

# Leave No Trace Practices: Behaviors and Preferences of Wilderness Visitors Regarding Use of Cookstoves and Camping Away From Lakes

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**Abstract**—This research used descriptive information collected in visitor studies conducted between 1990 and 1992 in eight different wildernesses around the United States to evaluate behaviors and preferences of wilderness visitors regarding cookstoves and camping away from lakes. The majority of visitors used stoves for cooking. However, in all but the Desolation Wilderness, at least 50% of visitors had a wood fire on their trip. In all five areas, most visitors prefer camping within 200 feet of a lake. Appeals were successful in convincing over half of the campers to move farther away from lakeshores. Ecological appeals were more persuasive than social appeals. Progress has been made in persuading visitors to reduce fire use and camp farther from lakes.

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Wilderness managers are challenged by the need to control the social and ecological impacts of recreation use while minimizing restrictions on access and behavior in wilderness. Visitor education is a preferred management technique because it does not restrict access or freedom. The primary objections to relying too much on education are its effectiveness, its timeliness (how long will it take for education to work?) and whether costs are distributed equitably. When behaviors are recommended rather than required, conscientious users absorb all the costs (in terms of giving up preferred activities, such as having a fire), while unconscientious visitors do not.

Although there is controversy about the extent to which education should be considered an appropriate response to specific existing management problems (Cole 1995), most people agree that education is a worthwhile preventive action that should be universally applied. Over the past few decades, numerous idiosyncratic programs have been developed that attempted to teach visitors low-impact practices. Recently, these efforts have culminated in the coordinated Leave No Trace program, an effort promoted by all management agencies, as well as private nongovernmental organizations and for-profit corporations.

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The Leave No Trace program—and other educational programs—advance many recommended behaviors that, if followed, will clearly reduce impacts (Hampton and Cole 1995). Perhaps the original and best-known practice is the “pack-it-in, pack-it-out” anti-littering message. Evidence suggests that litter is much less a problem in wilderness than it was a few decades ago (Cole and others 1995). This is at least partially a result of this educational campaign (Roggenbuck 1992).

Two other practices that have been promoted for decades are (1) to use cookstoves for cooking and minimize the use of wood fires and (2) to camp away (usually at least 200 feet) from lakeshores. The rationales behind these recommendations are that (1) impacts from collecting and burning wood would be reduced if all visitors cooked on gas stoves and minimized the use of wood fires for enjoyment and (2) the potential for ecological and social impacts would be reduced if visitors camped away from lakeshores. Less likelihood of water pollution and soil and vegetation impact can potentially justify camping away from lakeshores. However, there are reasons to expect that proximity to lakeshores is poorly correlated with impact potential, particularly soil and vegetation damage (Cole 1981). Social justifications for camping farther from lakeshores are that if you camp away from a lake (1) fewer people would walk through your camp, (2) you would see fewer people, and (3) you would see fewer lakeshore camps. Despite the prevalence of these recommendations, we have little understanding of compliance with them or of the effectiveness of persuasive arguments intended to increase compliance.

The data source used in this paper is a number of wilderness visitor surveys from around the United States, collected for other purposes, that asked questions regarding use of stoves/wood fires and camping close to lakeshores. This paper presents descriptive information collected in visitor studies from eight different wildernesses regarding (1) use of and preferences for stoves and wood fires, (2) opinions about restrictions on wood fires, (3) preferred camping distances from lakeshores and (4) the likely persuasiveness of various social or ecological reasons to camp farther than preferred from a lakeshore. The unusual opportunity to look for consistency across as many as eight wildernesses allowed us to assess how well findings could be generalized. This information should give managers insight into how prevalent preferred behavior is and the persuasiveness of alternative messages.

In addition, we assessed the extent to which various visitor characteristics (trip attributes, sociodemographic characteristics, motivations, evaluations and management preferences) explain variation in behavior and persuasiveness. Specifically, we assessed the influence of visitor characteristics on (1) whether groups had any wood fires for enjoyment on their trip, (2) whether they thought they could be persuaded to camp farther than preferred from lakeshores by any of three social reasons and (3) whether they thought they could be persuaded to camp farther than preferred from lakeshores by either of two ecological reasons. If any visitor characteristics are strongly related to either behavior or persuasiveness of different messages, managers can use this information to target certain noncompliant visitors and to focus on the most persuasive messages.

Theory suggests that visitor characteristics are one of a number of attributes that should influence both behavior and persuasibility (Ajzen 1992, Manning 1985). We would expect that groups on long trips would be more likely to have at least one wood enjoyment fire simply because they have more opportunities to do so. Of more interest, we expect groups that had wood enjoyment fires to be larger because fires contribute to socializing. We expect that less experienced visitors would also be more likely to have wood fires because they might be less knowledgeable about and/or committed to avoiding the impacts associated with fires. Groups that are less motivated to be alone and are less sensitive to crowding and ecological impacts, particularly those associated with fire, should be more likely to have wood fires.

