Florida Fish And Wildlife Conservation Commission/University of Florida, School of Forest Resources and Conservation

Research on the Public and Fire Management

A Literature Review of Current Social Science in Florida

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ABSTRACT

A team of researchers at the University of Florida reviewed existing public and fire management social science literature to develop a targeted synthesis of scientific knowledge in the following themes: 1) understanding of fire's role in the ecosystem, 2) perceptions of effects of prescribed fire on wildlife, 3) acceptance of fuels treatments and smoke concerns, 4) trusted sources of information about fire, 5) cost and responsibility, and 6) differences among ethnic groups.

The common findings and patterns identified from existing fire research on these six themes are summarized in this review. Overall, a majority of the public understands fire risk, behavior, and ecology, and recognizes that prescribed fires are important in managing wildlife. Members of the public understand the shared risk across land ownerships and the shared responsibility to mitigate the fire risk on public or private lands; therefore, they support active fire management practices.

Federal, state and local governments can play a role in sharing the responsibility to mitigate the fire risk and are often responsible for providing educational materials on mitigating fire risk. Government agencies should improve their ability to communicate with landowners, visitors, and residents. The most important element in determining the trustworthiness and usefulness of an information source relies on personal interactions with trusted professionals.

Other key findings from the literature review found:

- Wildlife and habitat are held in high value along with other forest resources; potential detrimental effects on wildlife from fuels treatment practices are a concern among the public.
- Participation in education programs can effectively increase the public's knowledge and tolerance of use of prescribed fire.
- Prescribed burning and mechanical thinning are generally acceptable management practices to the public. What the public understands fuels treatment, and who is performing such treatment appear to be the major factors that govern public acceptance of the practice of fuels reduction.
- Smoke is not a significant barrier for the use of prescribed fire as a method to reduce wildfire risk for the majority of the Florida residents.
- As a tourism destination, smoke does have some impacts on certain inbound travelers that might result in canceled trips and modified destinations.

- Ethnicity and race are important socio-demographic characteristics that help explain variation in public views on fire management.

INTRODUCTION

In January 2014, the Florida Fish and Wildlife Conservation Commission (FWC) asked the School of Forest Resources and Conservation (SFRC) at the University of Florida for assistance with identifying how current research could best inform its education and outreach efforts to increase public understanding of fire's role in ecosystems and the benefits of fire management to ecosystems and public well-being. FWC funded a targeted review of scientific knowledge on public views and understanding of fire and management. In a recent national social science review, McCaffrey and Olsen (2012) targeted a series of topic questions synthesized for scientific knowledge of public views and understanding of fire and management. Most of those questions were applicable to fire and management issues in Florida. Our review is focused on the following themes based on the framework by McCaffrey and Olsen (2012):

1. Understanding of fire's role in the ecosystem
2. Perceptions of effects of prescribed fire on wildlife
3. Acceptance of fuels treatment
4. Trusted sources of information about fire
5. Cost and Responsibility
6. Differences among ethnic groups

A theme on the public's perceptions of effects of prescribed fire on wildlife was emphasized and several topic questions from their framework were consolidated into themes according to specific issues in Florida. This review addresses these theme topics through a summary of common findings and patterns identified from existing fire research.

METHODS

The process began by reviewing the theme topics of interests and making a list of relevant keywords that would be used in database searches, as well as a list of authors known for having contributed on the interested topics. Keywords included prescribed fire, wildlife, smoke, public perceptions, knowledge, ethnic, communication and fuels reduction. Based on the questions of interest and using keywords and author names, the literature search was conducted in several online databases (e.g., Google Scholar, OneSearch, and Treesearch). Searches were also conducted using commonly cited journals (e.g., Journal of Forestry, International Journal of Wildfire, Society and Natural Resources, and Wildlife Society Bulletin). To best represent current scientific knowledge, the searches were limited to publications after 2000 except for studies that address special issues directly relating to the topic or Florida. Article sources included journal articles, technical reports, working papers, book chapters, and conference proceedings.

A team of UF researchers conducted the literature search in spring 2014. A database was created in Excel to organize key interests related to the six-targeted themes (see Appendix I). This spreadsheet was then used as a guide to synthesize the relevant finding for each theme.

FINDINGS

In order to address each theme topic, we summarized key findings from existing research through the literature review. Our discussion of findings is organized according to these themes in the following sections. Many of the topics are interconnected among the studies. From a recent national review, Toman et al. (2013) indicated that overall social science studies on public and fire management in southern United States were only 12 percent and the majority of research (52 percent) was conducted in the west. In spite of the difference, their findings did not indicate an apparent shifting of key social dynamics across regions. Therefore, in our review, some studies conducted beyond Florida were also included.

1) Understanding of Fire's Role in the Ecosystem

In general, research show that the majority of individuals potentially affected by fire in forests have a reasonable understanding of fire ecology. In a study conducted in four western states, respondents showed reasonably high level of knowledge about fire; 79 percent understood that some plant species need fire to regenerate and 50 percent recognized that fires do not kill most animals and that fire can impact stream water quality (Brunson and Shindler 2004). In another survey conducted in the western United States, Toman and Shindler (2006) found that participants were highly knowledgeable about fire: more than 90 percent understood that fire had significant role in shaping forests and more than three-quarters understood that wildfire suppression increased fire risk. In another survey, respondents showed similar high level of knowledge: four-fifths of households correctly answered all seven local fire ecology questions (Collins 2009).

