

Adaptive Participation in Forest Planning Contingent on a Hypothetical Large-Scale Forest Disturbance

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Abstract: Public involvement in management decisions is a vital requirement for successful adaptive forest management. I suggest that a critical and systematic examination is needed to understand why various publics become involved in forest-related management decisions and, more importantly, how public involvement in forest planning is likely to change under altered biophysical and social conditions caused by large-scale forest disturbances such as invasive species outbreaks. I address this need through a field-based stated preference experiment administered to three communities located near national forests within the eastern United States. I specifically examine three reasons that might compel individuals to become involved in forest planning: the loss of forest-related jobs, the loss of recreational amenities, and the loss of wildlife habitat and also examine the effects of gender on contingent behavior. The data suggest that all three potential losses have significant effects on individuals' behavioral intentions to participate in forest planning. The potential loss of wildlife habitat had the strongest influence on individuals' behavioral intentions. The potential loss of local forest-related jobs and recreational amenities had slightly less influence. Behavioral intentions to participate in forest planning also differed significantly by gender. The results suggest that changes in biophysical and social systems due to large-scale forest disturbances have the potential to dramatically alter public participation in environmental decisionmaking processes. Various factors, including the system properties likely to be affected, the extent to which those properties are affected, and the gender of potential participants, are likely to be key variables that result in new patterns of involvement in forest planning and management decisions. FOR. SCI. ■(■):000–000.

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DECADES OF SCIENTIFIC RESEARCH from the biological and physical sciences has led to a near consensus that climate change will affect forest ecosystems by altering the frequency, intensity, duration, and timing of large-scale forest disturbances such as fire, drought, and insect and pathogen outbreaks (Baker 1995). In response to the increased probability that forest ecosystems will experience increasingly severe and more frequent large-scale disturbances in the future, managers are searching for more adaptive forest policy and management responses (Millar et al. 2007). Specifically, past research on adaptive forest management suggests that when smaller, more localized levels of management have access to and control over decisionmaking capabilities, resource governance is more successful (Stringer et al. 2006). Concurrently, promoting and facilitating sustained local public participation can yield mutual benefits for both forest managers and stakeholders (Steelman 2001). Sustained public participation can lead to forest managers being more aware of alternative management approaches and how well those approaches will be socially accepted and to increased awareness of whether those strategies are likely to produce undesirable social or ecological consequences (Wondellick and Yaffee 2000). In short, with the knowledge that forest ecosystems will experience increasingly severe and more frequent large-scale forest disturbances in the years to come,

planners and managers should promote flexible environmental and natural resource laws, policies, and management systems capable of rapid response to social and ecological change (Millar et al. 2007); planners and managers should also promote and facilitate local public participation in management decisions (Koontz et al. 2004).

I suggest that a critical and systematic examination is needed to understand why various publics become involved in forest-related management decisions and, more importantly, how public involvement in forest planning is likely to change under altered biophysical and social conditions. Specifically, the purpose of this research is to understand how various changes in specific ecosystem services produced by forest resources influence individuals' willingness to become involved in forest-related management actions. I accomplish this by first reviewing existing literature on public participation in forest management with a focus on how individuals' willingness to become involved in forest-related management actions would change given various impacts to the biophysical and social properties of forests caused by large-scale disturbances. I then conduct a field-based contingent behavior experiment in three communities located near two national forests within the eastern United States. The research highlights the increasingly important role of engaging local publics in forest management decisions.

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Public Participation in Forest Planning Under Change

Public participation in forest planning has become an increasingly prevalent topic of scientific inquiry and theoretical debate since management agencies were explicitly required to give individuals and organizations access to the forest planning process. For federal lands and national forests within the United States, this mandate came with the passage of the National Environmental Policy Act of 1969 and the National Forest Management Act of 1976. The existing literature on public participation in forest planning is diverse, with little theoretical or empirical consistency. A large amount of previous research has attempted to discern the effectiveness of certain participation processes (e.g., task forces/advisory groups or workshops) relative to that of others (e.g., Halvorsen 2001, Steelman 2001, Webler et al. 2001). Another body of related scholarship has attempted to discern specific barriers to effective participation processes (e.g., Manring 1998, Wondelleck and Yaffee 2000, Germain et al. 2001, Davenport et al. 2007a, 2007b). However, little empirical research has attempted to identify specific motivations or held values that influence individuals' willingness to participate in forest planning and management activities (Cheng and Mattor 2006). Despite this fact, the diverse literature devoted to describing effective public participation processes has inferred, or indirectly identified, what some of these motivations or held values might be. Specifically, the factors influencing individuals' decision to participate are likely to include the following:

- the perceived ability to affect the decisionmaking process (Davis 1997, McCool and Guthrie 2001);
- perceptions of others involved in the planning process (Brandenburg and Carroll 1995, Wondelleck and Yaffee 2000);
- the level of trust placed in the management agency to acknowledge and accommodate their concerns (Lawrence et al. 1997, Smith and McDonough 2001); and
- the likelihood of incurring costs as a result of a management agency's subsequent actions (Stelman and Maguire 1999, Germain et al. 2001).

The latter two factors are particularly germane to this research because they imply that individuals cognitively evaluate and weigh perceived risks associated with nonparticipation against potential benefits of participation. In the broader social-psychological literature, for several decades this assumption has been central to understanding why individuals become involved in public or collective action initiatives (Olson 1965). With the knowledge that forest ecosystems are likely to change as a consequence of large-scale forest disturbances, individuals' perceptions of those changes (i.e., perceived risks) might play a large role in how willing they are to become involved in participatory forest management practices focused on mitigating or adapting to those impacts. The existing literature on how risk perceptions influence policy preferences and behavioral intentions can inform this proposition.

