

A National Assessment of Physical Activity in US National Forests

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ABSTRACT

In an era of declining timber harvests on federal lands, the US Forest Service has sought to better describe the public benefits associated with the nation's continued investment in managing the national forests. We considered how national forests contribute to public health by providing significant outdoor recreation opportunities. Physical inactivity has become a persistent national concern owing to its association with chronic diseases, obesity, and other public health concerns. We estimated the net energy expenditure (in calories) for a range of outdoor recreation activities engaged in by visitors to national forests. We conclude that national forest contributions to physical activity among the American public likely are significant and could be enhanced with continued and targeted investments in recreation infrastructure and public outreach.

Keywords: outdoor recreation, public health, obesity, US Forest Service, Kids in the Woods

Physical inactivity has become a persistent national concern owing to its association with chronic diseases, obesity, and other public health issues. Only one-half of people in the United States meet physical activity recommendations established by the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention 2010a). Nevertheless, an increasing body of research suggests that parks and recreation providers can play an important role in motivating greater physical activity by providing necessary infrastructure, such as walking and hiking trails, bike paths, and other recreation resources (Rosenberger et al. 2005, 2009). Local availability and accessibility are especially important in facilitating routine day-to-day physical activity (Rosenberger et al. 2009). Most research examining the influence of public infrastructure on physical activity has focused on more locally managed parks and

trail systems (Kaczynski and Havitz 2009, Dahmann et al. 2010). Less studied is the potential role that our national forests and grasslands play in motivating physical activity by providing outdoor recreation opportunities. These lands receive over 173 million visits annually involving a variety of recreation activities (US Forest Service 2010). What role might they play in promoting public health in the United States simply by providing opportunities for physical activity?

Originally, set aside to meet natural resource objectives regarding timber and water, national forests have long been major attractions to outdoor recreation enthusiasts. In fact, long-term recreation use of national forestlands predates the establishment of the national forest system (Waugh 1918). The recreation legacy of national forests is manifest today in the current strategic plan of the US Forest Service, which includes the

goal of sustaining and enhancing outdoor recreation opportunities (US Forest Service 2007). The recent Kids in the Woods initiative broadened the scope of US Forest Service interests to include conservation education of America's youth. With overweight and obesity rampant in the United States, should the agency now include public health goals as well? Perhaps not coincidentally, the US Forest Service views providing opportunities for America's youth to build life-long skills and develop healthy lifestyles through experiential and imaginative outdoor play as a "growth opportunity" (US Forest Service 2008).

In light of these emerging themes, we examined the extent to which national forests might provide public health benefits by virtue of the outdoor recreation opportunities they offer to the American public. Specifically, we estimated the net energy expenditure (in calories) for a range of outdoor recreation activities engaged in by visitors to national forestlands. We did this by combining data describing national forest visitors' outdoor recreation activities with data characterizing the calorie expenditures associated with each type of physical activity. We computed total calorie expenditures associated with different outdoor recreation activities and compared expenditure totals with physical activity recommendations by the Centers for Disease Control and Prevention. The analysis suggests that in terms of total energy expended, the physical activity asso-

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ciated with outdoor recreation in national forests likely is significant.

Outdoor Recreation and Public Health

Although leisure-time physical activity often implies exercise, the *Dictionary of Sport and Exercise Sciences* defines physical activity as “movement of the human body that results in the expenditure of energy at a level above the resting metabolic rate” (Anshel et al. 1991, p. 113). Physical activity can take place not only as intentional exercise, but also at the workplace, in routine household activities, and in self-powered transportation (e.g., walking and biking), as well as leisure-time recreation activities (e.g., hiking and hunting). The Centers for Disease Control and Prevention recommend that adults perform 150 minutes or more of moderate-intensity aerobic physical activity (e.g., brisk walking) weekly and muscle-strengthening activities on two or more days per week that work all major muscle groups (Centers for Disease Control and Prevention 2010b). Recommendations suggest that the 150 minutes of moderate-intensity physical activity can be replaced by 75 minutes of vigorous-intensity aerobic activity (e.g., running) weekly or a mix of the two. For youths, the Centers for Disease Control and Prevention recommend 60 or more minutes of aerobic activity daily and muscle strengthening activities at least 3 days/week as part of the daily 60 minutes. Daily aerobic activity can include a combination of moderate- or vigorous-intensity activity, with a minimum of 3 days/week engaged in vigorous-intensity activity (Centers for Disease Control and Prevention 2010b).