In Florida, surveys found that residents have good or, even, a sophisticated understanding of the factors that contribute to fire risk, behavior, and ecology (Agrawal and Monroe 2006, Monroe et al. 2006). For example, in a study of 80 homeowners in neighborhoods at risk of wild fire in north central Florida, Monroe et al. (2006) found that the majority (84%) of respondents were aware of their risk of wild fire and had a sophisticated understanding of various environmental conditions that influence their risk, including fire behavior, forest ecosystem, or climate. Despite residents' knowledge of fire, this study found that people still had misconceptions and concerns about wild fire behaviors. For example, "those who knew a fire had jumped a six-lane highway…did not believe that 30 feet of defensible space would reduce their risk" (Monroe et al., 2006). Results indicated that most respondents had taken some action to reduce their risk. The three most popular actions in north central Florida were reducing vegetation near the home, installing a water source, and reducing vegetation far from the house. From observing properties in study sites, they found most homeowners might not be doing enough to effectively reduce their risk. The study suggests that agency materials should target specific wildfire prone problems in an ecosystem and methods to reduce the risk of those problems, and that agency's effort on communication

with the public should focus on "what they know, what they don't know, and what they care about" (Monroe et al., 2006).

In a survey of 673 rural and suburban Florida residents living in counties that experienced severe wildfire, Jacobson et al. (2001) assessed residents' knowledge of fire. They found that over two-thirds of respondents accurately answered six technical questions regarding the science of fire in Florida. Also, over 79 percent of the respondents knew that fire helps renew forests; 67 percent understood that fire is useful in creating wildlife habitat; and 63 percent knew the correct definition of prescribed fire.

In a more general study assessing public knowledge about ecosystem management on Department of Defense land in Florida, Jacobson and Marynowski (1997) found that respondents had some basic ecological knowledge and held positive attitudes toward native and endangered species conservation and ecosystem management. The authors suggest that most respondents are a stable, educable population that would respond positively to programs designed to improve knowledge of and attitudes toward ecosystem management goals.

In fact, Agrawal and Monroe (2006) examined how to better communicate and educate homeowners regarding fire. In a study of 3,744 homeowners in 7 neighborhoods of 3 communities, Agrawal and Monroe used a mail-back questionnaire to examine individuals' perception of wildfire risk, participation in wildfire education programs, steps taken to reduce risk of wildfire, and involvement and perception of their community. Results found community activities that encouraged participation, interaction, and communication, such as, talking to neighbors, friends, or community leaders, or participating in a wildfire preparedness event, attending a firewise program, and seeing others involving in fire risk reduction activities, were the most effective methods to improve homeowners' knowledge about of wildfire risk to their homes and the associated environmental conditions.

Studies also suggest that the public's knowledge about fire and its support for various fire management practices can be significantly raised using educational efforts. In a study of residents' knowledge and attitudes toward wild and prescribed fire via pre- and post- surveys covering nine counties in central Florida, Loomis et al. (2001) found that residents became more knowledgeable and supportive of prescribed fire after respondents received basic educational information and illustrations about wild and prescribed fire. The proportion of residents who think prescribed fire effectively reduces the amount of excess fuels in the forest increased from 71 percent to 89 percent. The proportion of residents who though prescribed fire was too dangerous to be used reduced from 28 percent to 18 percent once educational information was introduced. Studies conducted in other states showed a similar pattern. In Oregon and California, exposures of educational information significantly increased both participants' understanding and support among those with lower level of knowledge of fire and support for fire management. Also, Parkinson et al. (2003)

found that participants in Idaho after participatory workshops resulted in significant increase in both knowledge of fire and supportive attitudes towards fire management.

Overall, studies show clear evidence that members of the public understand fire risk, behavior, and ecology. In particular, those who live in high risk of wildfire areas, often exhibit fairly high level of knowledge of fire ecology. Studies also suggest that exposure of education information about wild and prescribed fire, social engagement in neighborhoods, and participation in community fire programs can effectively increase the levels of knowledge and support for fire management.

2) Perceptions of the Effects of Prescribed Fire on Wildlife

Prescribed burning is an important tool for wildlife management; and prescribed fires affect the variety and quantity of food and cover for wildlife by modifying habitat structure therefore impact the wildlife community (Cain et al. 1996). For example, in a study of wildlife response to prescribed fire, Main et al. (2002) found that maintaining a regular prescribed fire rotation of less than 48 months actually improve habitat quality of pine flatwoods for white-tailed deer, wild turkey, and other wildlife in southwestern Florida. In another study, in southern Florida, where amphibians and reptiles are rich and abundant, Russell et al. (1999) found that a 5- to 7-year prescribed burn cycle can effectively maintain diverse herpetofaunal communities in the sandhills of southern Florida. However, use of large-scale

prescribed fire presents complex issues with potential long-term effects on all forest resources including wildlife, and it is necessary to understand the range of these effects on all resources and values before implementing prescribed fire in a large scale (Tiedemann et al. 2000).

From social science perspective, studies found that respondents had mixed views on the effects of prescribed fire on wildlife. DeLorme at al. (2005) found that despite the majority of central Florida participants understood and accepted prescribed fire, they clearly perceived its dangers to wildlife. Also in Florida, surveying 673 rural and suburban residents living in counties that experienced severe wildfire, Jacobson et al. (2001) found the majority of residents (67 percent) understood that fire is useful in creating wildlife habitat. In a survey of Wildland-Urban Interface (WUI) residents in northern Michigan who participated in nearby outdoor recreation activities, Kwon et al. (2008) found that participants generally believed that prescribed fires would improve wildlife conditions. In particular, participants who were hunters and anglers were more likely than wildlife viewers to believe prescribed fire to be beneficial for wildlife. In northeastern Oregon, examining public perceptions of prescribed fire in Blue Mountains region, Toman et al. (2004) found that 70 percent respondents believed prescribed fire caused acceptable changes for wildlife.

