Communicating the Wildland Fire Message: Influences on Knowledge and Attitude Change in Two Case Studies

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Abstract—*Current wildland fire policy calls for citizen involvement in planning and management. To be effective in their efforts to engage outside stakeholders, resource professionals need to understand citizens' understanding and attitudes toward current practices as well as how to best communicate about proposed actions. A variety of outreach methods have been used to communicate the rationale behind fuel reduction techniques. Limited evaluation of these efforts has occurred resulting in a lack of information available to guide the outreach decisions of agency personnel. This paper evaluates the effects of two basic communication strategies—unidirectional information exchange and interactive approaches—on participant understanding and attitudes. Data was collected in two phases; first, citizens completed a survey on-site prior to outreach participation, then, a follow-up questionnaire was mailed to each participant two weeks following initial contact. Resulting data enable assessment of the influence of outreach activities on participant understanding and attitudes and evaluation of factors that contributed to program success. Findings suggest interactive outreach methods may be more effective at influencing knowledge. However, unidirectional and interactive approaches influenced participants with low initial understanding of fire management or less supportive attitudes toward fuel practices. Results also showed a strong association between knowledge and attitude change suggesting fire professionals have a real opportunity to help shape public perceptions about appropriate management actions.*

Introduction

Recent federal initiatives such as the National Fire Plan and Healthy Forests Restoration Act require a new approach to fire management. These policies emphasize two primary themes. First, there is an increased focus on using fuel reduction activities (such as prescribed fire or mechanized thinning) prior to a fire event to decrease the vegetation available to burn as fuel if a fire occurs. Second, both initiatives call for, and in some cases require, collaboration with stakeholders (including local citizens) in planning and prioritizing fire and fuel management activities. Natural resource communicators, including federal and state agency personnel, county extension agents, and interpretive staff, play an essential role in accomplishing these objectives.

Substantial research over the last several years has indicated the necessary role of social acceptability in resource management activities (see review in Shindler and others 2002) and specifically in fuel reduction efforts (Shindler and Toman 2003, Winter and others 2002). Accordingly, many management units are moving towards greater citizen involvement in the development and implementation of fire and fuel management strategies. To be successful,

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resource professionals need to understand citizens' knowledge of and attitudes toward current practices as well as how to best communicate with local communities about proposed actions. Outreach activities, as the primary interface between resource agencies and citizens, play an essential role in these efforts (Bright and Manfredo 1997).

In recent years, resource agencies have used a variety of methods to communicate the rationale behind fuel reduction techniques. Approaches have ranged from traditional text and graphic displays, such as brochures and exhibits, to more targeted activities, including demonstration areas and guided field tours. To date, limited evaluation of these efforts has occurred resulting in a lack of available information to guide the outreach decisions of resource professionals. The purpose of this paper is to fill this research gap by exploring the influence of two basic communication strategies—unidirectional information exchange and interactive approaches—on participant understanding and attitudes.

Related Research

Research on the social aspects of fire management has increased steadily in recent years. A review of the literature suggests a number of findings relevant to this study. First, research over nearly three decades has identified a positive association between fire-related knowledge and treatment support among citizens (e.g., Stankey 1976, Carpenter and others 1986, Shindler and Toman 2003). This finding has prompted researchers to call for increasing fire-related outreach activities to raise public awareness and support (e.g., McCool and Stankey 1986, Carpenter and others 1986). However, public acceptance is a complex issue and is not based solely upon technical understanding. Support for fire management is particularly influenced by the interactions between citizens and resource managers over time and reflects citizen confidence in agencies to effectively manage risk as well as provide an adequate planning process that includes a role for the public (Winter and others 2002, Shindler and Toman 2003). Ultimately, understanding is a strong precursor to support, but not sufficient on its own.

Second, public understanding and acceptance of fuel treatments have increased over time. Early research found that participants generally overestimated the negative impacts of fire while underestimating fire's beneficial effects (Stankey 1976). Not surprisingly, a majority preferred complete fire suppression. Subsequent research has consistently identified an upward trend in citizen understanding of key fire management principles and acceptance of manager-ignited prescribed fire (e.g., Carpenter and others 1986) as well as thinning for fuel reduction (Loomis and others 2001, Shindler and Toman 2003). However, Manfredo and others (1990) cautioned that the identified increases may only be occurring in particular geographic regions, specifically those areas most affected by fire, and may not be representative of general attitudes. Brunson and Shindler (2004) also found variations in understanding and support among locations and cautioned against implementing "one-size-fits-all" management or communication approaches.

