So-called frivolous activities, such as recreation, are frequently identified as objects for energy reduction policies. The effectiveness of such policies, however, require an understanding of how the energy is consumed, how much is consumed, and the size of such consumption with respect to other areas of the economy.

Our knowledge of energy consumption for recreation activities is very limited. Osborne and Piene (1979) have attempted to rank a number of recreational activities according to their energy intensiveness but their methodology is open to question. More recently, Armbruster, et al. (1980) attempted to estimate future fuel consumption for "recreation-oriented" vehicles. Their estimate suggested that such vehicles -- including snowmobiles, motorcycles, recreational boats, and recreation vehicles -- accounted for about 3% of the total motor vehicle consumption in the United States. However, their analysis failed to examine the energy or fuel requirements on an activity by activity basis.

Recently, McCool (1980) has suggested that such analyses be conducted, yet recognize that there are four major sources of energy consumption in recreation:

(1) Travel Energy -- This is the energy used to travel to and from recreation sites. Most frequently, in Montana, this is gasoline used to fuel automobiles.

(2) On-site Energy -- This involves energy consumed in the course of the recreational activity. In the correct analysis, On-site Energy includes gasoline energy only.

(3) Management Energy -- Energy is often needed to manage or maintain the recreational setting, for example, to operate the lifts at a ski run or to provide electricity for lights and utilities at a campground or visitor center.

(4) Production Energy -- Energy required to produce equipment used in the recreational activity.

Answering the question "How much energy do participants in different recreational activities consume?" is difficult for three major reasons. First, there are a number of ways such a question can be addressed. For example, energy consumption may be reported for all participants by each activity or it could be reported on a person-hour basis. Second, while answering such a question requires only a limited amount of data, the data required for each activity is often not available. Third, such analyses require the use of averages or medians to estimate energy consumption. Recreation behavior is extremely diverse and such averages frequently do not adequately reflect such diversity.

This report has the objective of answering the question "How much energy is consumed by participants in different outdoor recreation activities?". The report is limited to activity participation by Montanans aged 18 years or older. Only Travel Energy and On-site Energy consumption are estimated. Four answers to the above question are provided:

1. Estimated total annual gasoline consumption for each of 18 outdoor recreation activities.
2. Estimated energy consumption per person per year of participation (in British Thermal Units) by activity.
3. Estimated energy consumption per person per occasion (in British Thermal Units) by activity.
4. Estimated energy consumption per person per hour (in British Thermal Units) by activity.

Assumptions

A number of assumptions must be made in order to estimate energy consumption. In this analysis there are two classes of assumptions: (1) General Assumptions, which deal with the whole analysis and (2) Activity Specific Assumptions, which identify the specific assumptions for each activity. The Activity Specific Assumptions are shown,

by activity in Appendix A. The reader should become familiar with these assumptions before interpreting the results.

The following General Assumptions were used:

(1) All travel was by automobile.

(2) Automobile fuel efficiency was estimated at 15 miles per gallon -- close to the nation's fleet average.

(3) One vehicle was used to travel to and from the recreation site.

(4) There are 546,000 Montanans aged 18 years and older. (This figure is used because source 26 reports participation rates for this population.)

(5) There are 125,000 British Thermal Units (BTUs) in one gallon of gasoline.

Methodology

The following methodology will provide the Travel Energy, On-Site Energy, and Total Energy consumption as found on Tables 1-4. Letters in parenthesis refer to the column in Appendix A from which values were taken. Numbers in parenthesis refer to previous steps in the methodology from which values were taken.