In their focus group study of WUI residents in four states (California, Florida, Michigan, and Missouri), Winter et al. (2006) found that many people already understand the diversity of

positive outcomes of fuel reduction treatments. In fact, respondents showed that they expect the fuels reduction treatment to improve certain ecosystem conditions including wildlife. Specifically, large proportions of WUI residents from each study state believed it was highly likely that prescribed fire results in improved conditions for wildlife. Also, large proportions of residents in Florida held strong beliefs that mechanical fuels reduction also improves wildlife conditions among other positive outcomes. They suggested that the beliefs of likely outcomes of fuels treatment are associated with the attitudes towards the practice; therefore, that residents require being informed how fire management activity e.g., prescribed fire, will affect them and their forest community including impacts to wildlife among others. Specifically, residents in California and Michigan who believed that prescribed fire improved wildlife conditions had a positive connection to approve the fuels treatment practice, but interestingly no effect in Florida and Missouri. In another study, surveying 48 visitors in three state parks in eastern Texas, Rideout et al. (2003) found that those respondents who believed prescribed fire creates wildlife habitat and other positive outcomes were very likely to support the prescribed burn practice. However, from the same study, they also found that respondents who believed prescribed fire harms wildlife showed reluctance to support the use of prescribed fire because of their beliefs of high risks associated with prescribed fire.

A number of studies found that respondents placed high value on wildlife and they were concerned about fuels treatment practices that could harm wildlife and habitat (Bright et al. 2007, Cortner et al. 1984, Jacobson et al. 2001, Lim et al. 2009, Miller et al. 2002, Nelson et al. 2005, Patel et al. 1999, Ryan and Wamsley 2008, Taylor et al. 1986); and others found that wildlife is among the highest concerns for both prescribed fire and mechanical treatment (Blanchard and Ryan 2007, Jacobson et al. 2001, Monroe et al. 2006, Nelson et al. 2005, Shindler et al. 2009). For example, in a study of interviewing 80 WUI homeowners in northern Minnesota and central Florida, Nelson et al. (2005) found that respondents not only understood their natural landscape providing wildlife habitat but also strongly valued wildlife and habitat among other qualities such as privacy, aesthetics, and recreation. They also found that residents were concerned about prescribed burning because of fear for wildlife. When discussing the application of herbicide for vegetation management in Florida, more than 50 percent of the respondents were strongly against its use because they worried about the risk to wildlife and other inhabitants as well as groundwater contamination. In a national survey to examine the differences of public response among three ethnic groups (African American, Hispanics, and Caucasians), Lim et al. (2009) found that African American and Hispanics were significantly less likely than Caucasians to approve prescribed fire practice and more concerned about harm to wildlife, smoke, and aesthetics.

In Oregon, interviewing 60 forest owners, Fisher (2011) found that owners who concerned about the wildlife and ecological values were one and half times more likely to adopt mitigation treatments such as prescribed

burn than those who concerned about timber production, livestock, and enjoying recreation and scenic beauty.

Study shows that the levels of knowledge about prescribed fire are associated with the levels of concerns about the impacts of prescribed fire on wildlife. In a survey of residents and landowners of southeastern Massachusetts, Blanchard and Ryan (2007) found that a high degree of knowledge was associated with lower concerns about the impacts on wildlife and their habitat. Also, residents who experienced wildfire had lower concerns about several risks of prescribed fire e.g., damage to wildlife habitat among others. In a survey of 193 Arizona residents, Taylor and Daniel (1984) found that education material including fire effects on wildlife could increase the public's knowledge and tolerance of use of prescribed fire. In another study, McCaffrey (2004) surveyed 643 property owners in Nevada and found that educational materials about prescribed fire made participants more likely believe that prescribed fire improves wildlife habitat.

Overall, studies show that the majority of the public understands that prescribed fires are improving wildlife conditions, and believes that prescribed burning causes acceptable changes to wildlife. Meanwhile, individuals hold high value on wildlife and concern about fuels treatment practice to harm wildlife and their habitat. For those who hold negative attitudes toward prescribed fire, one of the main reasons is the concern and fear of damage to wildlife and habitat. Studies also suggest that higher level of knowledge and experience of

prescribed fire actually made people less concerned about the impacts of prescribed fire to wildlife. Effective education programs can improve public understanding the benefits of prescribed fire on wildlife therefore generate more support for the practice.