Third, and particularly relevant to our study, fire-related outreach activities can positively influence participant knowledge and, in some cases, attitudes. Prior studies have evaluated response change following exposure to various communication activities (brochures, slide shows, workshops, etc.). Such activities can be classified as interactive or unidirectional based on the type

of outreach experience they provide. Interactive activities (including guided visits to demonstration sites and agency workshops) allow for two-way communication with resource professionals while unidirectional methods (such as brochures, public service announcements, and static displays) consist of a one-way flow of information. Toman and others (2006) suggest that interactive programs may be more consistent with principles of adult learning by relating information to the local context, incorporating citizen experiences and concerns, and providing greater opportunities to develop personal relationships between citizens and agency personnel. This project provides an opportunity to further test these ideas.

A review of prior research suggests that both unidirectional and interactive activities have achieved some success. For example, brochures have been effective at increasing knowledge (Taylor and Daniel 1984) and leading to more supportive attitudes (Loomis and others 2001). Nielsen and Buchanan (1986) evaluated a unidirectional (slide show) and an interactive activity (interpreter guided walk); both of which resulted in higher knowledge and attitude scores among participants. Marynowski and Jacobson (1999) report outcomes for an ecosystem management education program that targeted fire ecology as one of four content areas. The program consisted of various unidirectional communication methods including posters, brochures, youth activity booklets, and multiple news releases. These educational materials significantly increased knowledge of fire ecology, but did not result in a corresponding increase in support for fire management activities.

Recent research has increasingly emphasized interactive activities. For example, Parkinson and others (2003) evaluated the influence of workshops on attitudes and knowledge. The workshops consisted of hands-on activities adapted from FireWorks, an education program originally developed by the USDA Rocky Mountain Research Station to target middle school students. Following the workshop, participants experienced an increase in knowledge and more supportive attitudes toward fire management. Another study evaluated the influence of visits to sites treated by prescribed fire (Toman and others 2004). In a self-assessment, a majority indicated that prescribed fire was more acceptable to them as a result of having observed treated sites.

Finally, in a recent evaluation of a multi-faceted information program that used both unidirectional (brochures, mass media) and interactive methods (personal contact, group presentations, neighborhood meetings), McCaffrey (2004) found that personal contact contributed substantially to communication success. Indeed, educational materials, including unidirectional items, were more effective if delivered via personal contact. Findings suggest workshops, site visits, and other interactive activities may not only offer a means for information provision but also provide an opportunity for meaningful interaction with citizens.

Methods

Two study sites were selected; Sequoia and King's Canyon National Parks (SEKI) and the World Forestry Center (WFC). SEKI is comprised of adjacent parks located in the Sierra Nevada Mountains in central California. The parks have an active fuel management program that emphasizes management-ignited prescribed fires and managing naturally ignited fires to achieve resource objectives. Thinning, though less prevalent, is also used near structures to reduce fuel levels.

A broad range of outreach activities are represented at SEKI, including both unidirectional and interactive methods. Upon entering the park, all visitors receive a multi-page newsletter with details about park resources and facilities as well as general interpretive information. Within SEKI there are five visitor centers, each containing various interpretive activities including brochures, film strips, and static displays. Among these, the Giant Forest Museum offers a different, more sophisticated visitor experience than the other centers. Following recent renovation the Museum now provides a broad range of interactive and unidirectional activities, many of which emphasize the role of fire in the Sequoia lifecycle. National Park Service interpretive personnel are highly visible at the Museum and frequently engage visitors. Other outreach activities within SEKI include interpreter and self-guided walks and evening "naturalist talks" at the primary park campgrounds.

Given that visitors to SEKI were potentially exposed to both unidirectional and interactive communication methods, their responses provide an opportunity to assess the influence of communication type. In the follow-up questionnaire, respondents from SEKI indicated the specific programs they participated in while at the parks. Each activity was classified as interactive or unidirectional. Interactive programs included conversations with agency personnel, guided interpretive walks, evening naturalist programs, and visits to the Giant Forest Museum; all others were unidirectional.

The WFC is located in Portland, Oregon. From May through December 2003 the center presented "Fire: Forces of Nature." Each aspect of the exhibit was unidirectional and included photographs and text descriptions, examples of fire suppression equipment, videos on home protection and Smokey Bear, as well as an abridged version of the Nova film "Fire Wars" in the center's theater. The displays provided information about the use of prescribed fire and thinning to reduce fire risk. Overall, the exhibit represented a series of traditional formats that resource agency personnel could use to provide interpretive information at visitor kiosks, information centers, or state and county fairs. Although these formats are still largely unidirectional, recent technological advances have substantially increased the ability of outreach personnel to create high quality, visually appealing displays.