1) $\frac{\text{(A) Round Trip Mileage miles}}{\text{15 miles/gallon}} = \text{Trip Fuel Consumption gal/trip}$

2) (C) (Annual Participation Days)(24 hours/day) = Annual Participation Hours

3) $\frac{\text{(2) Annual Participation hours/year}}{\text{Average Length of Stay hours/trip}} = \text{Annual Trips trips/year}$

Note: If (E') E' is less than or equal to 24, then E'=24

4) (1) (Fuel Consumption gal/trip)(3) (Annual Trips trips/year) = Annual Group Consumption gal/year/group

5) $\frac{\text{(4) Annual Group Consumption gal/year/group}}{\text{Average Group Size persons/group}} = \text{Annual Individual Consumption gal/year/person}$
(B)

6) 546,000 x (D) Percent Participation = Persons Participating

7) (5) (Annual Individual Consumption gal/year/person) x (6) (Persons Participating) = Annual Travel Consumption gal/year
- Table 1 Column 1 -

8) (6) (Persons Participating)(3) (Annual Trips trips/year) = Annual Individual Trips trips/person/year

9) $\frac{\text{(8) Annual Individual Trips trips/person/year}}{\text{(B) Average Group Size persons/group}}$ = Annual Group Trips group trips/year

10) (A') (On-Site Fuel Consumption gal/hour)(E) (Length of Stay hours) x (B') (Number of engines per group) = Occasion Group Consumption gal/group/occasion

11) (10) (Occasion Group Consumption gal/group/occasion) x (9) (Annual Group Trips group trips/year) =
Annual On-Site Consumption gal/year
- Table 1 Column 2 -

12) (7) (Total Annual Consumption gal/year) + (11) (Annual On-Site Consumption gal/year) =
Total Annual Consumption gal
- Table 1 Column 3 -

13) (7) (Annual Travel Consumption gal)(125,000 BTUs/gal) = Annual Travel Consumption BTU

14) $\frac{\text{(13) Annual Travel Consumption BTUs}}{\text{Persons Participating (6)}}$ =
Annual Travel Consumption/Individual BTUs
- Table 2 Column 1 -

15) (11) (Annual On-Site Consumption gal)(125,000 BTUs/gal) = Annual On-Site Consumption BTU

16) $\frac{\text{(15) Annual On-Site Consumption BTUs}}{\text{Persons Participating (6)}}$ =
Annual On-Site Consumption/Individual BTUs
- Table 2 Column 2 -

17) (14) Annual Travel Consumption/Individual + (16) Annual On-Site Consumption/Individual =
Total Annual Consumption/Individual BTUs
- Table 2 Column 3 -

18) $\frac{\text{(14) Annual Travel Consumption/Individual BTUs}}{\text{(3) Annual Trips}} =$ trips

Individual Travel Consumption Per Occasion BTUs/individual/occasion
- Table 3 Column 1 -

19) $\frac{\text{(16) Annual On-Site Consumption/Individual BTUs}}{\text{(3) Annual Trips}} =$ trips

Individual On-Site Consumption Per Occasion BTUs/individual/occasion
- Table 3 Column 2 -

20) (18) Individual Travel Consumption/occasion + (19) Individual On-Site Consumption/occasion =

Total Individual Consumption/occasion BTUs/individual/occasion
- Table 3 Column 3 -

21) $\frac{\text{(18) Individual Travel Consumption/occasion BTUs/individual/occasion}}{\text{(E) Length of Stay hours}} =$

Individual Travel Consumption Per Hour BTUs/individual/hour
- Table 4 Column 1 -

22) $\frac{\text{(19) Individual On-Site Consumption/occasion BTUs/individual/occasion}}{\text{(E) Length of Stay hours}} =$

Individual On-Site Consumption Per Hour BTUs/individual/hour
- Table 4 Column 2 -

23) Individual Travel Consumption Per Hour + Individual On-Site Consumption Per Hour =

Total Individual Consumption Per Hour BTUs/individual/hour
- Table 4 Column 3 -

Results

Results are indicated in Tables 1-4. Data in all tables is limited to Montana residents aged 18 or older. Table 1 identifies the total estimated fuel consumption statewide for specific recreation activities.