3) Acceptance of Fuels Treatments and Smoke concerns

A variety of research has examined means to reduce fuels in forest ecosystems such as prescribed burning, mechanical thinning, and use of herbicides. Specifically, after 80 residents who lived in neighborhoods at risk of wildfire in northern Minnesota and north central Florida, Monroe et al. (2006) found that most people accepted fuel treatments, such as prescribed fire and mechanized thinning. When commenting about specific management practices to reduce wildfire risk, the respondents clearly differentiated between prescribed fire, mechanized thinning, and herbicide use for reducing vegetation. Nearly all respondents (91 percent in Minnesota and 96 percent in Florida) thought prescribed burning was effective. In terms of thinning or mechanical removal of vegetation, more than half of the homeowners were supportive of thinning (68 percent in Minnesota, 57 percent in Florida). People who were against mechanized thinning, wanted the forest to be natural or believed that thinning would not have much effect on reducing the wildfire risk. When asked about the use of herbicides for vegetation management in Florida, participants had dramatically different perceptions when

compared to prescribed burning and mechanized thinning. Only 7 percent of participants approved of herbicide use, with most people rating the practice low. Groundwater contamination and the risk to wildlife and other inhabitants were the major concern. From this study, the authors suggested that managers should have a good communications with neighbors of properties that require treatment to reduce fuel. The emphasis of communication should be on the qualifications and experience of the staff who will perform the treatment as well as the explanation of short- and long-term consequences of the method used and the risk involved.

In another study of 4,850 residents in fire-prone wildland/urban interface sites in California, Michigan, and Florida, Fried et al. (2006) found that responses from different regions showed significant differences in fire-related beliefs, attitudes, experiences and acceptance of fuel management approaches. On average, California wildland/urban interface residents had strong positive attitudes towards mechanized thinning to reduce vegetation on public lands (5.8 on a 7-point scale), while Florida residents had a strong positive attitudes towards prescribed burning (5.7 on a 7-point scale). Michigan wildland/urban interface residents were merely positive towards mechanized thinning (5.0 on a 7-point scale). They were also relatively neutral on prescribed burning method.

In a sense, to see other national studies, there is a pattern showing that the relative location of a treatment appears to relate treatment

preference. In general, studies have indicated a preference for use of mechanized thinning to reduce vegetation in more populated areas while for prescribed fire in more remote areas (Brunson and Shindler 2004, Borrie et al. 2008, Paveglio et al. 2010, Ryan et al. 2006). However, several studies conducted in parts of eastern, western and mid-western states found that participants preferred use of both practices together (Kent et al. 2003, McCaffrey et al. 2008).

With regards to the general acceptance of fuels treatment, respondents clearly showed their concerns of the potential consequences of treatment. In spite of fairly high acceptance level of prescribed fire as a practice of fuels treatment, risk of escape is the major concern. In a study of 80 residents who lived in neighborhoods at risk of wildfire in northern Minnesota and north central Florida, Monroe et al. (2006) found that nervousness about burning too close to homes and concerns about burning getting out of control were the main issues for people who were less supportive to prescribed fire as the way to reduce the wildfire risk. Other studies found that erosion is usually the dominant concern with mechanized thinning treatments; and wildlife is often the next major concern for both prescribed fire and mechanized thinning methods followed by aesthetics (Blanchard and Ryan 2007, Jacobson et al. 2001, Shindler and Toman 2003, Shindler et al. 2009). More studies about effects of prescribed fire on wildlife were included in Theme 2.

Studies also illustrated awareness of positive outcomes of fuels treatment among

respondents towards the practice. For example, in their focus group study of WUI residents in four states (California, Florida, Michigan, and Missouri), Winter et al. (2006) found that many people already understand the diversity of positive outcomes of fuel reduction treatments. In fact, respondents showed that they expect the fuels reduction treatment to improve certain ecosystem conditions. Specifically, large proportions of WUI residents from each study state believed it was highly likely that prescribed fire results in reduced costs of future firefighting, less smoke over the long term, improved conditions for wildlife, and more natural forests. Also, large proportions of residents in Florida held strong beliefs that each of the four positive mechanical fuels reduction outcomes: saves money on future firefighting; extracts usable wood products; improves wildlife conditions; and restores the forest to a more natural condition.

Generally, people will accept fuels treatment if they have knowledge of the treatment practice and trust the agency and individuals who perform the practice. Several studies conducted in western states and one study in the eastern states demonstrated that higher levels of knowledge were most commonly associated with higher levels of acceptance. (Absher and Vaske 2006, Blanchard and Ryan 2007, Brunson and Shindler 2004, McCaffrey 2004, Parkinson et al. 2003, Shindler and Toman 2003).

In Florida, in a study of 43 homeowners at risk of wildfire, Monroe et al. (2006) found that public acceptance of fuels reduction treatment is largely influenced by perceptions of agencies and the individuals who are performing the practice. Most people approved land fuels treatment including prescribed burning and mechanical thinning, "as long as they were done by knowledgeable people, preferably local individuals who knew the land" (Monroe et al., 2006). In another study, surveying homeowners living in WUI areas of California, Michigan, and Florida, Fried et al. (2006) found positive statistical relationships between the trust in agencies to perform a practice and treatment acceptance or approval, i.e., the higher levels of trust the higher levels of acceptance.

In another perspective, few studies focused on liability issues for prescribed burning on private and public land. In a study of nation-wide liability or property rules, Yoder et al. (2004) suggested that while prescribed burning provides broad public benefits such as reduction of wildfire risk and enhanced ecosystem health, the application of liability rules by courts often discourages its application as a fuels management option.

In Florida, studies have focused on smoke issues related to prescribed burning, which were part of several questions related to fire and fuels management (Jacobson et al. 2001, Loomis et al. 2001, Vogt et al. 2005). These studies suggest that people are concerned about smoke, but it is not a high priority. In their study of 1,492 residents in nine Florida counties, Loomis et al. (2001) found that 34 percent of respondents indicated relatively a high level of concern about prescribed fire smoke due to its potential health problems. From the same study, the authors concluded

that generally more knowledge of and/or experiences with prescribed fire are associated with less concern about smoke. In another study of 1,120 rural and suburban residents of north and central Florida, Jacobson et al. (2001) found that 79 percent of respondents believe that individuals who choose to live near natural areas should accept smoke from fire. Winter et al. (2006) also found that in Florida 72 percent of respondents believe prescribed fire would eventually help reduce in less smoke.