Data Collection

Data were collected in two phases. In the first phase, visitors were contacted and completed a brief questionnaire on-site before exposure to outreach activities. The on-site questionnaire included measures of citizen awareness and attitudes toward fuel treatments before soliciting respondents' contact information and agreement to participate in the follow-up survey. The follow-up was mailed to respondents two weeks following their initial contact. The delayed test was used to assess the enduring effects of exposure to outreach activities and control for experimenter expectancy effects (Leeming and others 1993). A primary benefit of the pre-test/post-test design is the collection of panel data, responses by the same individuals to the same measures at different points in time. Responses from individual participants can be "paired," or linked, over the separate data collection points to identify shifts in individual attitudes and beliefs.

Questionnaire design was informed by semi-structured interviews with agency personnel and project partners. Two questionnaires were developed, one for the on-site survey and another for the follow-up phase. The follow-up questionnaires replicated on-site questions while soliciting further information on awareness, attitudes, and understanding of fuel treatments, evaluations

of the outreach activities, and demographic information. Resulting data enable assessment of *between* and *within*-site differences as well as contributory factors. Follow-up mailings were conducted using a modified version of the "total design method" (Dillman 1978); surveys were sent in three waves beginning approximately two weeks following on-site contact.

Sample sizes and response rates are displayed in Table 1. As might be expected, overall visitation levels differ greatly between SEKI and the WFC. These differences are reflected in substantially different sample sizes between the two sites. Where comparisons are made between locations, chi-square tests are used. Because the test is based on the proportion rather than the number of responses, the chi-square statistic is robust to differences in sample size (Cohen and Lea 2004). The remainder of the comparative analysis is based on responses from participants within each location. Thus, the differing sample sizes have little influence on findings reported here.

Results

Respondents were similar demographically (age, education, gender, urban-rural residence) between locations. Overall, respondents had a mean age of 49 and were well educated; two-thirds (66%) had a bachelor's degree or higher. Just under half (44%) were women. Two-thirds (66%) lived in an urban area, while 34% came from a rural community.

Geographic Variation

Knowledge—To gauge citizen knowledge specific to fire and fuel management, respondents completed a five-item true/false quiz about treatment objectives and potential effects. Item development was based upon prior studies (Stankey 1976, Cortner and others 1984, Loomis and others 2001, Shindler and Toman 2003). Respondents appeared relatively knowledgeable with a majority answering each question correctly (Table 2). Indeed, participants' average initial score was 76% at SEKI and 82% at the WFC.

Chi-square tests indicate a few differences in responses between study locations. Specifically, in the on-site surveys, fewer SEKI respondents understood the role of fires in shaping natural forests or the impact of fires on wildlife. Interestingly, in the follow-up survey significantly more SEKI respondents correctly indicated that prescribed fires effectively reduce the amount of fuel in forests.

Table 1—Sample sizes and response rate.

	On-site sample size*	Post-surveys received	Response rate
World Forestry Center (WFC)	92	68	74%
Sequoia and King's Canyon National Parks (SEKI)	395	269	68%
Total	653	459	70%

* Represents number who completed the on-site questionnaire and provided valid mailing addresses.

Table 2—*Between*-site differences in response to quiz questions measuring knowledge about fire management issues.

		Percent of respondents				
	Location	Generally true	Generally false	Not sure	X^2	Significance
Wildfires have played a significant role in shaping natural forests in the western United States.						
On-site	SEKI	*87*[a]	3	10	7.9	.019
	WFC	*99*	2	0		
Follow-up	SEKI	*93*	2	6	2.0	.361
	WFC	*97*	2	2		
Wildfires usually result in the death of the majority of animals in the area.						
On-site	SEKI	12	*66*	22	6.3	.042
	WFC	3	*79*	18		
Follow-up	SEKI	9	*71*	20	2.0	.361
	WFC	7	*79*	13		
Prescribed fire or controlled burns effectively reduce amounts of fuel in most forests.						
On-site	SEKI	*70*	9	21	1.6	.447
	WFC	*77*	4	19		
Follow-up	SEKI	*90*	2	8	7.8	.019
	WFC	*78*	6	16		
Prescribed fires or controlled burns reduce the chance of high-intensity wildfire.						
On-site	SEKI	*89*	3	9	3.6	.162
	WFC	*91*	6	3		
Follow-up	SEKI	*91*	3	6	.19	.906
	WFC	*90*	3	7		
A history of suppressing wildfires has increased the risk of a destructive fire in the western United States.						
On-site	SEKI	*68*	10	23	.54	.762
	WFC	*69*	12	19		
Follow-up	SEKI	*75*	8	18	2.5	.277
	WFC	*84*	4	12		

[a]The most correct responses are indicated by italics.