The health benefits of outdoor recreation are widely recognized and may extend in part from our affinity for the physical environments—the natural landscapes—of our origins as a species as opposed to the largely indoor lifestyles that most Americans now lead (Godbey 2009). It is estimated that Americans now spend about 95% of their time indoors (Robinson and Godbey 2000). This differs substantially from the lifestyle for which our bodies evolved over millennia, spent mostly “in small groups, hunting and gathering on the plains of Africa” (Godbey 2009, p. 2). Evolution has given us bodies that are ill-equipped to deal with the crowded and mostly sedentary lives we now lead and the diets many of us now consume (e.g., Nesse and Williams 1996). Research

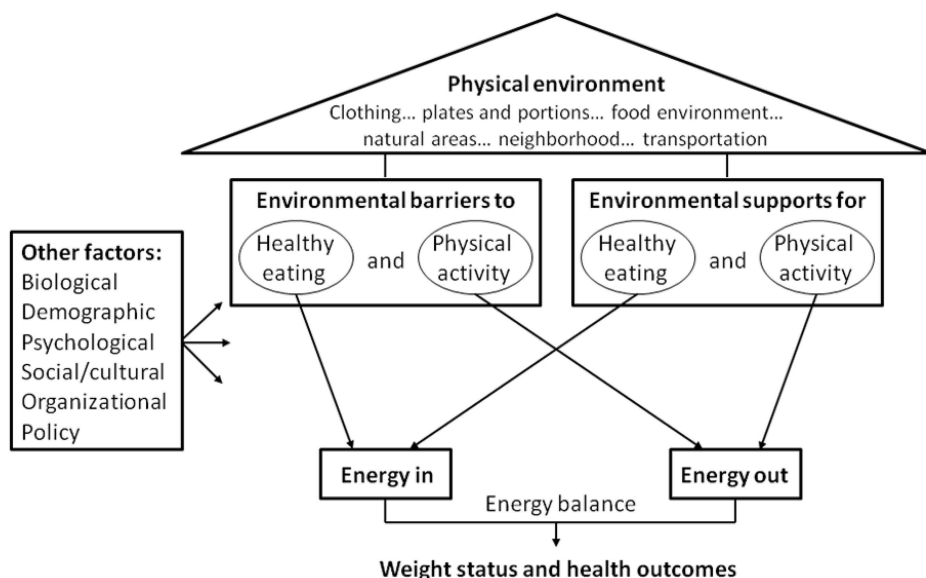


Figure 1. Conceptual physical environment link to weight and health outcomes (Wells et al. 2007).

suggests that this “legacy of evolutionary history” (Nesse and Williams 1996, p. 134) is a factor in why humans seem to benefit both physically and psychologically from physical activity conducted in nature (e.g., Gullone 2000, Godbey 2009).

From a conceptual perspective, national forests and the natural landscapes they comprise are just one of many factors that make up the physical environment in which we live (Figure 1). This physical environment strongly influences two key processes that determine public health: calorie intake (eating) and calorie expenditure (physical activity) (Wells et al. 2007). The relative amounts of eating and physical activity largely determine the net energy balance for an individual in terms of weight status and health. Other factors, of course, also play a role, including biological, demographic, social, and cultural factors, as well as public policy (Wells et al. 2007). Governments have opportunities to influence public health outcomes either directly through public policies that encourage healthy living or indirectly by enhancing the physical environment in ways that encourage or promote healthy eating and physical activity.

Following this conceptual framework of public health, an emerging line of inquiry has been examining the role of public infrastructure in promoting public health by providing opportunities for regular physical activity. Access to local parks and trails consistently is found to be positively correlated with physical activity (Sallis and Kerr 2006, Roux et al. 2007, Kaczynski et al.

2009) as well as lower rates of overweight and obesity (Rosenberger et al. 2005, 2009). In one example of this research, Gordon et al. (2004) found that 25% of visitors at a newly constructed rail-trail in a rural city were sedentary before trail development. Since construction, nearly all (98%) these previously sedentary users had increased their physical activity levels by pursuing activities including walking, running, and in-line skating. Moreover, one-half (52%) of previously physically active (nonsedentary) trail users had also increased their activity levels after trail construction (Gordon et al. 2004). Parks and other public lands would appear to promote public health by providing the physical infrastructure necessary for physical activity. People who have the opportunity and ability to visit public open space lands have been found to be three times more likely to regularly meet recommended physical activity levels (Giles-Corti et al. 2005).

What is less certain is the degree to which national forests might contribute to public health by facilitating physical activity associated with the outdoor recreation opportunities they provide. Research literature reviews by Humpel et al. (2002) and Williams (2007) suggest that physical activity is strongly associated with the availability, accessibility, and aesthetic attributes of recreation destinations. In some locations, such as where they abut cities, towns, and other population centers, national forests conceivably may have a comparative advantage over other potential recreation destinations, such

as city and other local parks, by providing access to diverse, expansive, and often highly scenic open space lands via well-developed road and trail networks, as well as more specialized recreation resources such as rivers, lakes, and rugged terrain not as often found in the neighborhood park. We sought to examine national forest contributions to physical activity and public health by estimating net energy expenditure (in calories) for a range of outdoor recreation activities engaged in by national forest visitors.