One study in particular addressed public response to wildfire smoke. In their study of surveying 771 non-resident travelers who had previously visited Florida, Thapa et al. (2013) found that smoke concerns such as, health problems, automobile accidents, and general smoke impacts the cautious type of traveler greatly. This segment of travelers was more likely to change their travel behaviors due to smoke concerns, as 46 percent would cancel the trip, 47 percent would change the destination, and 41 percent would change activities. Even among the courageous type of travelers, 5 percent would cancel their trip and roughly one-third would change their destination.

Overall, studies show that the public generally finds prescribed burning and mechanical thinning as acceptable management practices, particularly in Florida. As they better understand the practices and trust the agencies, the public is more likely to accept the practice of fuels reduction. However, risk of escape, erosion, and impacts to wildlife are the major concerns associated with fuels treatment practices. Studies suggest that people's fear of

smoke should not be seen as a rationale to reduce the use of prescribed fire as the method to reduce wildfire risk. Benefits in improving ecosystem health and reducing future wildfire risk tend to outweigh smoke concerns. As a tourism destination, fire smoke does have some impact to certain travelers resulting in canceled trips and modified destinations.

4) Trusted Sources of Information

The public generally prefers government agencies to provide information on fire issues (Jarrett et al. 2009, Monroe and Nelson 2004). In a study of private forestland owners in Alabama, Florida, Georgia, Mississippi, and South Carolina to identify their perceptions, awareness, and adoption of wildfire prevention and mitigation programs, Jarrett et al. (2009) found that state forest agencies (38 percent) were the most popular sources for information regarding wildfire prevention for private forestland owners, followed by friends and family (25 percent) and state or county extension offices (24 percent). The least popular information source was federal agencies (9 percent). They also found that the most preferred way to receive information on wildfire prevention and mitigation was by consulting with professionals (54 percent), followed by informational pamphlets (36 percent), workshops (23 percent), and the Internet (12 percent). This study suggests that personal consultation with either government-employed professionals or private consulting foresters is a preferred way to communicate

with landowners about wildfire prevention and mitigation.

In another study to understand residents' perceptions of their landscape, risk, and their willingness to reduce that risk in forested areas of Florida and Minnesota, Monroe and Nelson (2004) phone-interviewed 80 homeowners and found that respondents trusted agency sources for information about reducing their risk of wildfire, but preferred the news media for the information about current fire updates. In California, Winter and Cvetkovich (2010) found that top five preferred sources for information about fire by the respondents were Forest Service public meetings, community meeting, websites, brochures, and articles in the local paper. These findings show that the variability of sources of information for fire risk and the use of sources vary by locations.

In a study of private forestland owners in five southern states (i.e., Alabama, Florida, Georgia, Mississippi, and South Carolina), Jarrett et al. (2009) also found a preference for one-on-one interactions between landowners and forest professionals in communicating about fire risk information. It was suggested that personal relationships with agency personnel can be important for landowners in judging the trustworthy of the information about wildfire and taking appropriate actions to prevent wildfire. In another study of 80 homeowners in Florida and Minnesota, Nelson et al. (2004) found that while homeowners understood the risk of fire, they varied in their perceptions of effective wildfire prevention measures and willingness to take actions to reduce the risk. The study suggests that acknowledging the

complexity of wildfire risk and implementing specific mitigation methods, such as techniques to create defensible space while maintaining homeowner highly valued landscape, can improve the interactions between managers and homeowners.

In four western states, Idaho, Nevada, Oregon and Utah, Shindler et al. (2011) found that a positive citizen-agency interaction was significantly correlated with high acceptance of prescribed fire application for both urban and rural residents. In Toman et al.'s study (2008), after participating in a U.S. Forest Service organized postfire field tour, more than 60 percent of participants considered that the direct interaction with Forest Service personnel was the most valued element of post-fire field tour. Results also showed that participants were more supportive of fuels treatments and more confident in the Forest Service's abilities to manage fuel after participating in the tour. In spite of respondents' preference for one-on-one interactions with government agency representatives, Agarwal and Monroe (2006) found that neighbors and community leaders could be influential information sources to help homeowners gain the knowledge about wildfire risk through community activities.

Overall, research shows that people use a variety of information to learn about fire, but they generally trust government agencies (particularly state forest agencies). Also, the most important element in determining the trustworthy and usefulness of an information source relies on personal interactions with trusted professionals.

5) Cost and Responsibility

The majority of studies focused on public knowledge about fire, perceptions of effects of prescribed fire on wildlife, acceptance of fuels treatment, and trusted sources of information. There are limited studies focused on the public perception of cost related to wildfire or prescribed fire.