Attitudes—Participants also responded to a series of five statements regarding their attitudes toward fire management issues (Table 3). The first four items were based on prior research (Stankey 1976, Loomis and others 2001, Shindler and Toman 2003). The final item about thinning was included because previous studies suggest citizens may be concerned that thinning is simply an attempt to increase timber harvests on public lands (Shindler and others 2002, Shindler and Toman 2003). Results here indicate considerable uncertainty (don't know responses) about thinning activities even following exposure to outreach activities.

Overall, on-site responses were positive toward fire management, indicating a generally high level of support for treatments initially. There were no differences between SEKI and WFC on-site responses; however, agreement with management burning of underbrush differed in follow-up responses. While statistically significant, these differences have relatively minor implications for fire managers; in both cases a strong majority support periodic burning.

Changes Within Locations

Knowledge and Attitude Indices—A primary objective of this study was to examine the influence of participation in outreach activities on knowledge and attitudes. To assess change in understanding we created an index based on *within*-site participant performance on knowledge questions (responses presented in Table 2). A correct answer was coded as 1 while incorrect and "not

Table 3—*Between*-site differences in responses to belief statements measuring attitudes toward fire management issues.

		Percent of respondents				
	Location	Agree	Disagree	Don't know	X^2	Significance
All fires, regardless of origin, should be put out as soon as possible.						
On-site	SEKI	16	78	6	2.4	.295
	WFC	9	85	6		
Follow-up	SEKI	3	93	4	1.3	.511
	WFC	6	90	4		
Managers should periodically burn underbrush and forest debris.						
On-site	SEKI	84	3	13	1.4	.494
	WFC	82	6	12		
Follow-up	SEKI	86	2	13	7.1	.027
	WFC	82	8	10		
Prescribed fires or controlled burns are too dangerous to be used.						
On-site	SEKI	5	83	12	1.8	.393
	WFC	6	88	6		
Follow-up	SEKI	2	93	5	4.7	.091
	WFC	6	85	9		
Prescribed fire or controlled burns should not be used because of potential health problems from smoke.						
On-site	SEKI	6	81	14	.16	.920
	WFC	4	82	13		
Follow-up	SEKI	3	86	12	.77	.678
	WFC	5	82	13		
Thinning for fuel reduction will lead to unnecessary harvesting.						
On-site	SEKI	15	51	34	2.7	.253
	WFC	19	57	24		
Follow-up	SEKI	18	55	27	1.2	.538
	WFC	21	59	21		

sure" responses were coded as 0; scores were then summed. Each participant received a score from 0 to 5. Using paired t-tests, on-site and follow-up indices were compared (Table 4). Mean knowledge scores significantly increased among SEKI participants, while scores at the WFC remained similar.

An index was also created for attitude scores based on responses presented in Table 3. Each variable was recoded with a response of 1 indicating a positive attitude toward fire management and 0 indicating either a negative attitude

Table 4—Within location changes—Knowledge and attitude indices.

	Mean response	
	SEKI	WFC
Knowledge index		
On-site	3.81	4.10
Follow-up	4.21	4.26
t-statistic	5.864	1.120
Significance	<.001	.267
Attitude index		
On-site	3.78	3.98
Follow-up	4.11	4.04
t-statistic	4.446	.414
Significance	<.001	.680

or don't know response; responses were then summed. Each respondent received an index score from 0 to 5 for the five attitudinal statements. As with the knowledge indices, the WFC scores remained similar throughout the study period while attitudes toward fire management improved significantly at SEKI.

Trends in individual change—Comparisons of mean index scores indicate whether an aggregate change occurred among the sample at each location, but do not provide an assessment of changes experienced by individual participants. To explore such changes we created two new variables, knowledge and attitude change, by pairing index ratings across the study period and subtracting the on-site from the follow-up scores. Thus, if a respondent answered two questions correctly in the pre-test and four on the post-test, their knowledge change would be two. These variables provide a measurement of change for each study participant.