The data reflect not only travel energy but also on-site energy. It was assumed that activities not using vehicles during the activity would have a minimal or zero on-site energy consumption. The figures also reflect differences in travel distances,

frequency of participation, and proportion of the population participating. Thus, what appears to be a low energy consumptive activity, hiking, actually is the highest of the activities listed on Table 1 - Total Consumption. Other high energy consumers include camping, trail biking, deer hunting, and off-road driving.

Table 2 estimates energy consumption per person per year. This provides a contrast to Table 1 in that its calculations disregard the popularity or participation rate in each activity (Appendix A, Column D). Trail biking and deer hunting are the largest consumers in this category displacing hiking and camping in Table 1, both of which exhibit high participation rates.

Table 3 details estimated energy consumption per individual activity occasion disregarding annual participation days (Appendix A, Column C) which were included in Table 2. This figure is greatly influenced by the group size, i.e. a large group travelling in one vehicle is more fuel efficient per person than a small group. Elk hunting, off-road driving, and deer hunting are the top three consumers in this category. Both elk and deer hunting have a relatively low average group size of less than two persons (Appendix A, Column B). Off-road driving appears at the high end of the scale despite a much higher average group size of these three because of heavy on-site consumption.

Energy intensity or energy consumption per person per hour of participation is shown in Table 4. Hiking, cross-country skiing, and boating are the most energy intensive activities. This estimate for the first two activities reflects relatively long travel distances and relatively short lengths of stay. Backpacking, overnight canoeing, elk hunting, and camping were ranked lowest, primarily because of relatively long lengths of stay.

Regardless of the method of analysis, bicycling is consistently the lowest energy consumer according to this data. Also ranked somewhat consistently as low energy consumers are backpacking, overnight canoeing, and bird hunting.

It should be noted from this discussion that what is a high relative energy consumer is dependent upon the question as depicted in Tables 1-4. For example, camping ranks second on Table 1 for total consumption because a lot of people travel a considerable distance for this activity. However, the same activity ranks 10 on Table 2, consumption per person per year, because the average length of stay is relatively long and the number of trips/year is relatively low.

The reader should be cautioned that the fuel consumption data may not be additive. It could not be determined from our data sources if participation in each activity is independent of other activities.

Recommendations

This study has attempted to estimate fuel consumption for selected recreation activities. The estimates provide a fairly reliable attempt to achieve this objective. In the future, we suggest state participation surveys include the following information:

(1) percent of the population participating

(2) average number of days participated for each participant

(3) for the last recreation trip (before the survey):

  a. length of stay

  b. group size

  c. distance travelled

  d. activities participated in.

This information would greatly increase the reliability of energy consumption estimates if it was available on a statewide basis for each activity.

Table 1

Estimated Total Energy Consumption, in Thousands of Gallons of Gasoline per year

	Activity	Travel Energy	On-Site Energy	Total
1)	Day Hiking	10,166	0	10,166
2)	Camping	8,387	0	8,387
3)	Trail Biking	3,832	4,024	7,856
4)	Deer Hunting (1)	6,813	0	6,813
5)	Off-road Driving	1,155	5,544	6,700
6)	Fishing	6,659	0	6,659
7)	Bicycling (1)	5,837	0	5,837
8)	Boating	2,555	2,821	5,377
9)	Deer Hunting (2)	4,769	0	4,769
10)	Jogging	4,077	0	4,077
11)	Spectator Sports	2,782	0	2,782
12)	Horseback Riding	2,576	0	2,576
13)	Elk Hunting (1)	2,057	0	2,057
14)	Snowmobiling	718	1,010	1,728
15)	Elk Hunting (2)	1,646	0	1,646
16)	Canoeing (day use)	1,638	0	1,638
17)	Downhill Skiing	1,502	0	1,502
18)	Cross-Country Skiing	1,137	0	1,137
19)	Canoeing (overnight)	1,092	0	1,092
20)	Bicycling (2)	531	0	531
21)	Backpacking	510	0	510
22)	Bird Hunting	359	0	359