Data and Methods

The mission of the US Forest Service is to “sustain the health, diversity, and productivity of the Nation’s forests and grasslands to meet the needs of present and future generations” (US Forest Service 2008). The agency pursues this mission by managing 155 national forests and 20 national grasslands totaling 193 million ac in 44 states across the United States. The predominant proportion of this land—167.3 million ac (87%)—is located in the western states, with smaller proportions in the northeast (12.1 million ac or 6%) and southeast (13.4 million ac or 7%; US Forest Service 2009). Management focuses on restoring and maintaining species diversity and ecological productivity necessary to provide recreation, water, timber, fish, wildlife, and other natural resource values. Sustaining and enhancing outdoor recreation opportunities is one of seven strategic program directions outlined in the agency’s current strategic plan (US Forest Service 2007).

Data for describing national forest visits and associated recreation activities come from the US Forest Service’s National Visitor Use Monitoring program (English et al. 2002, Zarnoch et al. 2011) and the Compendium of Physical Activities (Ainsworth et al. 1993, 2000). The National Visitor Use Monitoring program produces regular estimates of recreation use, detailed participation data describing recreation activities and visit characteristics, and summaries of visitors’ satisfaction for all national forests and grasslands in the United States. The National Visitor Use Monitoring data are a key resource for outdoor recreation research in the United States (e.g., White and Stynes 2008) and are also used by the US Forest Service to support broader programmatic analyses (e.g., Wilson 2010). The latest available National Visitor Use Monitoring data describe visitation based on surveys conducted between 2004 and 2009.

The Compendium of Physical Activities (Ainsworth et al. 2000)—commonly referred to as “the Compendium”—reports relative metabolic equivalents (or METs) for various activities that are based on a combination of exercise research and expert opinion. These METs are commonly used by nutrition and physical fitness professionals to estimate calorie expenditures resulting from physical activities and exercise (Harrell et al. 2005, Ridley et al. 2008). The METs are the ratio of the metabolic rate for each activity to the resting metabolic rate (Ainsworth et al. 1993, 2000, Harrell et al. 2005). A relatively strenuous recreation activity such as backpacking, has a MET value of 6.5, while a less strenuous activity such as picnicking has a MET of 1.5. The “at rest” MET is 1. We used Compendium METs to estimate calorie expenditures for a variety of physical activities, based on assumptions regarding participant weights and other factors. The Compendium reports METs only for adults. Energy expenditures for youths tend to vary from those for adults depending on the activity (e.g., Harrell et al. 2005, Ridley and Olds 2008). We developed MET values for youths (less than 16 years) based on Compendium values for adults combined with youth adjustment factors suggested by Ridley et al. (2008).

We assigned METs to each of the recreational activity reporting categories found in National Visitor Use Monitoring data (see US Forest Service 2010 for a listing). The Compendium (Ainsworth et al. 1993, 2000) lists 605 specific activities for adults, enabling fairly easy transference of MET values to like recreation activities reported in National Visitor Use Monitoring data. However, the activity list for youth (Ridley et al. 2008) is less extensive and required us to make assumptions in a few cases to develop a complete list of METs for youths. For example, there was no youth MET for camping, so we used the adult value of 2.5 but adjusted downward for the lesser average weight of youths. When more than one MET value was reported for an activity based on different intensity levels, e.g., walking, we used the “low to moderate” value to produce a conservative calorie expenditure estimate. For both adults and youths, the METs used were net of the at rest value of 1—meaning that they represented the net energy expenditure associated with each national forest recreation visit over and above the energy expended in an at rest state.

We used the MET values to estimate the

Box 1. Estimating net energy expenditures associated with recreation activities in national forests.

Energy expenditures associated with recreation activities in national forests were computed by combining the number of visit hours reported annually for each activity estimated from the National Visitor Use Monitoring program data (US Forest Service 2010) with MET values developed for each activity for adults and youths based on Ainsworth et al. (1993, 2000) and Ridley et al. (2008). An MET is defined as 1 kcal of energy expended per kilogram of body weight per hour of activity. The actual computation for each activity was

$$\begin{aligned} \text{Net energy expenditure} \\ &= \text{Net MET} * \text{Average weight} \\ &\quad * \text{Total visit hours} \end{aligned}$$

where net energy expenditure is measured in calories (kcal) and net MET is the MET for each activity net of the “at rest” value of 1 (Ainsworth et al. 2000, Ridley et al. 2008). Assumed average weights were 81.4 kg for adults and 46.5 kg for youths. These average body weights were derived from McDowell et al. (2008), assuming a gender composition proportional with that of the US population for adults and equal proportions by gender and age classes 6–16 years old for youths. Total visit hours for each recreation activity are from National Visitor Use Monitoring data (English et al. 2002).

energy expended during national forest recreation activities (Box 1). Energy expenditure is measured in units commonly called “calories.” Calories actually refer to the more formal nutritional unit the kilogram calorie (or kcal), which is the amount of energy necessary to increase the temperature of 1 kg of water by 1° C. We computed total energy expenditures in calories for recreation activities and examined how visits and energy expenditures differ among adults and youths and by activity. Although somewhat of a “back-of-the-envelope” analysis of energy expenditure associated with national forest recreation, the computations provide a starting point for considering the role that national forests might play in providing public health benefits in the United States through outdoor recreation.

Table 1. Annual national forest visits by recreation activity.