The knowledge and attitude change variables revealed two important points (Table 5). First, preliminary observation suggested that respondents who showed the greatest amount of change were those with the lowest initial scores. To quantify this apparent difference, we used a t-test to compare the mean change between respondents with low (0-3) versus high (4-5) initial index scores. Mean change was significantly greater among those with lower initial index ratings. Specifically, respondents with low initial understanding or support were significantly more likely to experience positive shifts in knowledge or attitude following exposure to outreach activities.

Second, a substantial number of respondents in each location experienced a positive shift (increase of one or greater in index scores). At SEKI, 39% of respondents improved their performance on quiz questions and over one-third had more supportive attitudes following participation in outreach activities. Although slightly lower at the WFC, still more than 30% of respondents demonstrated higher knowledge and attitude scores in the follow-up.

Table 5—Within location changes—Trends in participant change.

	Mean response	
	SEKI	**WFC**
Knowledge change[a]		
Low initial knowledge group mean change[b]	1.16	1
High initial knowledge group mean change[c]	–0.01	–0.1
t-statistic	8.32	2.70
Significance	<.001	0.01
Percent of respondents with positive knowledge change following outreach participation	39%	31%
Attitude change[a]		
Low initial attitudes group mean change[b]	1.44	1
High initial attitudes group mean change[c]	–0.12	–0.31
t-statistic	9.29	4.78
Significance	<.001	<.001
Percent of respondents with positive attitude change following outreach participation	34%	32%

[a] Change was calculated by pairing responses and subtracting pre-test from post-test scores.
[b] Initial index score was 0-3.
[c] Initial index score was 4-5.

Factors Influencing Change

The number of outreach activities available at SEKI provides an opportunity for further exploration of the influence of program and participant characteristics on responses. Of particular interest is the influence that type of outreach experience (interactive or unidirectional) has on knowledge and attitude change. Certain SEKI activities (conversations with agency personnel, guided interpretive tours, evening naturalist programs, and visits to the Giant Forest Museum) were coded as interactive; all others (park newsletter, brochures, other visitor centers, and self guided trails) were treated as unidirectional. Each respondent then received a score based on their participation in interactive activities. Scores ranged from 0 (for no interactive experiences) to 4 (for participation in each interactive activity).

We then created two multiple linear regression models to assess the relative influence of respondent and program characteristics on knowledge and attitude change (see Table 6). Independent variables in both models include demographics (gender, age, education, urban-rural residence), individual relevance of fire topic (as measured by amount of prior thought given to wildfire), and participation in interactive activities. Because our findings suggest initial knowledge and attitudes may influence participant change, each model also includes the appropriate on-site index (e.g., the on-site knowledge index is included in the knowledge change model and the on-site attitude index in the attitude change model). Lastly, the models also included knowledge or attitude variable.

F-test results indicate that both models are statistically significant. Furthermore, each explains at least half of the variance in participant change as indicated by the R-squared statistics. Among the four demographic variables, gender and age significantly influenced knowledge change, while age and education had significant impacts on attitude change. Males and younger participants were more likely to increase in knowledge; older individuals and those with lower education levels were more likely to experience an attitude shift. Interestingly, despite prior research that has identified differences between urban and rural residents (Brunson and Steel 1996), residence type did not influence change in either model. Personal relevance of wildfires had

Table 6—Regression models testing influence of variables on knowledge change and attitude change at SEKI.

	Knowledge change		Attitude change	
	Standardized coefficient	Significance	Standardized coefficient	Significance
Gender (males = 1, females = 2)	–.140	.007	–.059	.240
Age	–.120	.020	.136	.007
Education	.080	.132	–.167	.001
Urban-rural residence	–.013	.800	–.041	.412
Relevance of fire topic	.173	.001	.102	.047
Participation in interactive activities	.134	.007	.045	.361
On-site knowledge index	–.702	<.001	—	—
Attitude change	.133	.011	—	—
On-site attitude index	—	—	–.692	<.001
Knowledge change	—	—	.106	.039
F-statistic	26.844	<.001	28.673	<.001
Adjusted R squared	.500		.518	

a significant effect; in both models, those who had previously thought more about wildfire were more likely to experience positive change.

Participation in interactive outreach activities significantly contributed to knowledge change; however, a corresponding influence on attitudes was not recorded. In both models, the variables with the largest influence on participant change were initial knowledge or attitudes (as measured by the on-site indices); standardized coefficients were –.702 and –.692 for on-site knowledge and attitude indices respectively. The negative coefficients reflect that respondents with low initial knowledge or attitudes were significantly more likely to experience a positive increase throughout the study period. Findings here demonstrate a significant association between knowledge and attitudes even when accounting for the influence of other variables; participants who experienced an increase in knowledge were also significantly more likely to experience a positive change in attitude.