Table 2

Energy consumption per person per year, Thousands BTU's

Activity	Travel Energy	On-Site Energy	Total
1) Trail Biking	4,667	4,900	9,567
2) Deer Hunting (1)	7,188	0	7,188
3) Off-Road Driving	1,111	5,333	6,444
4) Day Hiking	6,061	0	6,061
5) Downhill Skiing	6,033	0	6,033
6) Deer Hunting (2)	5,031	0	5,031
7) Jogging	4,667	0	4,667
8) Bicycling (1)	4,074	0	4,074
9) Boating	1,800	1,988	3,788
10) Camping	3,333	0	3,333
11) Elk Hunting (1)	3,226	0	3,226
12) Horseback Riding	3,137	0	3,137
13) Elk Hunting (2)	2,581	0	2,581
14) Snowmobiling	1,111	1,563	2,674
15) Fishing	2,593	0	2,593
16) Spectator Sports	2,123	0	2,123
17) Cross-Country Skiing	1,783	0	1,783
18) Canoeing (day use)	1,500	0	1,500
19) Backpacking	1,167	0	1,167
20) Canoeing (overnight)	1,000	0	1,000
21) Bird Hunting	690	0	690
22) Bicycling (2)	370	0	370

Table 3

Energy Consumption per person per occasion, Thousands BTU's

	Activity	Travel Energy	On-Site Energy	Total
1)	Elk Hunting (1)	1,000	0	1,000
2)	Elk Hunting (2)	1,000	0	1,000
3)	Off-Road Driving	139	667	806
4)	Deer Hunting (1)	719	0	719
5)	Deer Hunting (2)	719	0	719
6)	Trail Biking	333	350	683
7)	Camping	667	0	667
8)	Boating	300	331	631
9)	Downhill Skiing	603	0	603
10)	Canoeing (overnight)	583	0	583
11)	Backpacking	567	0	567
12)	Snowmobiling	222	313	535
13)	Horseback Riding	314	0	314
14)	Day Hiking	303	0	303
15)	Cross-Country Skiing	297	0	297
16)	Bird Hunting	276	0	276
17)	Canoeing (day use)	250	0	250
18)	Bicycling (1)	204	0	204
19)	Fishing	185	0	185
20)	Spectator Sports	117	0	117
21)	Jogging	26	0	26
22)	Bicycling (2)	19	0	19

Table 4

Energy Consumption per person per hour of Participation, BTU's

	Activity	Travel Energy	On-Site Energy	Total
1)	Day Hiking	303,030	0	303,030
2)	Cross-Country Skiing	148,551	0	148,551
3)	Boating	56,604	62,500	119,104
4)	Snowmobiling	44,444	62,500	106,944
5)	Horseback Riding	104,575	0	104,575
6)	Off-Road Driving	17,361	83,333	100,694
7)	Downhill Skiing	100,556	0	100,556
8)	Spectator Sports	77,778	0	77,778
9)	Deer Hunting (1)	71,875	0	71,875
10)	Bicycling (1)	67,901	0	67,901
11)	Trail Biking	23,810	25,000	48,810
12)	Fishing	46,296	0	46,296
13)	Canoeing (day use)	41,667	0	41,667
14)	Bird Hunting	34,505	0	34,505
15)	Deer Hunting (2)	29,948	0	29,948
16)	Jogging	25,641	0	25,641
17)	Camping	13,889	0	13,889
18)	Elk Hunting (1)	13,441	0	13,441
19)	Elk Hunting (2)	13,441	0	13,441
20)	Bicycling (2)	9,259	0	9,259
21)	Backpacking	8,105	0	8,105
22)	Canoeing (overnight)	6,944	0	6,944