Risk Perceptions and Behavioral Intentions

The assumption that individuals cognitively assess the desirability and likelihood of possible outcomes resulting from their decisions is foundational in "all current theories of choice under risk or uncertainty" (Loewenstein et al. 2001, p. 267) as well as the expected utility model that informs much of economic and psychological theory. Individuals anticipate future risks on the basis of available information and act accordingly, depending on their preferences. These preferences are shaped by a variety of factors including individuals' personal values and worldviews (Mullainathan and Thaler 2000). For example, empirical evidence from several surveys of residents living near national forests in the United States has found individuals who hold strong values toward the anthropogenic benefits or services provided by public forests (i.e., valuing forests because they provide timber, minerals, and tourism opportunities) are more likely to prefer forest management actions that yield those benefits or services (Brown and Reed 2000, Clement and Cheng 2011). Conversely, those same individuals are much less likely to prefer management actions that conserve forestlands for wilderness or wildlife habitat. These findings would be expected under any social-psychological theory that suggests individuals' values are good predictors of their attitudes and behaviors (e.g., value-belief-norm theory, the theory of reasoned action, and the theory of planned behavior). These findings also suggest that the values individuals hold toward public forests are likely to influence their assessments of risk associated with large-scale forest disturbances, and, subsequently, their willingness to become involved in forest-related planning activities.

In this research, I discern between anthropogenic and biocentric forest values.¹ Whereas a vast amount of research has been conducted on environmental values and their influence on proenvironmental behaviors (Dietz et al. 2005), much less research has been done on various types of forest values and behavioral intentions to participate in forest planning. Existing research has tended toward behaviors or behavioral intentions of outdoor recreationists (e.g., Cottrell and Graefe 1997, Cottrell 2003). No research, to my knowledge, has examined the even more specific relationship of if and how certain forest values influence individuals' participation in forest planning activities; no logical assumption can be made either. Individuals who value public forests for their economic and recreational values (anthropocentric) could be just as willing to participate in forest planning activities as individuals who value public forests for the habitat they provide to wildlife (biocentric). Given this fact, my analysis of the relationship between various forest values (specifically the extent to which they are threatened under various future scenarios) and behavioral intentions should be seen as exploratory. More specific propositions can be drawn from my investigation of the relationship between gender and involvement in the forest planning processes.

Gender and Variations in Public Participation

Ensuring just and adequate access to public participation processes has been recognized by numerous scholars as a

critical factor influencing the social acceptability of decisions to come out of those processes (Daniels and Walker 1996, Wondelleck and Yaffee 2000). Frequently, research addressing stakeholder representation focuses on and defines various stakeholders according to their interests relative to a specific forest management decision (Grimble and Wellard 1997). Rarely is representation or participation in forest planning efforts evaluated relative to other criteria such as sociodemographic characteristics like age, education, or gender (Richardson et al. 2011). This research makes the contribution of understanding how engagement in forest planning activities contingent on degraded forest conditions varies relative to gender. A greater understanding of how behavioral intentions vary can give natural resource social scientists and resource managers some insight into if and why individuals are driven to become involved in forest planning activities for different reasons. In this research, I address three specific reasons that might compel an individual to become involved in forest planning: the loss of forest-related jobs, the loss of recreational amenities, and the loss of wildlife habitat. I focus on these three reasons because previous research has illustrated that individuals living near public forests perceive losses in these areas (jobs, recreation/aesthetics, and habitat) as losses to social welfare and, subsequently, are willing to alter their personal behavior to maintain the quality of these goods (Xu et al. 2003).

Past research on gender differences in public participation processes has focused on women's access to and influence on decisionmaking in developing countries (e.g., Agarwal 2001, 2009, Nuggehalli and Prokopy 2009). Given this fact, I inductively reasoned from more general studies of gender differences in environmental concern, environmental behavior, and public participation to discern whether gender differences would be expected or not. Generally, three trends have been noticed in the literature.

First, there is evidence to support differences in environmental concern or behavior relative to gender, so long as that concern or behavior is directed toward *local* issues. Consistently, women are more concerned about environmental changes that affect or are likely to affect their community or neighborhood relative to their male counterparts (Mohai 1992, Greenbaum 1995, Smith and Moore 2011). Regarding more *general* environmental changes and impacts, consistent gender differences have been found (again with women being more concerned), although the magnitude of the difference between genders is smaller (Davidson and Freudenburg 1996, Bord and O'Connor 1997, Dietz et al. 2002). Although this study does not explicitly address *environmental concern*, I believe that given the patterns observed in previous empirical work coupled with this study's focus on large-scale forest disturbances, we can expect there to be gender differences in individuals' behavioral intentions to participate in forest planning relative to potential economic, recreational, and ecological losses.

The second general trend noticed in the literature involves gender differences in concern over specific types of environmental values likely to be affected by changing

environmental conditions. Previous empirical work has consistently shown that men are more likely to be concerned over the loss of anthropocentric and utilitarian values than women, who, conversely, are more likely to be concerned over the loss of biocentric and intrinsic values (Mohai 1992, Davidson and Freudenburg 1996, Reed and Varghese 2007). Theoretical explanations for these observed differences are usually grounded in the concepts of social norms and early-life socialization processes. Generally, it is argued that women are expected to be family nurturers and caregivers, whereas men are expected to provide safety and subsistence. These social expectations, ingrained at an early age, are thought to carry over into latter stages of individuals' lives and influence attitudes toward a wide variety of social issues such as poverty, welfare, and appraisals of which aspects of natural environments are most valued (Mohai 1992). Given this observed trend in previous empirical work, I expect there to be gender differences in individuals' behavioral intentions to participate in forest planning relative to potential economic, recreational, and ecological losses. Specifically, I expect men to be more inclined to become involved in forest planning as the loss of local forest-related jobs and recreational amenities (an expression of anthropocentric and utilitarian values) becomes more severe. Conversely, I expect women to be more inclined to become involved in forest planning as the loss of wildlife habitat (an expression of biocentric and intrinsic values) increases. The classification of forest-related job losses and recreational amenities as anthropocentric values and habitat losses as a measure of biocentric values follows the typology of forest values developed by McFarlane and Boxall (2000) as well as several other similar typologies of values held toward forests (see Moyer et al. 2008, Owen et al. 2008).