Discussion

Recent policy directives require substantial public participation in developing fire management strategies. Successful participation depends upon the ability of resource professionals to communicate relevant information via effective outreach methods. Findings presented here provide information about participant understanding of and attitudes toward fire management, track changes following outreach participation, and assess factors that contribute to knowledge and attitude change. Several important points emerge from this study.

First, participants had relatively high knowledge and supportive attitudes before exposure to outreach activities. In many cases, responses were more positive than had been recorded in prior studies (Cortner and others 1984, Loomis and others 2001, Shindler and Toman 2001). While the research approach targeted individuals who generally may be more experienced with natural resource issues than the public at large (e.g., they chose to spend their leisure time at a natural resource site), the increase in scores over prior studies were substantial, even when compared with research that targeted wilderness visitors (Stankey 1976, McCool and Stankey 1986). Overall, responses here show a greater appreciation for the role of fire, as well as an increasing recognition of the consequences of fire suppression and the beneficial outcomes of the use of prescribed fire.

Likely contributors include recent agency emphasis on outreach promoting fire and fuel management as well as media coverage that has increased in both volume and depth. In particular, while media stories still highlight dramatic fire events, there has been increased attention paid to the factors contributing to fire activity (e.g., long-term fire suppression resulting in increased fuel loads) as well as potential responses by management agencies. Results here suggest this increased exposure has resulted in higher initial awareness of fire and a basic acceptance of some fire management practices among the general public. The management implication is that outreach activities and messages will need to become more sophisticated to continue to be relevant to an increasingly knowledgeable public.

Second, despite high levels of understanding and support, there appeared to be some uncertainty about thinning treatments. While previous research has found substantial support for thinning in some forest communities (Shindler and Toman 2003, Brunson and Shindler 2004), citizens have also expressed

reservations with thinning treatments as a new means to conduct "business as usual" and increase timber harvests on public lands (Shindler and others 2002). Indeed, much of the discussion in the popular press regarding the Healthy Forest Restoration Act has focused on whether the legislation would facilitate removal of large, mature trees (for example see McCarthy and others 2003, New York Times Editorial Desk 2003). Findings here suggest greater discussion within communities will likely be necessary before proceeding with large-scale thinning projects. Outreach activities can play an important role here, particularly interactive programs, as research has shown that personal contact can reduce the controversy surrounding thinning decisions (McCaffrey 2004).

Third, although prior research has suggested differences in citizen perspectives among locations (Manfredo and others 1990, Brunson and Shindler 2004), findings here were generally similar across study sites. This may partly be an artifact of our research approach. Specifically, contacting individuals at a recreation site (outside of their community) and not at their residence potentially reduces the influence of local contextual factors on citizen responses. That is, they may have responded to questions about fuel treatments in general rather than thinking about a prescribed burn near their back yard. It is important to note that while there appears to be good understanding and high support for the concept of fuel management practices, gaining acceptance among local residents for specific treatments will require more than general interpretive messages. The implementation of specific projects will require effective communication tailored to ecological and social issues at the local, and perhaps the neighborhood, level (Brunson and Shindler 2004).

Lastly, the data presented here demonstrate that outreach activities can positively influence citizen understanding and support. While only SEKI responses demonstrated an aggregate increase, approximately one-third of participants at both locations experienced some positive change throughout the study period. These program effects are particularly remarkable given the high initial scores as participant change is less likely when knowledge or attitudes are already well-developed (Dillard and Peck 2000). Results further reveal that participants with low initial knowledge or less positive attitudes were more likely to experience improvements across the study period. This trend was evident in both locations; even though there was not an increase in aggregate scores at the WFC, those with low initial scores were positively influenced. Importantly, populations with low understanding or less supportive attitudes are a key target audience of agency personnel and results here suggest they are likely to benefit the most from outreach activities.

Factors Influencing Change

A primary objective of these case studies was to assess factors that contribute to knowledge and attitude change. Of particular interest is the influence of interactive versus unidirectional outreach activities on participant responses. *Within*-location changes show that SEKI participants (exposed to interactive formats) experienced a significant improvement in knowledge and attitudes while the WFC responses (following a unidirectional experience) remained similar throughout the study period. While suggestive, these results may be confounded by additional variables. For example, SEKI responses were initially lower, albeit slightly, and these individuals may have been more susceptible to change. In addition, most SEKI respondents participated in multiple outreach activities; thus, knowledge and attitude changes may be influenced by greater exposure to fire-related information.