Activity	Visits			Percent of total
	Adults	Youths	All ^a	
Hiking and walking	28,949,242	4,791,133	33,740,375	19.5
Downhill skiing	23,269,249	4,366,439	27,635,688	15.9
Fishing	11,536,329	2,618,676	14,155,005	8.2
Hunting	11,718,251	1,537,689	13,255,940	7.6
Viewing nature	9,745,510	1,430,534	11,176,044	6.4
Relaxing	7,887,142	2,237,559	10,124,701	5.8
Driving for pleasure	6,862,154	989,281	7,851,435	4.5
Other	4,819,548	1,375,244	6,194,792	3.6
Camping (developed)	3,945,473	1,739,646	5,685,119	3.3
Cross-country skiing	4,624,533	571,572	5,196,105	3.0
Snowmobiling	4,378,906	585,840	4,964,746	2.9
Other nonmotorized activities	2,590,971	1,621,990	4,212,961	2.4
Biking	3,347,613	347,324	3,694,937	2.1
Viewing wildlife	2,868,750	451,562	3,320,312	1.9
Motorized trail riding	2,640,223	529,312	3,169,535	1.8
Picnicking	2,085,233	1,008,584	3,093,817	1.8
Nonmotorized boating	2,165,658	683,892	2,849,550	1.6
Off-highway vehicle use	2,186,114	598,745	2,784,859	1.6
Motorized boating	1,944,992	574,428	2,519,420	1.5
Gathering	1,490,728	415,574	1,906,302	1.1
Backpacking	967,514	312,266	1,279,780	0.7
Horseback	1,114,905	137,797	1,252,702	0.7
Camping (primitive)	880,904	281,239	1,162,143	0.7
Historic sites	526,057	157,134	683,191	0.4
Nature centers	393,144	97,672	490,816	0.3
Nature study	308,589	164,707	473,296	0.3
Resort use	371,526	64,026	435,552	0.3
Other motorized activities	159,188	57,689	216,877	0.1
Total	143,778,446	29,747,554	173,526,000 ^b	100.0

Source: National Visitor Use Monitoring data collected between 2004 and 2009 (US Forest Service 2010).

^a Ranked in descending order.

^b Total national forest visits has a 90% confidence interval of 3.1% (US Forest Service 2010). Confidence intervals for individual activities are not reported.

Results

National Visitor Use Monitoring data indicate that national forest system lands receive over 173 million visits per year, with adults accounting for nearly 144 million visits (83%) and youths (less than 16 years) accounting for nearly 30 million visits (17%; Table 1). Hiking and walking, downhill skiing, fishing, hunting, viewing nature, relaxing, and driving for pleasure as primary activities account for about two-thirds (68%) of all visits. Primary activities that account for the most visits among youths include hiking and walking, downhill skiing, fishing, relaxing, developed camping, other nonmotorized activities, and viewing nature—for 63% of national forest visits by youths. Based on average durations for each activity, outdoor recreation in national forests involves nearly 1.4 billion visit hours spent by visitors engaging in their primary recreation activities, of which over 1.1 billion visit hours are spent by adults and about 273 million visit hours are spent by youths.

The number of hours in which visitors engage in any given recreation activity, along

with its MET, determine the total calorie expenditure associated with that activity, after also taking into consideration participant weight. Many popular recreation activities among adults, such as hiking and walking, viewing nature, and driving for pleasure, typically involve relatively short-duration national forest visits compared with other activities, such as developed camping, backpacking, primitive camping, and resort use, which tend to involve longer-duration visits (Table 2). Hiking and walking, cross-country skiing, biking, and backpacking all have relatively high METs, whereas relaxing, driving for pleasure, picnicking, visiting historic sites, visiting nature centers, and resort use are examples of activities that have relatively low METs (Table 2). Similar to adults, METs for youths are highest with activities such as downhill skiing, hunting, cross-country skiing, and biking (Table 2). However, participation rates by youths relative to adults in these high-energy–burning activities tend to be relatively low in comparison with developed camping, picnicking, motorized and nonmotorized boating, and other

nonmotorized activities, for which youth participation is greater but METs are lower.

Some lower-energy–burning activities do yield notable health and other benefits, however, owing to longer than average visit durations involved. For example, the typical developed camping visit averages just over 39 hours—the longest of any activities reported. Developed camping also often involves other higher-metabolic–equivalent secondary activities, such as hiking and biking, which can yield greater overall energy expenditure by campers. Our analysis only considered “primary” activities. Combining the average visit hours for each recreation activity with its respective metabolic equivalent yields an estimate of the average net energy expenditure per visit associated with each activity. Among adults, at 13,396 kcal/visit, backpacking far exceeds any other activity in terms of average net energy expended per visit, followed by developed camping, primitive camping, and hunting (Table 3). These same activities top the list in terms of average net energy expended per visit for youths.