In a study of WUI residents of California, Florida, and Michigan, Winter et al. (2006) found that cost-effectiveness of an action, particularly its ability to reduce future wildfire costs, was an important consideration for the public. Their research shows cost considerations, such as costs of an escape, physical resources to do the job, were frequently discussed in focus groups. From the follow-up survey, more than 50 percent of respondents at each site (Missouri was added to the original three states) believed that mechanical thinning (53 to 76 percent) and prescribed burning (50 to 80 percent) would save money by reducing the cost of fighting a future wildfire, and rated it as an important outcome. In California, Florida, and Michigan, the belief that saving money was a likely outcome of a fuels reduction practice was positively associated with its acceptance of use. The notion that it is better to pay now to reduce fuels for wildfire risk than pay more later to fight fires coincided in ten focus groups conducted in Montana and Washington (Weisshaupt et al. 2007). From the same study, it was also found that participants had positive views about defensible space and believed

creating defensible space was a cost-effective activity.

From another perspective, focusing on the economic impacts of six weeks of large, catastrophic wildfires in northeastern Florida in 1998, Butry et al. (2001) modeled and analyzed the consequences of wildfires after strong El Nino-Southern Oscillation in 1998. They found that the Florida wildfires resulted in economic impacts of a minimum of $600 million, which is similar to the costs of recent category-2 hurricanes. The study suggests that a better understanding of the interactions between management, wildfire, and its costs is important to identify optimal intervention activities.

Overall, studies suggest that cost can be an important factor for fire mitigation efforts. Fuels treatments as well as defensible space are considered as cost-effectiveness in long-term benefits. The majority of public believe that the fire mitigation efforts will reduce the costs on future wildfires.

Several studies examined issues on responsibilities for home and property protection and mitigation. When asking participants in California, Montana, and Florida who (homeowners versus firefighters) was "most responsible for protecting private property from wildfire", McCaffrey and Winter (2011) found that the majority of participants put more (35 percent) or all (23 percent) of the responsibility on homeowners while about one quarter of respondents put equal responsibility on both homeowners and firefighters. In a study over WUI residents in western states via

focus group interviews, McCaffrey et al. (2011) found that most participants believed that the responsibility for wildfire mitigation and for fire management should be shared. In the meantime, respondents recognized that landowners, whether private or public, are primarily responsible for taking care of their property. Studies conducted in California, Florida, Minnesota, and Montana, further supported the sense that homeowners see themselves as responsible for mitigating fire risk on their property (McCaffrey and Winter 2011, Monroe and Nelson 2004). In their studies focused on defensible space, about two thirds of homeowners in areas at significant fire risk were undertaking a variety of fuels treatments and other defensible space measures on their property. However, in a study of six communities with WUI neighborhood at risk of wildfire in six states including Florida, Shiralipour et al. (2006) found that concern about fuel treatment actions on adjacent properties, whether the land was private or public, was an important consideration whether individuals believed they could effectively create defensible space. Concern about adjacent public land was about fairness; when the government asks residents to take care of their property, the government itself should be doing the same on the public land it manages (Winter et al. 2009).

In a study of private forestland owners in Alabama, Florida, Georgia, Mississippi, and South Carolina to identify their perceptions, awareness, and adoption of wildfire prevention and mitigation programs, Jarrett et al. (2009) found that state forest agencies were the most popular source for the information regarding

wildfire prevention for the private forestland owners. The 2009 Jarrett study suggests that relevant government agencies have some responsibilities for providing educational materials and advices to homeowners about reducing the wildfire risk. In another study to understand residents' perceptions of their landscape, risk, and their willingness to reduce that risk in forested areas of Florida and Minnesota, Monroe and Nelson (2004) phone-interviewed 80 homeowners and found that respondents trusted government agency sources for information about reducing their risk of wildfire. This further support the idea that government agencies have the responsibility to implement communication tools to encourage new behavior and enable themselves to craft a message that will be better heard and that helps to generate greater acceptance.

From a different perspective, Newman et al. (2011) examined land development patterns relation to community's adaptive capacity for wildfire in Lee County, Florida. The study suggests that structural conditions, such as development patterns, biophysical conditions, and demographics/socioeconomics, influence adaptive capacity and helps to identify local social characteristics and processes that support adaptation for the risk of wildfire.

Overall, studies show that the majority of the public recognizes the responsibility to mitigate fire risk is shared among all landowners. To most effectively implement fuels reduction measures across ownership boundaries, it is not only important to recognize the shared responsibility as fire does not recognize

property lines, but also recognize that actions taken on adjacent property can affects one's fire risk. Government not only can play a role in sharing the responsibility to mitigate fire risk, but it is also responsible to provide educational materials on mitigating fire risk and to enable itself to better communicate with landowners.

6) Differences among Ethnic Groups

In their national review of research perspectives on public and fire management, McCaffrey and Olsen (2012) found that contrary to common belief, geographic and social-demographic differences are rarely key factors in terms of fire management knowledge, attitudes, or actions. Limited research is beginning to suggest that ethnic group membership, culture, and worldview might be more meaningful as the key determents for the response difference in fire management knowledge, attitudes, and or actions. However, this research is still relatively new and more studies are needed.

In a survey to examine landowner awareness and adoption of wildfire programs in five southeastern states including Alabama, Florida, Georgia, Mississippi, and South Carolina, Jarrett et al. (2009) found significant different perception and experience with wildfire among races. White landowners were found more likely than nonwhite landowners to believe wildfire as a threat to their forests. They are also more likely than nonwhite landowners to have experienced wildfire and used program information about wildfire. However, white landowners were less likely to participate in

educational programs on fire mitigation programs than other races studied whereas nonwhite landowners were more knowledgeable than white landowners about these programs.