We expect that groups reporting they could be persuaded by social reasons to camp farther than preferred from lakeshores would tend to be more experienced in wilderness travel. We expect them to be more frequently motivated to be alone and more sensitive to social impacts. They also should be more accepting of rules and regulations. We would expect groups persuaded by ecological reasons to be more experienced in wilderness travel. We expect them to be more sensitive to ecological impacts and to be more accepting of rules and regulations. In general, we expect experienced visitors to be more easily persuaded (by either social or ecological reasons) than less experienced visitors.

## Study Areas and Methods

Eight separate wilderness visitor surveys, conducted between 1990 and 1992, were used in this study. However, only a few variables were evaluated for some of these wildernesses. One wilderness has no lakes and another has designated campsites, so questions regarding lakeshore setbacks make no sense. Another wilderness instituted a campfire prohibition the year of the survey, so results must be tempered by this regulation. We combined two different but adjacent wildernesses, John Muir and Sequoia-Kings Canyon, because many visitors used both wildernesses on the same trip.

### Boundary Waters Canoe Area Wilderness

This wilderness, in northern Minnesota, is the second largest wilderness east of the Rocky Mountains (1,086,000

acres) and the most-used wilderness in the system (about 1.5 million recreation visitor-days per year). Most travel is by canoe, with overnighters camping at one of over 2,000 designated campsites, each with a fireplace and a toilet. Entry permits are required, limited and sometimes difficult to obtain. Between mid-May and early September 1991, a sample of overnight visitors was obtained as visitors exited from 14 moderate- and heavy-use and 25 light-use trailheads that account for 80% of the use in the area. The number of usable surveys was 215 from the moderate- and heavy-use trailheads and 80 from the light use trailheads. Responses of low-use trailhead entrants were weighted, so the proportion of responses from each trailhead reflected the proportional distribution of permits across trailheads. Both group leaders and members were included in the sample. This sample should adequately represent overnight visitors during the main use season, particularly those exiting from popular trailheads. Only a few of the questions related to fire and stove use were asked here; no questions related to lakeshore setbacks were asked because camping was restricted to designated sites.

### Shining Rock Wilderness

The Shining Rock Wilderness, in western North Carolina, is of moderate size for an Eastern wilderness (18,500 acres). It is also quite heavily used on a per-acre basis (three recreation visitor-days per acre per year). There are no lakes in the wilderness to serve as destination areas. Most trails in the wilderness converge at a half-acre grassy bald, Shining Rock Gap, where about one-third of all camping occurs. Permits are not required, and there are few restrictions on behavior. In 1990, a representative sample of all main-use-season visitors over the age of 15—both day and overnight, both group leaders and members—was obtained during randomly selected time blocks at eight trail entry points. This sample produced 439 usable mail-back surveys. Questions were limited to those associated with use of stoves and wood fires.

### Desolation Wilderness

The Desolation Wilderness, in the central Sierra Nevada in California, is of moderate size for a Western wilderness (63,475 acres). Located close to Lake Tahoe, with about 130 scenic lakes, it is heavily used on a per-acre basis (about five recreation visitor days per acre per year). Entry permits have been required for close to 30 years. A prohibition on campfires was implemented in 1990, the year visitors were sampled. Both fire use and lakeshore setback data are presented, but the fire data suggest behavior that would have been very different the year before and probably is different today, when the prohibition is more established. The survey sample was obtained from permit-holders, both day and overnight visitors. Although a small sample of party members was obtained (81 useable surveys), party members were underweighted compared with the 438 surveys from permit-holders. Groups that did not obtain a permit were also not included, but a sample of 118 noncompliers did not differ from compliers on any of the questions reported in this paper.

## Mount Jefferson Wilderness

The Mount Jefferson Wilderness, in the central Cascade Mountains of Oregon, is larger than most wildernesses (107,000 acres). Located close to the heavily populated Willamette Valley, with many scenic lakes, it is among the more heavily used wildernesses in Oregon. Permits were required of all visitors beginning in 1991, the year the visitor survey was conducted. Campfires are generally permitted, but not within 150 feet of water or trails around certain popular lakes. A sample of day and overnight permit-holders was obtained in 1991. The full spectrum from low-use to high-use trailheads was included, with the total number of usable surveys approaching 600.