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APPENDIX A

Activity Specific Assumptions

Activity	A Average Round Trip Travel Distance to Site (Miles)	A' On-Site Fuel Consumption (gal/hour)	B Average Group Size (Persons)	B' On-Site Engines/Group	C Average Annual Participation (Days)	D Percent Population Participating	E Average Length of Stay (Hours)	E' If E ≤ 24 Then E'=24
Backpacking	320	0	4.7	0	6.0	10.0	70.0	70.0
Bicycling (1)	44	0	1.8	0	20.0	32.8	3.0	24.0
Bicycling (2)	4	0	1.8	0	20.0	32.8	2.0	24.0
Bird Hunting	53	0	1.6	0	2.5	11.9	8.0	24.0
Boating	72	1	2.0	1	6.0	32.5	5.3	24.0
Camping	248	0	3.1	0	10.0	57.6	48.0	48.0
Canoeing (day use)	60	0	2.0	0	6.0	25.0	6.0	24.0
Canoeing (overnight)	140	0	2.0	0	4.0	25.0	84.0	84.0
Cross-Country Skiing	82	0	2.3	0	6.0	14.6	2.0	24.0
Deer Hunting (1)	138	0	1.6	0	10.0	21.7	10.0	24.0
Deer Hunting (2)	138	0	1.6	0	7.0	21.7	24.0	24.0
Downhill Skiing	181	0	2.5	0	10.0	5.7	6.0	24.0
Elk Hunting (1)	192	0	1.6	0	8.0	14.6	74.4	74.4
Elk Hunting (2)	192	0	1.6	0	10.0	14.6	74.4	74.4
Fishing	60	0	2.7	0	14.0	58.8	4.0	24.0
Hiking (day)	80	0	2.2	0	20.0	38.4	1.0	24.0
Horseback Riding	64	0	1.7	0	10.0	18.8	3.0	24.0
Jogging	4	0	1.3	0	182.0	20.0	1.0	24.0
Off-Road Driving	50	2	3.0	1	8.0	23.8	8.0	24.0
Snowmobiling	120	0.5	4.5	4.5	5.0	14.8	5.0	24.0
Spectator Sports	28	0	2.0	0	18.2	30.0	1.5	24.0
Trail Biking	80	0.2	2.0	2	14.0	18.8	14.0	24.0

APPENDIX B

This is a Hewlett-Packard-65 program for estimating recreation activity energy consumption. The numbers in the left-hand margin correspond to the completion point of the steps in the methodology found on page 3.

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OPERATION OF PROGRAM

The above program will provide the Travel Energy and On-Site Energy consumption found in columns 1 and 2 respectively in Tables 1-4. The third column, Total Energy consumption, is derived by adding the previous two values.

Register 1, Store Appendix A, Column A', On-Site Fuel Consumption

Register 2, Store Appendix A, Column B, Average Group Size

Register 3, Store Appendix A, Column B', On-Site Engines/Group

Register 4, Store Appendix A, Column C, Average Annual Participation

Register 5, Store Appendix A, Column D, Percent Population Participating

Register 6, Store Appendix A, Column E, Average Length of Stay

Register 7, Store Appendix A, Column E'

Enter Appendix A, Column A, Average Round Trip Travel Distance

Select LBL A

Register 8, Recall Table 1, Column 1, Total Travel Energy Consumption

Register 3, Recall Table 1, Column 2, Total On-Site Energy Consumption

Register 1, Recall Table 2, Column 1, Travel Energy Consumption per Person per Year

Register 9, Recall Table 2, Column 2, On-Site Energy Consumption per Person per Year

Register 2, Recall Table 3, Column 1, Travel Energy Consumption per Person per Occasion

Register 7, Recall Table 3, Column 2, On-Site Energy Consumption per Person per Occasion

Register 5, Recall Table 4, Column 1, Travel Energy Consumption per Person per Hour

Register 6, Recall Table 4, Column 2, On-Site Energy Consumption per Person per Hour

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