The third and final general trend noticed in the literature is that men tend to be more actively involved in *formal* environmental organizations and institutions relative to women (Tindall et al. 2003, Hunter et al. 2004). Although women do tend to be more involved in less formalized groups such as grassroots organizations, this research is specifically focused on predicting active participation in federal public forest planning. Thus, I expect men to be more inclined to become involved in forest planning processes regardless of how altered forest conditions might affect local economies, recreational opportunities, or ecosystems.

Each of these three general trends shape our expectations about whether, how, and why men and women might perceive and respond to various environmental changes and impacts. This previous research, however, is not focused on public participation in forest planning and is not able to generate predictions of how individuals' behavior will change as various forest-related attributes become increasingly degraded. My field-based stated preference experiment, which was administered to three forest-related communities in the southeastern United States, will be able to make inroads into these previously unaddressed areas and also determine whether the three generalized trends concerning gender and environmental concern/behavior hold.

Materials and Methods

The primary objective of this research is to determine whether varied levels of hypothetical losses of forest-related jobs, recreational amenities, and wildlife habitat influence individuals' willingness to become involved in forest planning and management decisions. A secondary and related objective is to determine whether behavioral responses contingent on altered forest conditions are different between men and women. I achieve both of these objectives by conducting a stated preference field experiment on random samples of residents living within three communities located in western North Carolina, USA.

A Model of Contingent Behavior

Several hypothetical, yet realistic, scenarios were presented to respondents via a mail-back questionnaire. For each hypothetical scenario, respondents were asked to make two decisions regarding whether they would become involved in forest planning. Both of the "yes/no" decisions were modeled as a binary discrete choice where "yes" indicated that the respondent would become involved, and "no" indicated that her or she would not. Following the random utility framework (McFadden 1974), for each scenario j , a yes response indicated that the utility derived from becoming involved in forest planning and management was greater than the utility derived from not becoming involved. Utility formation for the binary discrete choices is expressed as

$$U_j = V_j + \varepsilon_j$$

where U_j is the random latent utility of a choice option, V_j is the systematic (explainable) component of utility, and ε_j is random disturbance.

In the case of a binary discrete choice within a single-choice scenario, a yes response indicates the utility derived from becoming involved in forest planning is greater than the utility of not becoming involved. For any scenario, the probability of a yes response is expressed as

$$\text{Probability}(Y|Y, N; X) = \text{Probability}(U_j^{\text{yes}} \geq U_j^{\text{no}})$$

where Y represents choosing yes, N represents choosing no, X is a design matrix describing the scenarios as combinations of attribute levels, and U_j is the true utility of the j th choice scenario.

More specifically, the utility that respondent i derives from a particular scenario j can be specified as

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta' X_{ij} + \varepsilon_{ij}$$

where the systematic utilities V_{ij} are assumed to be a function of a matrix of attributes and their levels are contained in the hypothetical scenario (X_{ij}). β' is the vector of coefficients associated with X_{ij} .

Given that the stated preference experiment presented each respondent with several scenarios (observations), an individual's responses across the scenarios are not independent and are likely to be correlated. I accommodated this with an error components assumption that decomposes the random disturbance down into two components. The first

component is individual-specific and allowed to correlate across a choice set; the second is the remaining random error. This random effects specification is frequently used to overcome the shortcomings of standard logit specifications (McFadden and Train 2000, Train 2009).

Choice Scenario

The primary hypothesis driving the design of this research was whether individuals would change their level of involvement in forest planning efforts given the probable impacts of large-scale forest disturbances. I chose to frame the potential impacts of large-scale forest disturbances through an example of the projected increase in southern pine beetle outbreaks as a result of increased regional temperatures and decreased precipitation. The increased frequency and severity of southern pine beetle outbreaks have been well documented and are a primary concern for forest managers within the region (Williams and Liebhold 2002, Gan 2004, Duehl et al. 2011). The dead stands that result from southern pine beetle outbreaks have a direct impact on local economies through a reduction in harvestable timber. Outbreaks also have an impact on forest recreational opportunities through their aesthetic impacts; they can also have a significant impact on the size and quality of wildlife habitat. Given that the impacts of southern pine beetle are broad and can affect human communities in a number of important ways, I believed this methodological approach was a unique way to express the potential effects of large-scale forest disturbances to respondents through a very tangible frame (Kahneman and Tversky 2000).

Contingent engagement in forest planning, given variations in the impacts of the southern pine beetle on local biophysical and social systems, was assessed by asking respondents if, given the attribute levels presented in a given scenario, they would perform two specific behaviors: "attend and provide input at a public meeting held by public land managers to address the outbreak" and "read a mitigation and adaptation plan prepared by public land managers to address the outbreak."

Attributes and Levels

In developing my stated preference experiment, I chose attributes related to three distinct biophysical and social systems (economic, recreational, and biological) likely to be affected by increased outbreaks of southern pine beetles. These three broad systems were chosen because they are sufficiently general enough to be readily understood by respondents and because they are relatively distinct enough to be simultaneously varied in a stated preference experiment.

One statement for each type of biophysical or social system was developed. For economic impacts, the statement referred to the proportion of "local forest-related jobs lost" as a result of the scenario. For recreational impacts, the statement referred to the proportion of "forest recreation amenities lost" as a result of the scenario, and for biological impacts, the statement referred to the proportion of "wildlife habitat lost" as a result of the scenario. Each attribute was described through one of three levels: 0% loss, 30% loss, or

70% loss. Only three attribute levels were assigned to keep the stated preference experiment relatively simple and, more importantly, to enable a complete factorial design.