## Mount Washington Wilderness

The Mount Washington Wilderness, in the central Cascade Mountains of Oregon, is of moderate size (52,000 acres). Located just south of the Mount Jefferson, close to the heavily populated Willamette Valley, with a number of scenic lakes, it is less heavily used than many other wildernesses in the Oregon Cascades. Permits were required of all visitors beginning in 1991, the year the visitor survey was conducted. A sample of day and overnight permit-holders was obtained in 1991. The full spectrum from low-use to high-use trailheads was included, with the total number of usable surveys exceeding 200.

## Three Sisters Wilderness

The Three Sisters Wilderness, in the central Cascade Mountains of Oregon, is larger than most wildernesses (287,000 acres). Located just south of the Mount Washington Wilderness, close to the heavily populated Willamette Valley, with many scenic lakes, it is among the more heavily used wildernesses in Oregon. Permits were required of all visitors beginning in 1991, the year the visitor survey was conducted. Campfires are generally permitted, but not within one-quarter to one-half mile of certain trails and/or lakes. Camping is not permitted within 100 feet of water or trails, at least in portions of the Wilderness. A sample of day and overnight permit-holders was obtained in 1991. The full spectrum from low-use to high-use trailheads was included, with the total number of usable surveys exceeding 600.

## John Muir and Sequoia-Kings Canyon Wildernesses

The John Muir Wilderness, managed by the Forest Service, and Sequoia-Kings Canyon Wilderness, managed by the National Park Service, are contiguous large wildernesses in the south-central Sierra Nevada of California. Together, they exceed 1.3 million acres. Located within a half-day drive of major metropolitan areas in California and containing hundreds of scenic lakes, each of these wildernesses is among the 10 most frequently visited wildernesses in the system, with a combined annual visitation of over one million recreation visitor-days. Permits, limited in number, have been required for close to 30 years. In addition, campfires have been prohibited above specified elevations, where

wood productivity is limited. Both wildernesses were separately sampled in 1990, using similar methods and questionnaires. When it became apparent that many visitors sampled when entering the John Muir spent most of their time in the Sequoia-Kings Canyon and the opposite was true as well, we decided to combine the two sets of surveys. Names of permit-holders were sampled from permits. Names of group members were obtained from permit holders. Eventually, we collected 515 usable surveys from the John Muir and 390 usable surveys from Sequoia-Kings Canyon. In both cases, about 75% of the surveys came from permit-holders.

## Data Analysis

Much of the analysis was simply descriptive statistics. Our analysis of visitor characteristics related to (1) having an enjoyment fire or not and (2) whether social or ecological reasons could persuade visitors to camp farther than preferred from lakes was more complex. For one thing we used only the John Muir/Sequoia-Kings Canyon data set and a second data set produced by combining the three wildernesses close together in the Oregon Cascades. For each of these two data sets, we initially examined bivariate relationships between these variables and a wide variety of visitor characteristics, particularly those for which we had developed expectations. Chi-square, Somer's d, and t-tests were used to search for significant bivariate relationships, depending on whether visitor characteristics were assessed as nominal, ordinal or interval level data, respectively. Variables that differed significantly were then entered into a multivariate logistic regression, using a backward stepwise algorithm, to identify variables that remained statistically explanatory in a multivariate context and to assess the predictive value of a multivariate model.

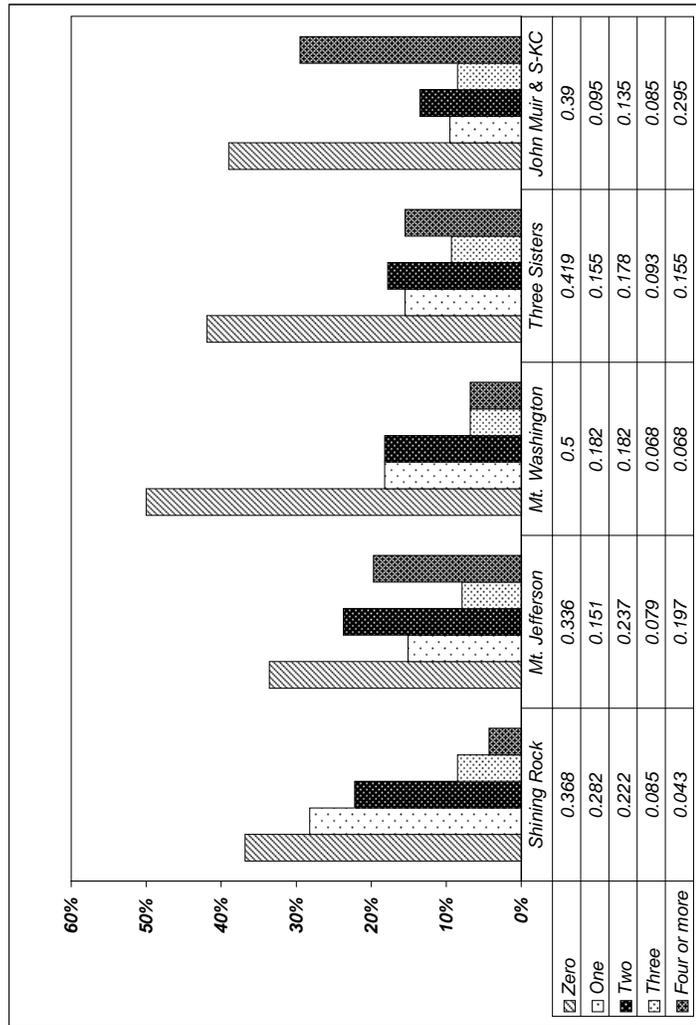
## Use of Cookstoves and Wood Fires Results