In aggregate, our estimates of energy expended on outdoor recreation activities in national forests total over 289 billion calories (kcal) expended per year, of which nearly 264 billion calories are expended by adults and nearly 26 billion calories are expended by youths (Table 4). Downhill skiing, hunting, hiking and walking, developed camping, fishing, and backpacking top the list and account for 76% of total energy expended annually. These same activities account for 78% of annual energy expenditures by youths, with developed camping alone accounting for 18%. A few activities are noteworthy for the disparity between numbers of visits and their contribution to total energy expenditure. For example, backpacking ranks rather low in terms of number of visits but rather high in terms of calories expended owing to both the longer duration of typical backpacking visits and the higher net energy expended per hour of duration. Going the opposite direction is driving for pleasure, which ranks fairly high in terms of number of visits but lower in total calories expended (Table 4).

Regional Differences

From a regional perspective, national forest system lands in western states account for the greatest share of both outdoor recreation visits (75%) and associated net energy expenditures (75%), followed by the south-

Table 2. Average hours per visit, percent youths, and relative metabolic equivalents (METs) associated with outdoor recreation activities in national forests.

Activity	Average hours per visit ^a	MET ^b		Percent of visits by youths ^c
		Adults ^c	Youths ^d	
Hiking and walking	4.0	6.0	4.6	14.2
Downhill skiing	5.8	5.5	5.5	15.8
Fishing	7.6	4.0	2.9	18.5
Hunting	12.8	5.0	5.0	11.6
Viewing nature	3.7	2.5	2.9	12.8
Relaxing	17.6	2.0	1.4	22.1
Driving for pleasure	3.7	2.0	1.4	12.6
Other	9.7	1.5	1.4	22.2
Camping (developed)	39.4	2.5	2.5	30.6
Cross-country skiing	3.5	8.0	8.0	11.0
Snowmobiling	5.9	3.5	2.5	11.8
Other nonmotorized activities	3.5	3.0	3.0	38.5
Biking	3.6	8.0	7.8	9.4
Viewing wildlife	4.3	2.5	2.5	13.6
Motorized trail riding	6.8	4.0	2.5	16.7
Picnicking	3.4	1.5	1.5	32.6
Nonmotorized boating	5.7	4.0	3.0	24.0
Off-highway vehicle use	6.6	4.0	2.5	21.5
Motorized boating	6.6	2.5	2.5	22.8
Gathering	3.7	3.0	3.0	21.8
Backpacking	29.9	6.5	4.2	24.4
Horseback	7.5	4.0	4.0	11.0
Camping (primitive)	35.4	2.5	2.5	24.2
Historic sites	3.9	2.0	1.4	23.0
Nature centers	1.8	2.0	1.4	19.9
Nature study	5.5	2.5	2.9	34.8
Resort use	33.5	2.0	1.4	14.7
Other motorized activities	4.5	2.5	2.5	26.6

^a Based on National Visitor Use Monitoring data collected between 2004 and 2009 (US Forest Service 2010).

^b Ratio of the work metabolic rate for an activity to the "at rest" metabolic rate, where one MET is defined as 1 kcal of energy expended per kilogram of body weight per hour of activity. The "at rest" metabolic equivalent is 1.

^c Based on Ainsworth et al. (2008).

^d Based on Ridley et al. (2008).

east (17%) and northeast (8%) regions (Table 5). However, average net energy expenditures per visit tend to vary across regions—higher in the northeast at 1,973 kcal for adults and lower in the west at 1,814 kcal—indicating regional differences in the types of activities conducted in national forests. For example, hunting, an activity involving relatively long-duration visits (average 12.8 hours) and a fairly high MET (5.0), accounts for 16% of national forest visits in the northeast and 15% of visits in the southeast but only 6% of visits in the west, likely contributing to proportionally lower total net energy expenditures in the west. For youths, average net energy expenditures per visit are similar for the northeast (903 kcal) and west (881 kcal), but lower for the southeast (820 kcal; Table 5). Regional activity differences among youths, e.g., indicate more downhill skiing—a high MET activity—in the west (19% of visits) and northeast (11%) compared with the southeast (0%) and less fishing—a low MET activity for youths—in the west (7%) and northeast (10%) compared

with the southeast (16%), among other differences.

Overall, although the share of national forest systems land is significantly less for the northeast and southeast compared with the west, results suggest that national forestlands in the northeast and southeast regions tend to yield proportionally greater net energy expenditures than lands in the west. With just 6% of national forest systems lands, the northeast yields almost 9% of total net energy expenditures. With 7% of national forest systems lands, the southeast yields almost 17% of total net energy expenditures. In addition to differences in activity participation, these regional disparities likely owe in part to the greater proximity of national forestlands in the northeast and southeast to major population centers compared with the west, making them relatively more accessible for a variety of intensive activities.

Local Visitors versus Nonlocal Visitors

Also of interest is the distribution of national forest visits and associated net energy expenditures among nonlocal versus local

visitors. We considered local visitors to be those people living within 60 road mi of national forest boundaries. Visits and net energy expenditures are both split fairly equally between nonlocal and locals, with nonlocal visitors accounting for about 49% of visits and net energy expenditures and local visitors accounting for 51% (Table 6). The popularity of visiting national forests among nonlocals and the willingness of nonlocal visitors to incur higher travel costs to do so suggest the importance of recreation opportunities offered by national forests above and beyond other recreation resources available to nonlocal visitors in other locations. Although average net energy expenditures per visit are relatively close among nonlocal (1,853 kcal) and local (1,815 kcal) adult visitors, average net energy expenditure is higher for nonlocal youth visitors (945 kcal) than for local youth visitors (802 kcal), again likely reflecting differences in the activities conducted by nonlocal and local visitors.