Experimental Design and Survey Instrument

Given that my stated preference experiment only contained three attributes and each attribute could be expressed through only three levels ($3^3 = 27$ possible combinations), a complete factorial design was possible. However, having respondents consider 27 distinct hypothetical scenarios was not feasible, so I blocked the design into nine versions

of three scenarios each. A typical choice set is shown in Figure 1.

Data Collection

A self-completed mail questionnaire was administered to residents living in three communities near public forests in Southern Appalachia during the summer of 2011. The three cities were Spruce Pine, North Carolina; Waynesville, North Carolina; and Franklin, North Carolina. These communities were selected because they all had been economically dependent ($\geq 10\%$ employment in forest-related

SCENARIO			
<p>We would like to know how to best engage local community members like you in decisions about land use issues that affect you. Below is a hypothetical issue concerning Southern Pine Beetle outbreaks in Southern Appalachia. Please read the issue below and answer the questions that follow.</p> <p>Assume that university scientists have recently discovered an outbreak of Southern Pine Beetles in forests near your community. These beetles bore into hardwood pines and lay their eggs. The tunnels created by the beetles eventually stop the flow of nutrients throughout the tree, causing the tree to die. Because pines are economically valuable for timber, the outbreak could affect local residents dependent upon the forest industry. The outbreak is also likely to have an impact on the recreational opportunities offered within the forest.</p> <p>Below is a table describing three possible outcomes of the Southern Pine Beetle outbreak. Differences in the three possible outcomes appear under the columns labeled SCENARIO 1, 2, and 3. For example, SCENARIO 1 suggests a 0% loss of local forest related jobs due to the outbreak, a 70% loss of recreational amenities, and a 30% loss in wildlife habitat due to the outbreak.</p> <p>Please look over the table and answer the questions that follow.</p>			
	SCENARIO 1	SCENARIO 2	SCENARIO 3
Outcomes	Estimated % of loss	Estimated % of loss	Estimated % of loss
Local forest-related jobs lost	0	30	70
Forest recreation amenities lost	70	0	30
Wildlife habitat lost	30	70	0
<p>QUESTION 1 Would you attend and provide input at a public meeting held by public land managers to address these losses?</p>			
	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> YES <input type="checkbox"/> NO
I would not attend the meeting under any circumstances <input type="checkbox"/>			
<p>QUESTION 2 Would you read a mitigation and adaptation plan prepared by public land managers to address these losses?</p>			
	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> YES <input type="checkbox"/> NO
I would not read the plan under any circumstances <input type="checkbox"/>			

Figure 1. Hypothetical scenario-framing statement and sample choice set.

industries) on forest-based industries between 1970 and 2010 and because each is surrounded by either the Nantahala or the Pisgah National Forests. All three communities have transitioned from extractive forest- or mining-based economies to being primarily dependent on tourism (Smith 2011). Within each community, random samples of 300 full-time resident homeowners were drawn from tax records (900 total households sampled). The mail questionnaires, which contained the stated preference experiment, were administered according to the tailored design method (Dillman et al. 2008). A total of 40 questionnaires were undeliverable. Of the successfully delivered questionnaires, 420 were returned completed. The subsequent 48.8% response is above the recommended 40% levels recommended by Dillman et al. (2008) for questionnaires administered to the general population via mail. I used US Census data for each of the cities to check for nonresponse bias; population estimates for all of the sociodemographic characteristics asked about (age, educational attainment, gender, and income) were not significantly different from US Census data on the age of owner-occupied housing units. Nonresponse bias checks via telephone were not conducted and are a limitation acknowledged by the author.

Estimation

Given that my field-based choice experiment included multiple hypothetical scenarios being administered to each respondent, the data generated are *clustered*. Clustered data are not independent and therefore violate an essential criterion of maximum likelihood theory: that observations in a model are independent of one another. The correlation present in clustered data is commonly addressed through panel models whereby the analyst creates a panel variable that corresponds to each choice set, thus enabling better estimation of the correlation between individuals' responses to each scenario within a set. Common models include generalized estimating equations and fixed-effects models; these approaches are well-suited when the data are not hierarchical (Hilbe 2009). Given that my data were collected from three sample communities, there is the possibility for the presence of within-sample correlation and bias to exist in the data. To deal with this issue, I chose a hierarchical mixed-effects logistic regression model. The hierarchical mixed-effects model is useful because distinct clusters can be treated as random effects, thus minimizing the potential bias of intracenter correlation, whereas the covariates of interest can be treated as fixed and estimated just as they would be in a standard logistic regression.

My model contains two levels, individuals and the sample communities in which they reside. Subsequently, the model can be specified as

$$\Pr(y_{ij} = 1) = \beta_0 + \beta_1 \text{job_loss}_{ij} + \beta_2 \text{recreation_loss}_{ij} + \beta_3 \text{habitat_loss}_{ij} + \delta_1 \text{community}_i + \delta_2 \text{gender}_i + \varepsilon_{ij}$$

where j indicates scenario and i indicates individual respondents. The dependent variable is the binary choice of whether or not to participate (either attend a forest planning meeting or read a forest plan) given the job-loss, recreation-

loss, and habitat-loss conditions stipulated in each hypothetical scenario. The levels of loss are treated as fixed effects, whereas intercepts are allowed to vary (i.e., treated as random effects) across samples (δ_1 community_{*i*}). I also estimated different coefficients for gender (through the random slope δ_2 gender_{*i*}) to determine whether men and women reacted dissimilarly to the scenarios. All estimation was completed with the `xtmelogit` command in Stata 12.0 (Stata-Corp. 2011).