The use of cookstoves and fires was assessed in the Boundary Waters Canoe Area, the Desolation, Mount Jefferson, Mount Washington, Three Sisters, Shining Rock and John Muir/Sequoia - Kings Canyon Wildernesses. The majority of people in all areas reported using (and preferring to use) stoves for cooking (table 1). Cookstove use ranged from 65% in the Boundary Waters to 95% in the Desolation (where campfires are prohibited). However, in all but the Desolation, at least 50% of people had at least one wood fire on their trip (fig. 1). Mount Washington respondents exhibited the lowest fire use, with 50% having no campfires. John Muir and Sequoia - Kings Canyon respondents reported the greatest use of campfires, with 30% indicating they had four or more on their trip. The number of campfires per trip generally increased with size of the areas, with smaller areas like Shining Rock and Mount Washington having fewer and the largest area, John Muir and Sequoia - Kings Canyon, having the most per trip. About half of all respondents, not including those in the Desolation, had campfires for enjoyment only (ranging from 41% at Mount Jefferson to 60% at Boundary Waters and Shining Rock). The proportion of respondents with enjoyment fires was highest in the two Eastern areas - the Boundary Waters and Shining Rock. It

**Table 1**—Campfire and cookstove use and evaluation of fire-related problems in wilderness.

	Boundary Waters Canoe Area (1991) n = 285					Desolation <sup>a</sup> (1990) n = 229		Mt. Jefferson (1991) n = 157		Mt. Washington (1991) n = 46		Three Sisters (1991) n = 141		Shining Rock (1990) n = 236		John Muir & Sequoia - Kings Canyon (1990) n = 866	
<b>Behaviors:</b>																	
Did you use a stove for cooking on this trip? (% Yes)	65%	95%	79%	78%	79%	84%	67%										
Do you prefer using a stove for cooking? (% Yes)		82%	70%	87%	70%	78%											
Did you have a wood fire any time on this trip (% Yes)		17%	65%	50%	65%	63%	61%										
Did you have a wood fire for enjoyment only (% Yes)	60%	18%	41%	43%	41%	60%	45%										
<b>Problem Evaluations:</b>																	
Not enough firewood (% indicating a problem)	25%	36%	30%	15%	30%	26%	16%										
Fire rings too built up (% indicating a problem)		41%	30%	21%	30%	28%											
Too many fire rings (% indicating a problem)		37%	39%	33%	39%	30%											
Fire rings full of trash, ashes (% indicating a problem)																	

<sup>a</sup>1992 was the first year that campfires were prohibited in the Desolation Wilderness.



**Figure 1**—Number of campfires on this wilderness trip.

is interesting to note that 18% of Desolation respondents had enjoyment fires despite their prohibition.

Desolation Wilderness respondents generally reported the highest levels of problems associated with the use of campfires (table 1). While campfires were prohibited in the Desolation during the time of the study, the restriction was newly implemented, and many of the impacts from past fire use apparently remained. Forty-one percent of the Desolation respondents reported problems with too many fire rings, while 37% saw problems with fire rings full of trash and ashes, and 36% felt that fire rings were too built up. These larger numbers may reflect a judgment of the inappropriateness of fires given the fire prohibition. Mount Jefferson Wilderness respondents also reported relatively high problem levels, with 30% reporting a shortage of firewood, 39% seeing problems with fire rings full of trash and ashes and 30% feeling that there were too many fire rings.