Discussion

We estimate that the food energy expended by visitors engaged in outdoor recreation in national forests approaches 290 billion calories (kcal) annually, with 91% of that expended by adults and 9% expended by youths. That is equivalent to about 83 million lb of body fat oxidized through physical activity per year. [1] Expressed in terms of food, it equals enough French fries placed end to end to reach the moon and back, twice. [2] More important are the implications regarding aerobic physical activity. An adult just meeting Centers of Disease Control and Prevention guidelines regarding aerobic physical activity engages in weekly exercise sufficient to expend about 750 calories weekly, 1,575 calories weekly for youths. To put the national forest visitation numbers into a national public health perspective, the energy expenditures associated with recreation in national forests are equivalent to the aggregate energy expenditures necessary for 6.8 million adults and almost 317,000 youths to just meet Centers of Disease Control and Prevention guidelines regarding aerobic physical activity annually. [3] Adding youths and adults together, those 7.1 million people would represent 2.3% of the US population. However, of one-half of the people in the United States who currently meet physical activity guidelines, those 7.5 million people would represent nearly 5%. From this admittedly coarse analysis, we suspect that the likely public

Table 3. Estimated average net energy expenditure per visit associated with outdoor recreation activities in national forests.

Activity	Net energy expenditure (kcal)	
	Adults ^a	Youths
Backpacking	13,396	4,452
Camping (developed)	4,815	2,750
Camping (primitive)	4,323	2,469
Hunting	4,178	2,386
Resort use	2,725	623
Downhill skiing	2,132	1,218
Biking	2,023	1,123
Cross-country skiing	1,972	1,126
Fishing	1,846	668
Horseback	1,829	1,045
Motorized trail riding	1,658	474
Hiking and walking	1,624	668
Off-highway vehicle use	1,609	460
Relaxing	1,434	328
Nonmotorized boating	1,385	527
Snowmobiling	1,199	411
Motorized boating	801	458
Nature study	669	484
Gathering	607	347
Other nonmotorized activities	568	325
Other motorized activities	553	316
Viewing wildlife	523	299
Viewing nature	454	329
Other	395	181
Historic sites	316	72
Driving for pleasure	297	68
Nature centers	146	33
Picnicking	138	79

^a Ranked in descending order.

Table 4. Estimated total annual net energy expenditure associated with outdoor recreation activities in national forests.

Activity	Net energy expenditure (millions kcal)			Percent of total
	Adults	Youths	All ^a	
Downhill skiing	49,611	5,319	54,928	19.0
Hunting	48,955	3,670	52,626	18.2
Hiking and walking	47,014	3,200	50,214	17.3
Camping (developed)	18,996	4,784	23,781	8.2
Fishing	21,299	1,749	23,048	8.0
Backpacking	12,961	1,390	14,351	5.0
Relaxing	11,307	733	12,039	4.1
Cross-country skiing	9,118	644	9,762	3.4
Biking	6,772	390	7,162	2.5
Snowmobiling	5,249	241	5,490	1.9
Viewing nature	4,427	470	4,897	1.7
Motorized trail riding	4,378	251	4,629	1.6
Camping (primitive)	3,808	694	4,502	1.5
Off-highway vehicle use	3,518	275	3,793	1.3
Nonmotorized boating	2,999	361	3,359	1.2
Horseback	2,039	144	2,183	0.7
Other	1,905	248	2,153	0.7
Driving for pleasure	2,039	67	2,106	0.7
Other nonmotorized activities	1,472	526	1,999	0.7
Motorized boating	1,558	263	1,821	0.6
Viewing wildlife	1,499	135	1,634	0.6
Resort use	1,012	40	1,052	0.4
Gathering	905	144	1,049	0.4
Picnicking	287	79	366	0.1
Nature study	206	80	286	0.1
Historic sites	166	11	177	0.1
Other motorized activities	88	18	106	0.0
Nature centers	57	3	61	0.0
Total	263,645	25,929	289,574	100.0

^a Ranked in descending order.

health benefits resulting from national forest recreation probably are significant, especially given that our analysis has considered only “primary” (and not secondary) activities of visitors.

There likely are socioeconomic and location factors that influence the distribution of these health benefits to the US public. National Visitor Use Monitoring data indicate that national forest visitors tend to earn higher than average incomes, with 64% of visitors earning household incomes of greater than \$50,000 compared with 52% of households nationally (Table 7). Only 11% of visitors earn household incomes of less than \$25,000 compared with 23% nationally. It is likely then that the public health benefits provided by national forests in the form of outdoor recreation opportunities are tending to accrue disproportionately to higher-income people. However, that is not necessarily surprising given that low-income people are likely less able to afford to take advantage of any number of public resources available to them relative to higher-income people.