The regression models also provide mixed evidence. While participation in interactive activities positively influenced knowledge change, results provide no evidence of a corresponding impact on attitudes. Ultimately, findings here are suggestive but inconclusive on the influence of interactive outreach experiences. Our inability to identify potential effects may be a consequence of the measures used in this study. We replicated measures used by others, but the high initial performance may indicate it is time to increase the level of sophistication in our tests. A different set of knowledge and attitude measures may be necessary to identify change and assess contributory factors among an increasingly informed public.

Regression findings also provide information on additional influencing factors among SEKI respondents. Demographic variables had mixed effects; influences were either inconsistent or contradictory between the models. Thus, findings do not suggest a particular portion of the population to target through communication activities. Personal relevance of fire management had positive effects on knowledge and attitude change. The implication here is that residents in the wildland urban interface are prime candidates for outreach programs and messages will likely be more successful when crafted to demonstrate their application to local issues of concern.

Also noteworthy is the strong association between knowledge and attitude change. While substantial research has identified a correlation between knowledge and support for fire management activities (e.g., McCool and Stankey 1986, Carpenter and others 1986, Shindler and Toman 2003), such associations are not evident for all natural resource issues. For example, attitudes toward clearcutting are unlikely to change simply on the basis of new information (Bliss 2000). The consistency of these findings over time suggests that outreach activities may have a greater influence on support toward fire than other management issues. Accordingly, resource professionals may see greater dividends by focusing their outreach efforts to communicate the fire and fuel message.

Conclusion

Effective communication is essential to building the understanding and support necessary for sustainable resource management. Findings here suggest two basic levels of communication are useful. One is general information dispersal; this usually involves broad messages that can be conveyed by unidirectional, mass communication formats such as newspapers, brochures and public service announcements. Messages delivered through this format are typically created for general public consumption and, as such, provide few opportunities to target specific audiences. Because it is difficult to ensure that information is received and understood, their effectiveness as an educational tool is limited. Indeed, as Atkin writes, "campaign messages that have the broadest reach can deliver only a superficial amount of information and persuasive content that is seldom customized to the individual recipient" (2001, p. 56). However, these programs can still be beneficial; they are typically inexpensive and can contribute to building awareness for important issues or projects (Atkin 2001, Jacobson 1999). Moreover, unidirectional activities, as demonstrated here, can positively influence citizens with low initial knowledge and a lack of formal opinions about these programs.

The second level of communication is more focused in scope and usually includes opportunities for interaction at the community or individual level.

Because such outreach activities target local priorities and specific environmental contexts, they will likely be more effective at influencing citizen understanding and acceptance (Brunson and Shindler 2004; McCaffrey 2004). Indeed, as citizen understanding of fire management becomes increasingly sophisticated, the flexibility of interactive activities to provide context-relevant information will become even more important. Of the factors that contributed to knowledge change in this study, the type of outreach experience was the only one that managers can directly control.

The take-home message from these case studies is that effective outreach goes beyond simply using standardized tools to provide information. As demonstrated here, outreach success is not only a result of the information provided but also the method of delivery. Indeed, "the availability of information does not necessarily mean that it will reach its audience or be effective once it gets there" (McCaffrey 2004, p. 12). Successful communication requires effective planning including consideration of the communication objective, the nature of the topic, and audience characteristics including prior knowledge and attitudes (Jacobson 1999). Fire and fuel management are resource issues that offer a real opportunity for achieving success through communication and outreach. The public has long looked to management professionals to provide sound information and leadership regarding fire issues (Shelby and Speaker 1990). As findings here suggest, managers can use this leadership role to influence public understanding and generate positive attitudes for management activities.

References

Atkin, C.K. 2001. Theory and principles of media health campaigns. Pages 49-68 *in* Public Communication Campaigns 3rd Ed., edited by R.E. Rice and C.K. Atkin. Thousand Oaks, CA: Sage Publications, Inc.

Bright, A.D., and M.J. Manfredo. 1997. The influence of balanced information on attitudes toward natural resource issues. *Society and Natural Resources* 10:469-483.

Brunson, M. and B. Steel. 1996. Sources of variation in attitudes and beliefs about federal rangeland management. *Journal of Range Management* 49 (1): 69-75.