To better understand the influence of visitor characteristics on campfire behaviors, we compared respondents who used wood fires for enjoyment with those who did not. The data sets used were the combined John Muir and Sequoia - Kings Canyon Wildernesses in California and the combined Mount Jefferson, Mount Washington and Three Sisters Wildernesses in Oregon. Visitors who had at least one campfire for enjoyment differed from those who had none in a number of ways. Significant relationships were as follows:

In the Mount Jefferson, Mount Washington and Three Sisters Wildernesses respondents who had enjoyment fires were more likely to:

- be in larger groups
- be horse users
- not be traveling alone
- have less educational attainment
- feel that a high number of groups walking past their camp was all right
- feel less crowded
- feel they had few problems with finding a suitable campsite
- feel they had few problems with too many fire rings
- feel they had few problems with privacy in camp
- feel they had few problems with campsite vegetation destruction
- feel that vegetation loss in campsites did not detract from their experience
- feel that litter detracted a lot from their experience
- not favor prohibiting camping at overused sites

In the John Muir and Sequoia - Kings Canyon Wildernesses, respondents who had enjoyment fires were more likely to:

- stay longer
- have made fewer visits to any wilderness in the past 12 months
- be horse users
- fish
- typically take long wilderness trips
- feel they had fewer problems with too many people
- not agree with the idea that wilderness should be a place to be alone
- not agree that the area is a place with too many people
- agree that they enjoyed sharing the experience with companions

- agree that spending time with companions was a trip focal point
- agree that their attention was focused on outdoor activities
- feel they had few problems with vegetation damage caused by horses

A logistic regression model was constructed for each of the two study areas. The model used the set of significant variables found in the bivariate analyses as predictors of whether respondents had campfires for enjoyment during their wilderness trips.

In the model constructed for the Oregon areas, three of the 13 bivariately significant variables remained significant in the multivariate model. Group size, number of groups walking past camp that is all right and level of agreement that vegetation loss detracted from the experience all remained significant in the regression model. The Nagelkerke  $R^2$  for the Oregon model was just 0.31, and the improvement over chance in classification ability was just 13%.

In the model based on the California areas sample, three of the original 12 variables remained significant. Length of stay, whether or not the group backpacked, and level of agreement that the wilderness is a place to be alone were significant predictors of enjoyment fire. The Nagelkerke  $R^2$  for the California model was just 0.10, and the improvement in predictability was just 10%.

These results suggest that a number of visitor characteristics are associated with the likelihood of having a wood fire for enjoyment. As expected, larger groups and groups on long trips were more likely to have fires, as were less experienced users and users who did not feel strongly about being alone or were less sensitive to social and ecological impacts. Unexpectedly, groups with fires were more likely to travel on horseback, fish, be less educated and more sensitive to litter. None of the relationships is particularly strong, however, suggesting very little ability to predict campfire behavior on the basis of visitor characteristics.

## Lakeshore Camping Setbacks

Respondents in the Desolation, Mount Jefferson, Mount Washington, Three Sisters and the combined John Muir and Sequoia - Kings Canyon Wildernesses were asked about their preferences for camping close to lakes and their willingness to move their campsite location farther from a lake than preferred. Most commonly, 200 feet is the recommended setback from lakes (Cole 1989). In all five areas, most visitors prefer camping within 200 feet of a lake (fig. 2). The Desolation and Mount Washington areas had the greatest percentage of respondents preferring to camp within 200 feet of a lake - 88% and 82% respectively. The Three Sisters Wilderness had the greatest percentage of respondents (33%) preferring to camp more than 200 feet from a lakeshore. The percent preferring to camp more than one quarter mile from lakes was greatest in those wildernesses with the fewest lakes.

Respondents in these study areas were also asked if they would voluntarily camp farther away from the lake than they preferred if it would result in reduced impacts - either sociological or ecological. Five questions were asked, two listing resource protection outcomes (less soil and vegetation impact and less water pollution) and three resulting in