This income disparity differs by proximity to national forests, with local people living within 60 road mi of national forests more often falling into lower-income categories than nonlocal people who live farther away. Fifty-five percent of local visitors earn greater than \$50,000 compared with 75% for nonlocal visitors, and local visitors are about twice as likely to earn less than \$25,000 (14%) than nonlocal visitors (7%; Table 7). Research suggests that physical activity rates tend to differ among individuals of different socioeconomic status, with lower income and minority people generally having less access to free recreation facilities such as public parks (Sallis and Kerr 2006, Dahmann et al. 2010). Given the remoteness of many national forests, physical accessibility and high transportation costs could be a factor in low visitation rates among low-income people located farther from national forests. However, for low-income people living nearby, national forests may exist as an important and affordable public health resource.

Recreation access fees too can induce lower visitation to sites that charge fees as many would be visitors choose to substitute other sites that do not charge fees (Schneider and Budruk 1999). Fee-driven visitor displacement can be significant. For example, implementation of the US Forest Service’s “Fee Demo” program in 1998 was found to

Table 5. Annual national forest visits, estimated net energy expenditure per visit and estimated total annual net energy expenditure, by region.

Region	Adults	Youths	All	Percent of total
Visits				
Northeast	11,701,247	2,331,371	14,032,618	8.1
Southeast	23,723,860	5,195,585	28,919,445	16.7
West	108,353,338	22,220,599	130,573,937	75.2
Total visits	143,778,445	29,747,555	173,526,000	100.0
Net energy expenditure per visit (kcal)				
Northeast	1,973	903	—	—
Southeast	1,855	820	—	—
West	1,814	881	—	—
National average per visit	1,834	872	—	—
Total net energy expenditure (millions kcal)				
Northeast	23,086	2,104	25,191	8.7
Southeast	44,016	4,259	48,275	16.7
West	196,543	19,566	216,108	74.6
Total net energy expenditure	263,645	25,929	289,574	100.0

^a Regions defined as: Northeast, CT, DE, IA, IL, IN, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VT, WV, WI; Southeast, AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA; West: AK, AZ, CA, CO, HI, ID, KS, OR, MT, ND, NE, NM, NV, SD, UT, WA, WY.

Table 6. Annual national forest visits and estimated annual net energy expenditure by nonlocal and local (within 60 road mi) visitors.

Region	Adults	Youths	All	Percent of total
Visits				
Nonlocal	69,793,481	14,440,171	84,233,652	48.5%
Local	73,984,965	15,307,383	89,292,348	51.5%
Total visits	143,778,446	29,747,554	173,526,000	100.0%
Net energy expenditure per visit (kcal)				
Nonlocal	1,853	945	—	—
Local	1,815	802	—	—
National average per visit	1,834	872	—	—
Total net energy expenditure (millions kcal)				
Nonlocal	129,352	13,647	142,999	49.4%
Local	134,293	12,282	146,575	50.6%
Total net energy expenditure	263,645	25,929	289,574	100.0%

coincide with more significant declines in recreation visitation in designated wilderness areas in western Oregon than occurred after major wildfire (Brown et al. 2008, p. 11). Fees add to the financial burden of visitors by increasing the costs of participation. Fee receipts in national forestlands during fiscal year 2005 were \$50 million (US Department of the Interior and USDA 2006, p. 66). It may be worth considering the degree to which changes in fee structures might improve the financial accessibility of outdoor recreation opportunities for lower-income people to help ensure that associated health benefits are as equitably distributed as possible, while maintaining revenues sufficient to invest in and maintain infrastructure necessary for providing recreation opportunities.

Proximity to national forests undoubtedly plays a significant role in numbers of visits. One-half (52%) of all national forest visits are made by people who live within 60 road mi of national forest boundaries, with

many of these local residents reporting more than weekly visits (White and Styne 2008). Participation rates for individual recreation activities indicate that visits by local residents account for 51% of all calorie expenditures in national forests. Research literature suggests that for most people, regular physical activity depends on having recreation resources close to home (Rosenberger et al. 2009). For people living in relative close proximity to them, national forests likely are a major resource facilitating regular physical activity. In those rural areas surrounding many national forests, the positive public health benefits associated with ready access to national forests likely are significant, especially if local parks and other open space are lacking or absent altogether.

For getting “Kids in the Woods,” policymakers and managers might ensure that national forests provide sufficient camping opportunities to meet demand. Developed camping has one of the highest rates of par-

ticipation and yields the greatest overall energy expenditure among youths. Moreover, although developed camping is one of the more expensive outdoor recreation opportunities that national forests provide owing to infrastructure and service costs, it facilitates longer visits as well as other secondary recreation activities. Encouraging moderate-to-vigorous intensity physical activities among youths and adults might also be viewed as important. Hiking and walking account for the greatest number of all national forest visits, but youths comprise only 14% of those visits—relatively low when compared with other activities. However, hiking and walking are among the least expensive activities available to families in terms of equipment and preparation. Because youths generally are accompanied by adults, improving hiking and walking participation among youths depends in part on increasing adult visitation. One wonders what public health benefit might result from a “go take a hike” or similar ad campaign targeted at families. Additionally, promoting hiking as a secondary activity that visitors might undertake while camping or picnicking may also yield greater calorie expenditure by youths in addition to conservation education benefits sought by the Kids in the Woods initiative. These are just a few examples of how national forest policy and management might be used to encourage physical activity in national forests and contribute to public health goals in the United States.