In a related study, Wyman et al. (2012) surveyed rural forestland owners in north central Florida and found that while Whites were more aware of existing resources, they tended to be less likely to incorporate preventive measures than Black residents. On the other hand, Black residents earned lower incomes and utilized their land less, but were more likely to manage and live on their land. The authors suggest that wildfire mitigation programs might be more effective when they work to connect White absentee rural landowners to their land.

Regarding to the different attitudes among ethnic groups towards effects to fuels treatment on wildlife and habitat, detailed discussions are included in Theme 2.

From a different aspect, Gaither et al. (2011) examined spatial and social vulnerability of wildfire in six southeastern states including Alabama, Arkansas, Florida, Georgia, Mississippi, and South Carolina. The study suggests that poorer communities in the Southeast, with high wildfire risk, might be at a greater disadvantage than more affluent, high fire risk communities in these states.

Overall, research suggests that demographic and geography differences in public response to fire management are difficult to attribute to easily measureable variables. Ethnicity and race

do affect people's perceptions of wildfire and fire management techniques.

CONCLUSIONS

The majority of the public understands fire risk, behavior, and ecology. In particular, for those who live in areas of high risk of wildfire, individuals often exhibit fairly high and sophisticated understanding of fire ecology. Exposure to education and information and participation of community fire programs can effectively increase the levels of knowledge and support for fire management. In the meantime, members of the public understand the shared risk across land ownerships and the shared responsibility to mitigate the fire risk on public or private lands; therefore, they are more likely to support active fire management practices.

The majority of the public also understand prescribed fire can improve wildlife conditions. Individuals hold high value on wildlife and are concerned about fuels treatment practice potential to harm wildlife and habitat. Studies also suggest that higher level of knowledge and experience of prescribed fire actually made people less concerned about the impacts of prescribed fire to wildlife. Effective education programs can improve public understanding the benefits of prescribed fire on wildlife therefore more supportive for the practice.

There are various fire information sources people seek for and find helpful. Two patterns are present. Government sources are generally a preferred information source and people tend to rate these highly, but some agencies were more trusted than others. The most important element in determining trustworthy and

usefulness of an information source relies on the interactive capacity (i.e., personal interaction) it provides.

Prescribed burning and mechanical thinning are generally acceptable management practice by Florida residents. Levels of understanding of a practice, particularly its ecosystem benefits, and levels of trust in those performing a practice are the major factors that govern public acceptance of fuels reduction practices. In fact, the public is more likely to support active land management to achieve healthy ecosystems and reduced wildfire risk, rather than activities that might be conceived as passive land management.

Most studies show that smoke is not a significant barrier for the use of prescribed fire as a method to reduce wildfire risk for the majority of the population. The benefits in improving ecosystem health and reducing future wildfire risk outweigh smoke concerns. However, communication with affected residents must be in place to ensure residents understand smoke is resulting from prescribed fire. As a tourism destination, smoke does have some impact to certain travelers in resulting canceled trips and modified destinations.

Finally, there are several areas that lack enough research, but are important in better understanding the public's attitudes and perceptions related to fire. For example, more work is needed to further understand how the public views the trustworthiness of the information source and its usefulness as it relates to fire management. Related to this, research should also examine how to build

better communication with information sources, in particular government sources, to cultivate trust, improve relationships, and build support for fire management practices. In addition, more research are needed on ethnic group membership, culture, and worldview, which might be the key factors explaining the response difference in fire management knowledge, attitudes, and or actions.

Even though the majority of public is fairly knowledgeable about fire risk, behavior, and ecology, more work is needed to better understand how the public views the effects of fire on wildlife, in particular on endangered species and their habitat. Prescribed burning and mechanical thinning are the two fuels reduction methods accepted by the public in Florida. However, there is still a lack of understanding about how the public in different geographic settings views the risk and benefits of other methods. As the public is becoming more involved in fire management activities and more knowledgeable and supportive for fire mitigation practice, a better understanding these questions could help to build that support and implement programs and policies that can effectively maintain the health of ecosystem and reduce fire risk.

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APPENDIX I. SUBJECT AREA GUIDE

This subject area guide was created to guide the development of the review of social science research finding since 2000 (with some exemptions). In total, 69 articles were selected for analysis according to the six themes: understanding of fire's role in the ecosystem, perceptions of effects of prescribed fire on wildlife, acceptance of fuels treatment, trusted sources of information, cost and responsibility, and differences among ethnic groups.

This subject area guide, reflecting the six-targeted theme topics, indicates the topics addressed in each article and provides a basic description of the methods, study sites, and the general topics.

APPENDIX I. SUBLECT AREA GUIDE

Author	Study Site	Method	General Topics	Theme
Absher & Vaske 2006	CO	Survey	Defensible space Communication	Acceptance
Agrawal & Monroe 2006	FL	Survey	Communication Defensible space	Understanding
Blanchard & Ryan 2007	MA	Survey	Fire management Defensible space	Acceptance Responsibility
Blatner et al. 2003	WA	Interview	Fire management	Understanding
Borrie et al. 2008	MT	Survey	Prescribed fire Wildness visitors	Understanding Acceptance
Brenkert-Smith 2011	CO	Interview	Defensible space	Understanding
Bright et al. 2007	CO	Survey	Prescribed fire	Wildlife
Bright & Newman 2006	CO	Survey	Fire management Defensible space	Acceptance
Brunson & Shindler 2004	AZ, CO, OR, UT	Survey	Fire management	Understanding Acceptance
Burns & Cheng 2007	CO	Interview	Fuels management	Understanding
Butry et al. 2001	FL	Analysis	Wildfire impact	Cost
Cain et al. 1996	AK	Experiment	Prescribed fire	Wildlife
Carroll et al. 2005	AZ	Interview	Fire experience	Understanding
Cohn et al. 2008	AZ, CO, ID, MT, UT	Interview	Fire experience	Understanding
Collins 2009	AZ	Survey Observation Interview	Defensible space	Understanding
Cortner et al. 1984	AZ	Survey	Prescribed fire	Wildlife
DeLorme et al. 2005	FL	Focus group	Prescribed fire	Wildlife
Daniel 2006	MN	Survey	Forest management	Acceptance
Fisher 2011	OR	Interview	Prescribed fire	Wildlife
Fried et al. 2006	CA, FL, MI	Focus group Survey Analysis	Prescribed fire Fuels management	Acceptance
Gaither et al. 2011	AL, AR, FL, GA, MS, SC	Analysis	Fire risk	Difference