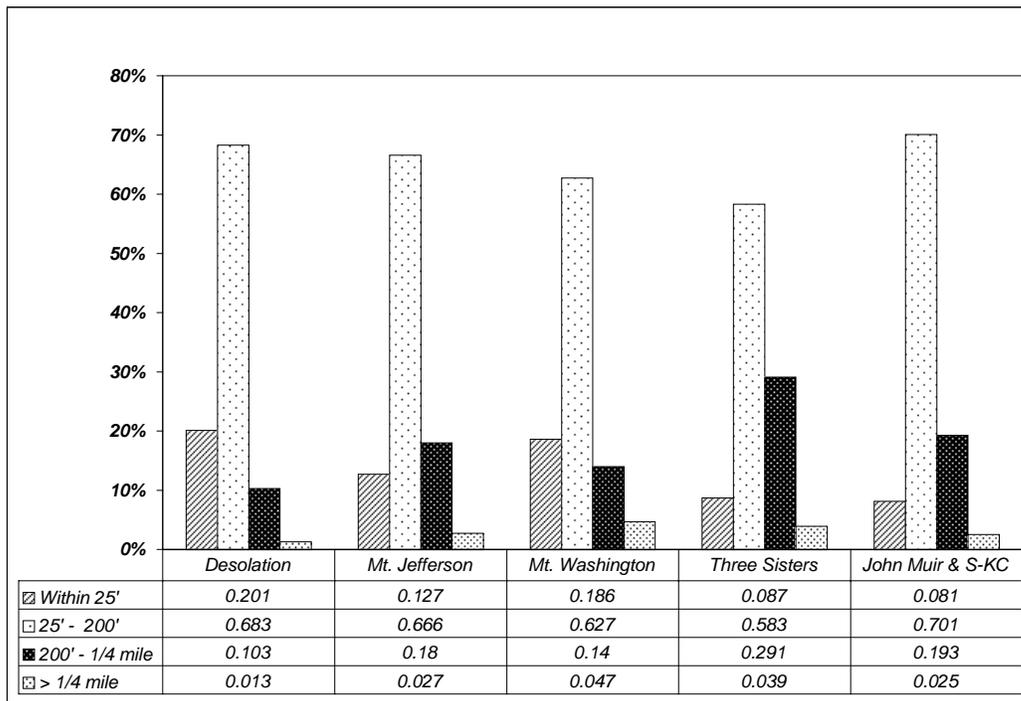


Figure 2—Preferred camping distance from a lake.

reduced encounters of various kinds with other people (see fewer people, fewer people through camp, and not see other lakeshore campsites). This analysis was limited to only those people who preferred to camp within 200 feet of a lakeshore.

All of the appeals were successful in convincing over half of the campers who prefer a lakeside location to indicate that they would move farther away (table 2). Having fewer people walk through your camp was slightly more persuasive than other social arguments and reducing water pollution was

more persuasive than reducing soil and vegetation impacts. The two ecological appeals were somewhat more persuasive than the three social appeals. The percentage of respondents that could not be convinced by any of the appeals ranged from 6% at John Muir and Sequoia - Kings Canyon to 18% at the Three Sisters Wilderness. A very small percentage of respondents (1%-4%) indicated that they would be convinced only by the sociological appeals, while a substantial minority (20%-30%) were persuaded only by ecological reasons. This is an interesting finding, given arguments that

Table 2—Self-reported effectiveness of alternative appeals to get visitors to camp farther than preferred from lakes. <sup>a</sup>

	Desolation (1990) n = 229	Mt. Jefferson (1991) n = 157	Mt. Washington (1991) n = 46	Three Sisters (1991) n = 141	John Muir & Sequoia - Kings Canyon (1990) n = 866
% willing to volunteer to camp farther away from a lake than preferred:					
if you would see fewer people	59%	57%	74%	55%	56%
if fewer people would walk through camp	59%	60%	67%	57%	61%
if you wouldn't see other lakeshore camps	51%	54%	65%	54%	53%
if it would cause less soil and veg impact	80%	75%	83%	72%	82%
if it would mean less water pollution	86%	78%	80%	78%	88%
% of people for whom:					
no reasons are persuasive	9%	17%	9%	18%	6%
only sociological reasons are persuasive	4%	3%	4%	1%	3%
only ecological reasons are persuasive	20%	26%	22%	30%	22%
both types of reasons are persuasive	67%	54%	65%	51%	69%

<sup>a</sup>Confined to those who preferred to camp < 200 feet from lakes.

ecological reasons may be more difficult to substantiate than social reasons (Cole 1981). Both types of appeals would persuade the majority of respondents (51%-69%).

To further understand the influence of visitor characteristics on the persuasibility of respondents who preferred to camp within 200 feet of the lake, we compared those who reported they could be persuaded with those who reported they could not. These analyses were limited to two data sets – the combined Oregon samples of Mount Jefferson, Mount Washington, and Three Sisters and the combined California samples of John Muir and Sequoia-Kings Canyon. Analyses were conducted on (1) whether the respondent could be persuaded to change their behavior based on ecological appeals, and (2) whether or not the respondent could be persuaded by sociological appeals. Bivariate relationships were evaluated using either t-tests, Pearsons Chi-square or Somer's d statistics, as appropriate for the level of measurement.

At Mount Jefferson, Mount Washington and Three Sisters, visitors who preferred to camp within 200 feet of a lake, but would volunteer to camp farther away based on appeals regarding social impacts, were more likely to:

- have recently visited this wilderness for the first time
- have made fewer total visits to this area
- be backpackers
- not fish
- have seen greater number of hikers than expected
- feel crowded
- feel there were problems with privacy in camp
- feel there were problems with too many fire rings
- feel there were problems with campsite vegetation destruction
- feel that vegetation loss in campsites detracted from their experience
- feel they had few problems with too many rules
- favor prohibiting the use of over-used campsites
- favor camping in designated sites only
- favor closing over-used campsites

At John Muir and Sequoia - Kings Canyon, visitors who would volunteer to camp farther from lakes based on social impact appeals were more likely to:

- have seen more groups passing their camp
- feel there were problems with too many people
- agree to limiting party size
- feel that this wilderness should be a place to be alone
- agree that this wilderness is a place with too many people
- feel there were problems with litter
- notice physical impacts from inappropriate behavior
- feel there were problems with horse damage to vegetation
- agree that this wilderness should be a place with strict visitor regulations
- agree that this wilderness is a place without enough regulations
- agree that this wilderness is a place to test their skills
- disagree with the statement 'I get more satisfaction out of visiting this place than from visiting any other recreation place.'
- disagree with the statement 'I wouldn't substitute any other area for doing the type of things I did here.'