Conclusions and Research Implications

In an era of declining timber harvests on federal lands, the US Forest Service has sought new ways to describe the public benefits associated with our nation’s continued investment in national forest management. The agency also has implemented initiatives to encourage greater conservation education among America’s youth. Our preliminary assessment of the physical activity associated with outdoor recreation in national forests supports both of these interests. Our estimates suggest that the public health benefits associated with outdoor recreation opportunities provided by national forests are likely significant and may warrant greater consideration by the US Forest Service as an important benefit that national forests provide. This finding would seem to support recommendations that the federal

Table 7. Comparison of the income distribution (%) among nonlocal, local (within 60 road mi), and all visitors to National Forest System lands and US households.

Income (\$1,000s)	Nonlocal visitors ^a (%)	Local visitors ^a (%)	All visitors ^a (%)	United States ^b (%)
<25	7.6	14.2	11.0	23.2
25–49	17.6	31.0	24.7	24.8
50–74	24.9	21.8	23.3	18.8
75–99	18.3	16.1	17.2	12.5
100–149	18.6	10.9	14.5	12.2
150+	13.0	6.0	9.3	8.5

^a National Visitor Use Monitoring program data collected between 2004 and 2009 (US Forest Service 2010).

^b US Census Bureau (2010).

government “continue to support investments in a wide range of outdoor recreation venues, such as national parks, forests, refuges, and other public lands and expand opportunities for children to enjoy these venues” as one approach to lessening childhood obesity (Task Force on Childhood Obesity 2010, p. 84). Related policy implications suggest that outdoor recreation participation by youths should be considered a major factor in any conservation education strategy targeted at youths. The contribution of outdoor recreation to meeting these goals likely could be enhanced through targeted investments in recreation infrastructure and public outreach on federal lands, as well as on state and local parks, recreation areas, and other publicly accessible open space.

Our analysis was intended as a “first look” at the potential public health benefits of national forests. Future research could address several related issues. For example, there are several potential sources of endogeneity regarding national forest visitation and public health. Current forest visitors may already be relatively healthy, enabling them to participate in outdoor recreation in national forests. Thus, it is possible that the contribution of national forest recreation to visitors’ overall physical health found in our analysis may be overstated. Future research could evaluate the physical activity and health profiles of forest visitors versus forest nonvisitors to evaluate the actual marginal contributions of national forest visits to people’s overall physical activity. Physical activity profiles would identify and measure the types, duration, and frequency of physical activities at home and in the workplace, as well as in national forests and on other public lands. Health profiles would measure individuals’ overall health status, including height, weight, body mass index, and diet, among other factors.

Although research focused on physi-

cal activity and health profiles could directly address the marginal contributions of national forest recreation to people’s overall physical activity, it would ignore other physical and mental benefits that conceivably may derive from simply visiting natural places (e.g., Godbey 2009). Other research could examine whether the overall health benefits—including mental health benefits—of physical activity vary by the setting in which activities take place. For example, does running on an indoor track provide the same overall health benefit as running on a trail in a national forest or other natural setting? Related to this would be research examining the diversity of visitors and their preferences for recreation attributes and settings, especially those correlated with high levels of physical activity. This could be part of a broader needs assessment examining factors that influence visits and recreation participation by different groups, such as national forest proximity to major population centers, the availability of public transportation linking population centers to national forests, and the degree to which transportation costs, access fees, and other factors constrain participation levels. Finally, research could begin to establish more direct links between people’s willingness to pay user fees to fund investments in and maintenance of recreation facilities, by type of activity. Research in all of these areas would help to identify critical public lands management issues regarding recreation as well as enable public lands management agencies to better identify and weigh their comparative advantages as purveyors of public health.

Endnotes

[1] One pound of body fat when oxidized through physical activity is 3,500 calories (kcal).

[2] Computation assumes 10 calories/French fry having an average length of 59 mm. The distance to the moon at its farthest is 405,696 km.

[3] This is an “equivalent” measure; however, we should note that many visitors make multiple visits to national forests for recreation purposes in a given year. For adults, computation is 750 calories/week times 52 weeks/year equals 39,000 calories/year, and then 263,645 million total calories expended by adults per year (Table 4) divided by 39,000 calories/adult per year equals 6,760,137 adults. For youths, computation is 1,575 calories/week times 52 weeks/year equals 81,900 calories/year, and then 25,929 million total calories expended by youths per year in national forests (Table 4) divided by 81,900 calories/youth per year equals 316,590 youths.

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