Results

Descriptive Statistics

Descriptive statistics for the samples are shown in Table 1. In general, community residents across all three samples tended to be white and middle aged, to have obtained some college education, and to earn between \$35,000 and \$75,000 per year. Respondents also tended toward more conservative political ideologies. There was substantial variation across the samples, however, as respondents' age ($F_{2, 404} = 7.02, P = 0.007$), gender ($\chi^2(2) = 17.05, P < 0.001$), education ($\chi^2(12) = 54.74, P < 0.001$), income ($\chi^2(18) = 50.46, P < 0.001$), and political ideology ($\chi^2(10) = 91.19, P < 0.001$) all differed significantly among communities. These variations suggest that subsequent modeling needs to account for intracommunity correlation within the data, which I explicitly accommodated through the use of a hierarchical modeling structure, allowing slope estimates to vary relative to each sample (i.e., treating community identification as a random effect).

Contingent Behavior

Results from the first hierarchical mixed-effects model, which predicted individuals' intentions toward attending a forest planning meeting contingent on hypothetical losses of local forest-related jobs, recreational amenities, and wildlife habitat, are shown in Table 2. The data revealed that all three scenario attributes have significant effects on individuals' behavioral intentions. The loss of forest recreational amenities had the smallest effect on individuals' behavioral intentions ($P = 0.011$). The log-odds ($\beta = 0.007$) is interpreted as the unit change in the log-odds of attending the forest meeting for 1% increase in recreational amenities lost. Losses of local forest-related jobs have slightly more impact on individuals' intentions ($\beta = 0.009, P = 0.002$). The attribute having the largest influence on behavior was loss of wildlife habitat ($\beta = 0.014, P < 0.001$).

The shift coefficients for the fixed effects can be made more illustrative through the calculation of predicted probabilities at various levels of loss for each attribute. I generate predicted probabilities at 5% intervals for the entire range of potential losses (0–100). The predicted probabilities are illustrated in Figure 2. As can be seen, the slope for habitat losses is steeper than that seen for either losses of local forest-related jobs or forest recreation amenities. Interestingly, the probability estimates are greater for hypothetical job and recreation losses when those losses are relatively low (<30%). After the effects of the attribute

Table 1. Sociodemographic characteristics of respondents in all three study communities.

Respondent characteristics	Spruce Pine, NC (n = 103)	Waynesville, NC (n = 159)	Franklin, NC (n = 158)
 (%)		
Age (yr; mean ± SD)	49.1 ± 14.1	52.5 ± 14.0	53.6 ± 14.6
Women	26.3	31.2	41.9
Education (highest level completed)			
<9th grade	0.0	1.6	0.9
9th–12th grade	2.7	3.3	0.9
High school graduate	22.7	13.1	15.4
Some college, no degree	23.7	20.5	22.2
Associate’s degree	10.7	13.1	12.8
Bachelor’s degree	8.0	24.6	24.6
Graduate or professional degree	21.3	23.8	22.2
Income			
<\$10,000	1.5	2.8	3.9
\$10,000–\$14,999	7.3	4.6	7.8
\$15,000–\$24,999	13.0	7.3	10.8
\$25,000–\$34,999	13.0	11.9	19.6
\$35,000–\$49,999	21.7	15.6	10.8
\$50,000–\$74,999	17.4	18.4	22.6
\$75,000–\$99,999	11.6	16.5	9.8
\$100,000–\$149,999	8.7	18.4	9.8
\$150,000–\$199,000	2.9	3.7	2.9
≥\$200,000	2.9	0.9	2.0
Political ideology			
Conservative	49.3	28.2	25.4
Moderate conservative	18.7	18.0	21.9
Moderate	13.3	14.5	17.5
Moderate liberal	12.0	25.6	16.7
Liberal	5.3	12.8	8.8
Other	1.3	0.9	9.7
Race			
White, not of Hispanic origin	97.4	99.2	96.6
Other	2.6	0.8	3.4

Table 2. Results from the hierarchical mixed-effects model of contingent forest meeting attendance.

	Coefficient (log-odds)	SE	z	P > z
Fixed-effects (scenario attributes)				
Job loss	0.009	0.003	3.090	0.002
Recreation loss	0.007	0.003	2.550	0.011
Habitat loss	0.014	0.003	4.670	<0.001
Random-effects				
Community of residence	0.914	0.423	2.161	0.015
Gender	2.271	0.454	5.002	0.000
Summary statistics				
Wald $\chi^2(3)$		33.96		
Log likelihood		-479.99		
Likelihood ratio test versus logistic regression: $\chi^2(3)$		51.07***		

*** P ≤ 0.001.

levels reach parity near 30%, losses of wildlife exhibit a stronger influence on individuals’ behavioral intentions.

The slope estimates for the random-effects portion of the model suggest that there is evidence for intracommunity correlation of responses because the community of residence variable was significant ($\beta = 0.914$, $P = 0.015$). More importantly, responses also differed significantly by gender ($\beta = 2.271$, $P < 0.001$). The variations in responses by gender are illustrated in Figure 3, which displays the predicted probabilities of attending a planning meeting at various levels of loss for each attribute for both men and women. For both hypothetical forest-related job losses and

recreation amenity losses, men and women are roughly equivalent in their behavioral responses when losses are relatively small (i.e., <15%). However, the variation in probability estimates becomes noticeable when hypothetical losses are greater; the data suggest that men are more likely to attend a forest planning meeting once losses become substantial. The same pattern, however, was not seen in the data concerning potential losses of wildlife habitat. Men were more likely to attend a forest planning meeting if loss of habitat was less than 35%, above which the genders appear to be near parity in their willingness to be involved in forest planning activities.