At Mount Jefferson, Mount Washington and Three Sisters, visitors who preferred to camp within 200 feet of a lake, but would volunteer to camp farther away based on ecological impact appeals, were more likely to:

- be young
- have recently visited this wilderness for the first time
- have visited a large number of other wildernesses
- have visited this wilderness fewer times
- be backpackers
- not fish
- not have talked to a ranger
- feel that vegetation loss in campsites detracted from their experience
- feel that tree damage by people detracted from their experience
- feel there were problems with too many fire rings
- favor prohibiting use of over-used sites
- favor closing over-used sites

At John Muir and Sequoia - Kings Canyon, visitors who would volunteer to camp farther from lakes based on ecological impact appeals were more likely to:

- have visited this wilderness fewer times
- favor limiting party size
- agree that this wilderness is a place with too many people
- feel there were problems with too many people
- feel there were problems with litter
- notice physical impacts from inappropriate behavior
- feel there were problems with human-caused damage to vegetation
- agree that this wilderness should be a place with strict visitor regulations
- agree that this wilderness is a place without enough regulations
- disagree that this wilderness is a place with too many regulations
- agree that this wilderness is a place to test their skills

Multivariate modeling was conducted using variables found to be statistically significant in the bivariate analyses. Four logistic regression models, utilizing backward stepwise algorithms, were constructed - one for each of the two combined study areas and each of the two types of appeals. If successful, these models could be used to predict willingness to modify camping behavior based on a particular type of appeal - social or ecological.

In the model constructed for the Oregon areas, assessing willingness to modify behavior based on sociological appeals, just two of the 14 bivariately significant variables remained significant in the multivariate model. Whether the respondents felt there were too many regulations and whether they backpacked remained significantly related to their willingness to camp farther away based on sociological concerns. The Nagelkerke  $R^2$  for the model was just 0.19, and the improvement over chance in classification ability was just 9%.

In the California area model for the sociological appeals, three of the original 13 significant variables remained significant in the multivariate logistic regression. The three variables were: whether they noticed physical impacts from inappropriate behavior, the level of agreement with the

statement “I wouldn’t substitute any other area for doing the type of things I did here,” and agreeing that “this wilderness should be a place to be alone.” The Nagelkerke  $R^2$  was 0.30, and the improvement in classification was 1%.

The model for the combined Mount Jefferson, Mount Washington and Three Sisters Wildernesses based on ecological appeals had a Nagelkerke  $R^2$  of 0.62, but the improvement in classification ability was just 1%. Three variables of the original 12 remained significant in the regression model. These variables were: whether the respondent fished, whether they felt that vegetation loss detracted from their experience and whether they talked to a ranger.

The ecological appeals in the model for the John Muir and Sequoia - Kings Canyon Wildernesses had a Nagelkerke  $R^2$  of 0.73, but the model did not increase classification ability beyond that achieved by chance. The three variables of the original 11 that remained significant in the model were: whether they felt there were problems with too many people, whether they supported limiting party size and their agreement with the statement that “this wilderness is a place without enough regulations.”

These results suggest that many visitor characteristics are related to the likelihood that a camper could be persuaded to camp farther from a lake than preferred. As expected, those who could be persuaded by social appeals were more motivated to be alone, more sensitive to social impacts and more accepting of rules and regulations. Unexpectedly, general wilderness experience was not related to persuasibility, and local experience was inversely related to persuasibility. In addition, horse users, fishers and visitors with a high degree of place attachment were less readily persuaded. As expected, those who could be persuaded by ecological reasons were more generally experienced in wilderness travel, more sensitive to ecological impacts and more accepting of rules and regulations. As was the case with social appeals, local experience, horse use and fishing were all inversely related to persuasibility, and sensitivity to social impacts was positively related to persuasibility. None of these relationships are very strong, however, suggesting very little ability to predict the persuasibility of different visitor types.

It is interesting to note that general wilderness experience is positively related to persuasibility of only ecological appeals and that local experience is negatively related to both types of appeals. The finding that talking to a ranger was inversely related to persuasibility was a surprise. This could mean that talking to a ranger caused visitors to become less readily persuaded, but we doubt this. It is more likely that visitors who are not readily persuaded are more likely to talk to a ranger, either because they camp in places closer to where other people walk and are more gregarious – both of these reasons are supported by data – or because they are behaving in ways that cause a ranger to talk to them.