Brunson, M., and B. Shindler. 2004. Geographic variation in the social acceptability of wildland fuels management in the western U.S. *Society and Natural Resources* 17:661-678.

Carpenter, E.H., J.G. Taylor, H.J. Cortner, P.D. Gardner, M.J. Zwolinski, and T.C. Daniel. 1986. Targeting audiences and content for forest fire information programs. *Journal of Environmental Education* 17 (3): 33-42.

Cortner, H.J., M.J. Zwolinski, E.H. Carpenter, and J.G. Taylor. 1984. Public support for fire-management policies. *Journal of Forestry* 82(6): 359-365.

Cohen, B.H. and R.B. Lea. 2004. Essentials of statistics for the social and behavioral sciences. New Jersey: John Wiley & Sons, Inc. 289 p.

Dillard, J.P. and E. Peck. 2000. Affect and persuasion: Emotional responses to public service announcements. *Communication Research.* 27(4): 461-495.

Dillman, D.A. 1978. *Mail and telephone surveys: The total design method*. New York: John Wiley and Sons.

Jacobson, S.K. 1999. Communication skills for conservation professionals. Washington, D.C.: Island Press.

Leeming, F.C., W.O. Dwyer, B.E. Porter, and M.K. Cobern. 1993. Outcome research in environmental education: A critical review. *Journal of environmental education* 24 (4):8-21.

Loomis, J.B., L.S. Bair, and A. Gonzalez-Caban. 2001. Prescribed fire and public support: Knowledge gained, attitudes changed in Florida. *Journal of Forestry* 99 (11):18-22.

Manfredo, M.J., M. Fishbein, G.E. Haas, and A.E. Watson. 1990. Attitudes toward prescribed fire policies: The public is widely divided in its support. *Journal of Forestry* 88 (7):19-23.

Marynowski, S.B., and S.K. Jacobson. 1999. Ecosystem management education for public lands. *Wildlife Society Bulletin* 27:134-145.

McCaffrey, S.M. 2004. Fighting fire with education: What is the best way to reach out to homeowners? *Journal of Forestry* 102(5):12-19.

McCarthy, T., D. Cray, P. Dawson, E. Roston, and A. Zagorin. 2003. How Bush gets his way on the environment. *Time* 161(4):48-51.

McCool, S.F., and G.H. Stankey. 1986. Visitor attitudes toward wilderness fire management policy—1971-84. Research Paper INT-357 Ogden, UT: USDA Forest Service, Intermountain Research Station.

New York Times Editorial Desk. 2003. Empty Promises. *New York Times*. Late Edition, January 23, 2003: A-28.

Nielson, C., and T. Buchanan. 1986. A comparison of the effectiveness of two interpretive programs regarding fire ecology and fire management. *Journal of Interpretation* II (1):1-10.

Parkinson, T.M., J.E. Force, and J.K. Smith. 2003. Hands-on learning: Its effectiveness in teaching the public about wildland fire. *Journal of Forestry* 101(7): 21-26.

Shelby, B., and R.W. Speaker. 1990. Public attitudes and perceptions about prescribed burning. In *Natural and Prescribed Fire in Pacific Northwest Forests*, edited by J.D. Walstad, S.R. Radosevich and D.V. Sandberg. Corvallis, OR: Oregon State University Press.

Shindler, B., M. Brunson, and G.H. Stankey. 2002. Social Acceptability of Forest Conditions and Management Practices: A Problem Analysis. PNW-GTR-537, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR.

Shindler, B. and E. Toman. 2003. Fuel reduction strategies in forest communities: A longitudinal analysis. *Journal of Forestry.* 101 (6): 8-15.

Stankey, G.H. 1976. Wilderness fire policy: An investigation of visitor knowledge and beliefs. Research Paper INT-180. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station.

Taylor, J.G., and T.C. Daniel. 1984. Prescribed fire: Public education and perception. *Journal of Forestry* 82 (6):361-365.

Toman, E., B. Shindler, and M. Reed. 2004. Prescribed fire: The influence of site visits on citizen attitudes. Journal of Environmental Education. 35(3): 13-18.

Toman, E., B. Shindler, and M. Brunson. 2006. Fire and fuel management communication strategies: Citizen evaluations of agency outreach programs. *Society and Natural Resources* 19: 321-336.

Winter, G.J., C. Vogt, and J.S. Fried. 2002. Fuel treatments at the wildland-urban interface: Common concerns in diverse regions. *Journal of Forestry* 100 (1):15-21.