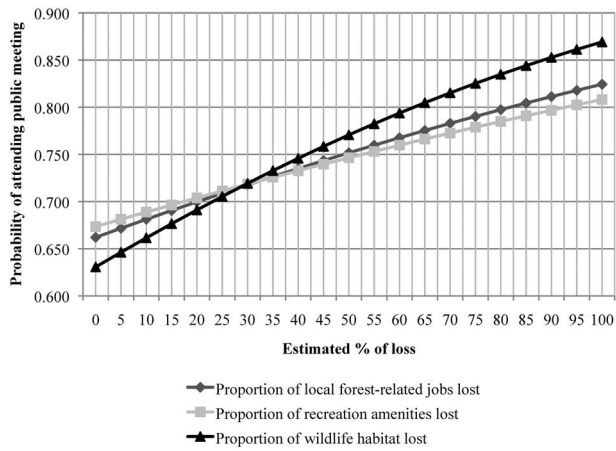


Figure 2. Probability of attending public meeting contingent on hypothetical losses of local forest-related jobs, recreation amenities, and wildlife habitat.

Results from the second model, predicting individuals' willingness to read an adaptation plan, are shown in Table 3. The results from this model mirror those of the first, because all three scenario attributes were significant predictors of behavioral intentions. Again, the loss of forest recreation amenities had the smallest effect size ($\beta = 0.007$, $P = 0.013$), followed by the loss of local forest-related jobs ($\beta = 0.008$, $P = 0.004$), and the loss of habitat for wildlife ($\beta = 0.012$, $P < 0.001$).

Again, I generated predicted probabilities of reading a forest or adaptation plan at 5% intervals for the entire range of potential losses; these probability estimates are shown in Figure 4. Much like the results from the first model, the slope for habitat losses is steeper than that seen for either potential job or recreation amenity losses, suggesting that individuals are more sensitive (i.e., more willing to alter their behavior) to impacts on wildlife habitat than to impacts on either local forest-related industries or recreational opportunities provided by the forest.

The slope estimates for the model's random effects are shown in Table 3; they suggest that the presence of intra-community correlation was minor ($\beta = 0.195$, $P = 0.078$). However, responses again differed significantly by gender ($\beta = 2.952$, $P < 0.001$). Variation in predicted probabilities for reading a forest plan contingent on varied levels of loss relative to gender are illustrated in Figure 5. Regarding hypothetical levels of forest-related jobs lost, the data suggest that men and women are roughly equivalent in their willingness to read forest plans when losses are minimal (<10%). However, the random coefficient estimated for men is much steeper than that for women; men are much more likely to read forest planning documents when potential economic losses are substantial. Regarding hypothetical levels of forest recreation amenities lost, the data suggest a notable gap between the genders when losses are small (men being more likely to read planning documents). The probabilities tend toward convergence, however, as the loss of recreational amenities becomes more severe. The analysis revealed a similar trend for contingent behavior relative to estimated losses of wildlife habitat; men are more likely to read planning documents when impacts to wildlife habitat

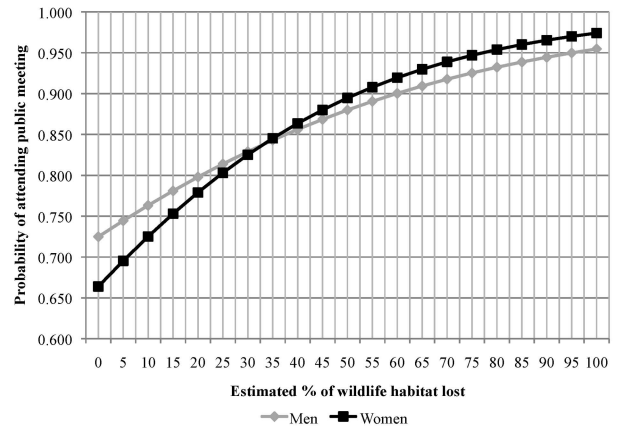
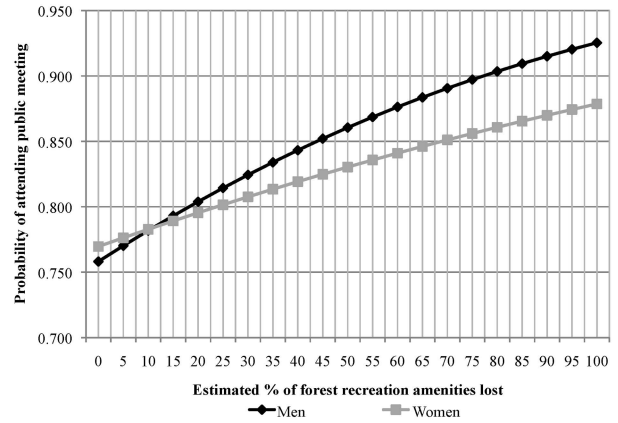
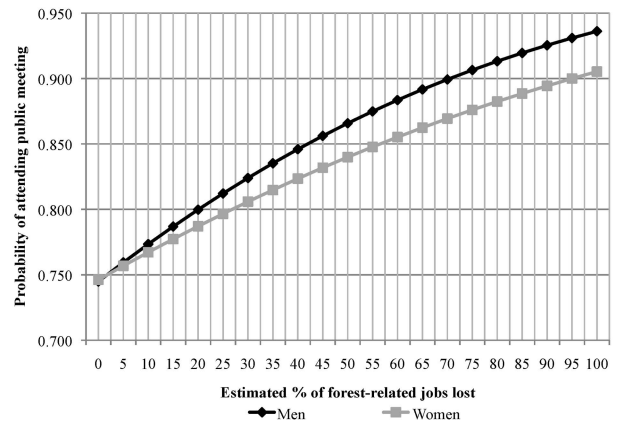


Figure 3. Gender differences in probability of attending public meeting contingent on hypothetical losses of local forest-related jobs (top), recreation amenities (middle), and wildlife habitat (bottom).

are small, but the gap narrows as estimated losses become greater. For the latter two attributes, the finding suggests that although men are more inclined to read forest planning documents when impacts are minimal, women are more likely to alter their behavior as impacts increase.