## Discussion and Implications

These data suggest that low-impact messages about using stoves, minimizing fires, and camping away from lakes have had an effect. Thirty to 40 years ago, virtually everyone had a campfire every night and, when camped at a lake, camped within 100 feet of it; few carried gas stoves. Today, most

groups bring a stove with them, and most prefer cooking on the stove to cooking over a wood fire. This is an impressive change. The reduction in fire use is less impressive. In all areas we surveyed, where campfires are allowed, at least 50 percent of groups had at least one fire on their trip. This continued use of fire may not be surprising, given our finding that only one-quarter to one-half of visitors felt that there were any problems with lack of firewood, too many fire rings or built-up and trashy fire rings. Reductions in fire frequency are more dramatic, however. In the two areas where we had length-of-stay data, the percentage of nights visitors had fires was 18% in Shining Rock Wilderness and 63% in the John Muir/Sequoia-Kings Canyon Wildernesses. This suggests a reduction in fire use of 50 to 90 percent, assuming that two fires a day is no longer the norm. At Shining Rock, virtually all fires were enjoyment fires. At John Muir/Sequoia-Kings Canyon, cooking fires were more common, so only about 75 percent of fires were enjoyment fires only.

It is also worth noting that although fires were prohibited at Desolation, 18 percent admitted to having at least one fire on their trip. This level of illegal behavior might be explained by the fact that this was the first year of the prohibition. It is also worth noting that at Desolation, although 78 percent supported a campfire prohibition where firewood was scarce and 75 percent supported the notion of not allowing new fire rings, only 37 percent supported a total ban on campfires.

If visitors camp where they prefer, progress in getting people to camp away from lakes is even less pronounced. Typically, only about 20 percent of visitors prefer to camp more than 200 feet from a lake. The good news, however, is that over 80 percent of visitors who prefer camping close to lakes report that they could be persuaded to camp farther back than they prefer. Ecological reasons are more compelling persuasive arguments than social reasons. Twenty to 30 percent of visitors who could be persuaded by an ecological reason to camp away from lakes would not be convinced by a social reason. Virtually nobody would be convinced by a social reason and not by an ecological reason. This suggests that messages might best focus on an ecological rationale for camping away from lakes, and indeed this is the most common rationale. However, some have questioned the validity of this rationale. Empirical data have shown that campsites close to lakes are not more highly impacted than camps away from lakes (Cole 1982).

It might be better, then, to focus on social reasons but to make them more compelling.

Many visitor characteristics influence visitor behavior and persuasibility, but relationships are not strong, so our ability to predict how people will behave or which ones might be readily persuaded is low. Those likely to have wood fires or to not be persuaded to camp farther from lakes than preferred include horse users, anglers, visitors who are highly experienced in this wilderness or highly attached to it, generally inexperienced wilderness visitors, visitors who are relatively insensitive to social and ecological impacts and visitors who are less supportive of rules and regulations. Where possible, managers may want to focus their attention on these types of visitors.

Our data indicate that progress has been made in persuading visitors to reduce fire use. Although we cannot prove it, we believe that progress has also been made in convincing people to camp farther from lakes. However, there is much

more room for progress, particularly regarding lakeshore set-backs. Much of the problem may be linked to the majority of visitors who feel there are no problems with impacts from wood fires and the minority who cannot be convinced there are good reasons to camp away from lakes. Our data can suggest the types of visitors who are most likely to be noncompliant. Targeting these visitors makes sense, although we should restate that none of the visitor characteristics we assessed explained much variation in behavior or persuasibility.

We suggest several avenues for further research. First, given the weak relationships we found with visitor characteristics, two potential interpretations could be made. It is possible that no visitor characteristics are important explanatory variables. Alternatively, however, there may be important visitor characteristics that differ from the traditional ones we surveyed. Research might uncover better visitor attributes to use as predictors. Second, there are no theoretical reasons we would expect horse users, anglers or visitors with high levels of experience in the local wilderness to be less compliant, persuadable, sensitive to ecological and social impacts or supportive of rules and regulations. Yet these were our empirical findings. Research might elucidate the underlying visitor characteristics that could better explain these findings.

Finally, the finding that more visitors are persuaded by ecological impacts than by social impacts is interesting. It is reminiscent of recent controversy in high-use areas in wilderness, where many visitors state they are willing to be regulated if regulation is needed to keep resource impacts to acceptable levels. However, they do not support regulations designed to provide high opportunities for solitude and other favorable social attributes. Research might attempt to understand whether these attitudes are common and where they come from.

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