(Appendix I continued on next page)

Author	Study Site	Method	General Topics	Theme
Jacobson & Marynowski 1997	FL	Survey	Ecosystem management Fire management	Understanding
Jacobson et al. 2001	FL	Survey	Defensible space	Acceptance Understanding Wildlife
Jarrett et al. 2009	AL, FL, GA, MS, SC	Survey	Fire management Communication	Information Responsibility Difference
Kwon et al. 2008	MI	Survey	Prescribed fire	Wildlife
Kent et al. 2003	CO	Interview Focus group	Fuels treatment Defensible space Communication	Acceptance
Lim et al. 2009	Multiple	Survey	Prescribed fire	Wildlife
Loomis et al. 2001	FL	Survey	Prescribed fire Educational materials	Understanding Acceptance
Main et al. 2002	FL	Experiment	Prescribed fire	Wildlife
McCaffrey 2004	NV	Survey	Fuels treatment Defensible space Communication	Acceptance Wildlife
McCaffrey 2008	AZ, CA, CO, MT, NV	Focus group	Defensible space Risk perception	Understanding Responsibility
McCaffrey et al. 2008	CA	Survey	Fuels treatment	Acceptance
McCaffrey & Olsen 2012	Multiple	Synthesis	Multiple	Multiple
McCaffrey et al. 2011	ID, OR, UT	Interview	Defensible space Fire management	Responsibility
McCaffrey & Winter 2011	CA, FL, MT	Survey	Defensible space Evacuation	Responsibility
Miller et al. 2002	IL	Survey	Prescribed fire	Wildlife
Monroe & Nelson 2004 Monroe et al. 2006 Nelson et al. 2004	FL, MN	Interview Survey	Fuels management Defensible space	Understanding Information Acceptance Responsibility
Newman et al. 2013	FL	Focus group	Fire management	Responsibility
Olsen & Shindler 2010	OR	Survey	Fire management	Acceptance
Parkinson et al. 2003	ID	Workshop	Education	Understanding
Patel et al. 1999	Canada	Focus group	Prescribed fire	Wildlife
Paveglio et al. 2010	WA	Focus group	Fire management Communication	Understanding Acceptance

(Appendix I continued on next page)

Author	Study Site	Method	General Topics	Theme
Rideout et al. 2003	TX	Survey	Prescribed fire	Wildlife
Russell et al. 1999	FL	Experiment		
Ryan & Wamsley 2008	NY	Survey	Fire management	Wildlife
Ryan et al. 2006	MA, NY,		Defensible space	Acceptance
Shindler et al. 2011	ID, NV, OR, UT	Survey	Fuels management	Information Acceptance
Shindler & Toman 2003	OR, WA	Survey	Fuels treatment	Information Acceptance
Shindler et al. 2009	MI, MN, WI	Survey	Fire management Communication	Information Acceptance
Shiralipour et al. 2006	AK, CO, FL, NJ, SD, TX	Interview	Fire management Communication	Responsibility
Taylor & Daniel 1984	AZ	Survey	Prescribed fire	Wildlife
Taylor et al. 1986	AZ	Survey	Prescribed fire	Wildlife
Tiedemann et al. 2000	Multiple	Analysis	Prescribed fire	Wildlife
Thapa et al. 2013	FL	Survey	Fire effect on visitor behavior	Acceptance
Toman & Shindler 2006	CA, OR	Survey	Fire management Communication	Understanding
Toman et al. 2004	OR	Survey	Prescribed fire	Wildlife
Toman et al. 2008	OR	Survey	Post-treatment tour	Information
Toman et al. 2013	Multiple	Synthesis	Multiple	Multiple
Vining & Merrick 2008	MN	Survey	Fuels management	Acceptance
Vogt et al. 2005	CA, FL, MI	Survey Focus group	Defensible space Fuels treatment	Acceptance
Weisshaupt et al. 2007	MT, WA	Focus group	Fire management	Understanding Cost
Winter & Cvetkovich 2007	AZ, CA, CO, NM	Survey	Fire management	Understanding
Winter & Cvetkovich 2010	CA	Focus group Survey	Defensible space Fire management	Information
Winter et al. 2009	CA, CO, MI, NM	Focus group Survey	Defensible space	Responsibility
Winter et al. 2006	CA, FL, MI, MO	Survey	Defensible space Fuels treatment	Acceptance Cost
			Prescribed fire	Wildlife
Wyman	FL	Survey	Fire management	Difference
Yoder et al. 2004	Multiple	Analysis	Treatment practice Liability	Acceptance