Discussion

Summary and Implications

Public participation in forest planning has been described as both an *end* and a *means to an end* (Buchy and Hoverman 2000, Parkins and Mitchell 2005). Public participation as a means to an end suggests that enabling local publics to be

Table 3. Results from the hierarchical mixed-effects model of contingent reading of forest plan.

	Coefficient (log-odds)	SE	z	P > z
Fixed-effects (scenario attributes)				
Job loss	0.008	0.003	2.850	0.004
Recreation loss	0.007	0.003	2.480	0.013
Habitat loss	0.012	0.003	4.170	<0.001
Random-effects				
Community of residence	0.195	0.138	1.413	0.078
Gender	2.952	0.622	4.746	<0.001
Summary statistics				
Wald $\chi^2(3)$		54.21		
Log likelihood		-437.10		
Likelihood ratio test versus logistic regression: $\chi^2(3)$		52.02***		

*** P ≤ 0.001.

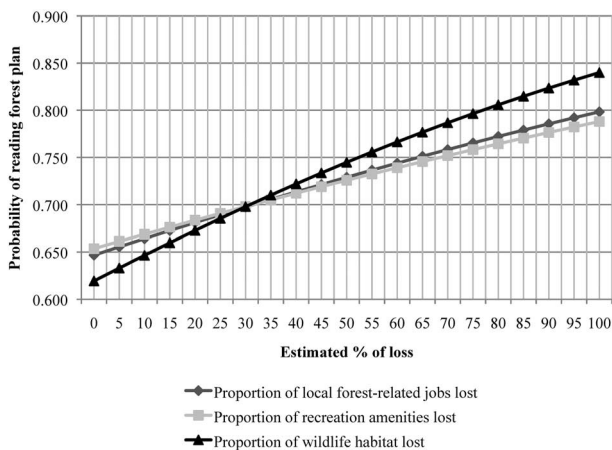


Figure 4. Probability of reading forest plan contingent on hypothetical losses of local forest-related jobs, recreation amenities, and wildlife.

involved in resource management decisions is an imperative required to ensure that local communities have control over their economic and ecological future. Public participation processes provide the opportunity for citizens to raise concerns over how their public goods are being managed and to ensure that they continue to produce desired benefits and services. As Tuler and Webler (1999) noted, the primary function of participation is to transfer or share the power of decisionmaking. For public participation processes to achieve the ultimate end of more stable local social and ecological systems, forest planners and managers need to understand the factors that drive individuals to become involved in the first place (Cheng and Mattor 2006). This research has directly addressed this issue and the results can influence how forest planners and managers approach and engage in public involvement processes.

First, my analysis revealed that localized impacts to social and biophysical systems due to increasingly severe invasive species outbreaks are likely to increase individuals' willingness to become involved in forest planning and management. Specifically, I found that more severe impacts in the form of local forest-related job losses, the loss of recreational amenities, and the loss of wildlife habitat all increased the likelihood of individuals attending public meetings or reading forest plans designed to address these issues. For resource management agencies, this evidence suggests

that, in the future, not only will planners and managers have to develop mitigation and adaption strategies to deal with the biophysical consequences of ecosystems altered by changing environmental conditions, they will also have to devote increasing financial and human resources to address the general public's increased desire to become involved in resource management and planning. In short, agencies are likely to face a double bind of simultaneously developing plans and management actions to adapt to changing conditions that are characterized by increasing scientific uncertainty and facilitating the needs of a citizenry who will become increasingly concerned about how more variable environmental conditions affect their economies, lifestyles, and environments.

Second, the data also reveal that among the three potential impacts, the loss of wildlife habitat was the most significant factor influencing individuals' intentions to change their behavior. Individuals' intentions were influenced by potential losses to both anthropocentric services (local jobs and recreational amenities) and ecological systems (wildlife habitat) but more so by losses to ecological systems. This statement might seem counterintuitive at first. However, a large body of social science suggests that general social values toward forest-related resources have been trending from anthropocentric to biological over the past 4 decades (Bengston 1994, Bengston and Xu 1995, Manning et al. 1999, Tarrant and Cordell 2002, Tarrant et al. 2003). More recent research on preferences for desired forest management outcomes also suggests that members of the general public tend to favor ecological benefits over aesthetic, economic, or recreational benefits (Smith et al. 2012). Couple this fact with continued empirical findings suggesting that individuals' environmentally oriented behaviors, such as participating in a forest meeting or reading an adaption plan, are driven by beliefs that there will be adverse consequences for valued objects (Stern 2000), and the findings become clearer. For my representative sample of local community members, the values held toward wildlife habitat were stronger than the values held for either the local forest-related industry or recreational opportunities. For resource management agencies, this finding suggests that future changes in public involvement in forest planning are likely to be related to which systems and their properties are affected most heavily.

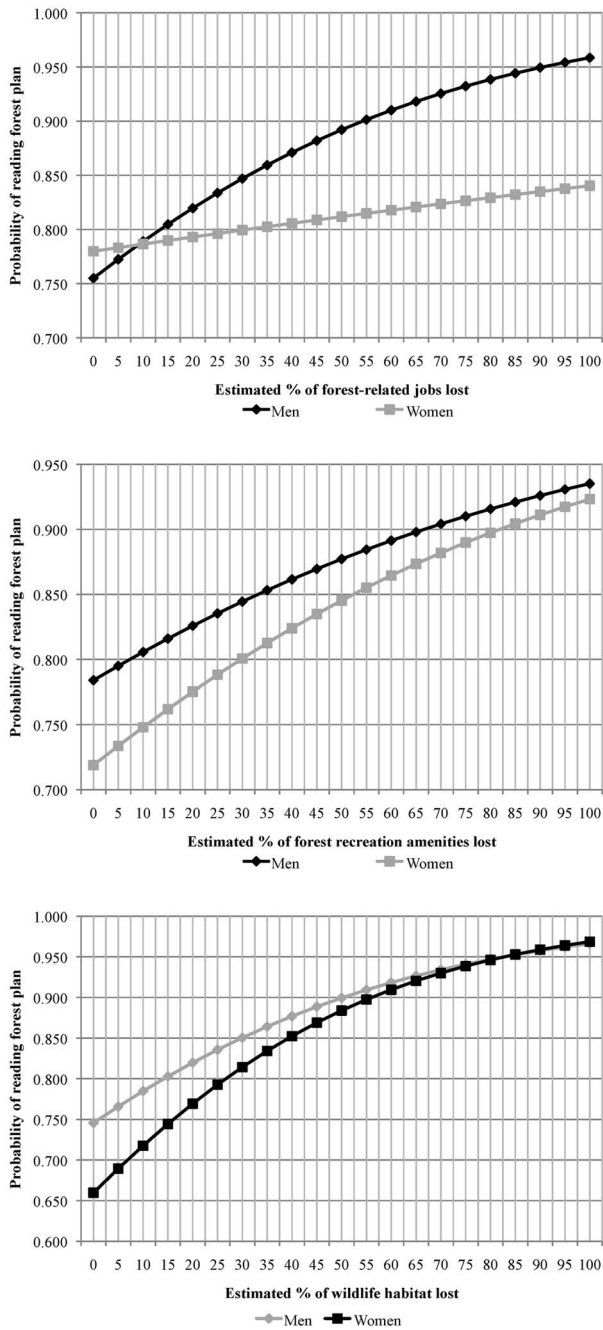


Figure 5. Gender differences in probability of reading forest plan contingent on hypothetical losses of local forest-related jobs (top), recreation amenities (middle), and wildlife habitat (bottom).

Third, my analysis showed significant differences in the contingent behavior of men versus women. Specifically, I found that parity exists in men's and women's behavioral intentions when the impacts to local forest-related industries were low (<15%). However, once expected losses become more severe, men were more likely to attend forest planning meetings or read forest plans. Concurrently, my findings suggest that men were more likely to attend forest planning meetings or read an adaptation plan as impacts to local forest-related recreational amenities became more severe. These findings support previous empirical research and social theory, suggesting that men are more inclined to be

concerned over the loss of anthropocentric and utilitarian values than women (Mohai 1992, Davidson and Freudenburg 1996, Reed and Varghese 2007). My findings suggest that greater levels of concern for anthropocentric and utilitarian values also translates to increased willingness to alter individual behavior or at least behavioral intentions, when these values are believed to be threatened. My analysis also revealed differential reactions among men and women to the potential loss of local wildlife habitat. I found that although men were more inclined to engage in forest planning processes when the estimated loss of habitat was low, women were much more sensitive to increasingly severe impacts (i.e., the slopes of expected probabilities was steeper). Consequently, the likelihood of men and women becoming involved in forest planning is roughly equal once expected habitat losses reach a certain equivalence point (~35% for attending a public meeting and ~75% for reading an adaptation plan). This finding offers partial support for the proposition that women tend to be more concerned over the loss of biocentric values. However, more definitive support would have been seen if women were more inclined to alter their behavior relative to that of men even at low levels of expected habitat losses. A possible explanation for these mixed findings can be found in previous empirical work that suggests men are more likely to be involved in *formal* environmental organizations and institutions relative to women (Tindall et al. 2003, Hunter et al. 2004). Forest planning processes would definitely classify as a more formal venue and consequently be perceived as more accessible by men, who tend to predominate in formal environmental decisionmaking processes (Harding 1998).

Collectively, these findings offer mixed support for existing theory focused on variations in public participation processes relative to gender. Regardless of the varied theoretical reasons that are given to attempt to explain these differences, my results suggest that variations in behavioral intentions do exist between men and women, and that these variations are influenced by the type of social or ecological system properties, which are likely to be affected by changing climatic conditions. For forest managers, these findings hold implications for understanding who is likely to perceive various changes to forest ecosystems as a result of large-scale forest disturbances and, consequently, who is more likely to become involved in future planning efforts. For example, if the annual yields that can be harvested from a public forest are likely to be negatively affected by large-scale forest disturbances, managers can expect a greater level of concern and concomitant involvement in adaptation planning by men. Conversely, for public forests in which biological resources are likely to bear the brunt of altered forest conditions, managers could expect equal or slightly higher levels of concern by men but much greater levels of concern and willingness to become involved in adaptive planning efforts among women.

Conclusion

Public participation can improve the quality and legitimacy of forest management decisions. Explicitly, public participation can lead to improved biophysical properties of

ecosystems and stronger social relationships among those individuals involved in the process (National Research Council 2008). However, forest management agencies cannot efficiently engage in public participation processes, such as soliciting public comments or drafting management plans, without a clear understanding of the factors influencing individuals' willingness to participate in the process (Cheng and Mattor 2006). This research demonstrates that individuals' willingness to engage in participatory processes is contingent on various factors, specifically the types of social and ecological system properties likely to be affected by managerial decisions. Consequently, forest management agencies should be cognizant of the likelihood that as the magnitude of changing environmental conditions becomes larger and more apparent, the general public will desire a greater stake in influencing forest planning and management strategies designed to mitigate or adapt to those impacts.

In summary, large-scale forest disturbances and their impact on biophysical and social systems have the potential to dramatically alter public participation in environmental decisionmaking processes. The data collected from the three small-study communities in this research suggest that a variety of factors, including the system properties likely to be affected, the extent to which those properties are affected, and the gender of potential participants, can be key variables determining new patterns of involvement in forest planning and management decisions.

Endnote

1. However, I acknowledge that considerable research has been done to develop detailed and more finely tuned typologies of values toward public forests (see Moyer et al. 2008 and Owen et al. 2008 for detailed reviews).

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