Forest Policy and Economics 25 (2012) 62–71

Contents lists available at SciVerse ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Identifying policy target groups with qualitative and quantitative methods: The case of wildfire risk on nonindustrial private forest lands

A. Paige Fischer *

USDA Forest Service, Pacific Northwest Research Station, Western Wildland Environmental Threat Assessment Center, 3200 SW Jefferson Way, Corvallis, OR 97331, USA

ARTICLE INFO

Article history:
Received 5 April 2011
Received in revised form 11 January 2012
Accepted 23 August 2012
Available online 21 September 2012

Keywords:
Policy design
Policy target groups
Segmentation
Nonindustrial private forest owners
Fuel reduction policy

ABSTRACT

Designing policies to harness the potential of heterogeneous target groups such as nonindustrial private forest owners to contribute to public policy goals can be challenging. The behaviors of such groups are shaped by their diverse motivations and circumstances. Segmenting heterogeneous target groups into more homogeneous subgroups may improve the chances of successfully identifying policy strategies to influence their behavior. Findings from a multimethod study of nonindustrial private forest owners in eastern Oregon suggest four unique subgroups of owners with different fuel management motivations and suitabilities for policy tools: commodity managers could benefit from market-based incentives; amenity managers could benefit from capacity building programs paired with symbolic campaigns; recreational managers could benefit from public incentives provided through consultants or contractors who can help plan the work; and passive managers may benefit from opportunities to respond to the policy strategies designed for the other groupings until more information can be gathered. Incorporating qualitative analysis of interview data with statistical analysis of survey data improved understanding of the groupings and appropriate policy strategies for them.

Published by Elsevier B.V.

1. Introduction

The success of any policy strategy depends on an accurate understanding of the target group. Identifying target groups' motivations and designing policies to harness these motivations will improve chances of successfully influencing their behavior. However, this process is a challenge with highly heterogeneous populations. Segmenting such populations into more homogeneous subgroups can be a helpful step. Segmentation is often done through analysis and classification of quantitative data about socio-demographic characteristics and behavior. Unfortunately, such data generally lack detailed information about target groups' underlying motivations (Schneider and Ingram, 1990). Qualitative data can offer additional insight into people's motivations with high internal validity (Lincoln and Guba, 1985; Patton, 2002). A segmentation approach that combines quantitative and qualitative methods in the development of theories of behavior may improve policy makers' abilities to design strategies that harness target groups' motivations.

I explored the usefulness of segmentation for identifying unique target groups for wildfire risk policy among nonindustrial private forest (NIPF) owners, and whether additional qualitative data enhanced understanding of the motivations of the target groups and the policies that would be suitable for them. I chose the fire-prone ponderosa pine (*Pinus ponderosa*) ecosystem in Oregon as the study area because of its relatively large proportion of land in NIPF ownership and high fire risk, and the great emphasis on hazardous fuel reduction in local policy and management discussions. The findings identify four unique subgroups of NIPF owners and provide a nuanced picture of why members of these groupings manage fire risk differently and, thus, may benefit from different policy strategies. While the findings are mainly applicable to NIPF owners in Oregon's ponderosa pine areas, the ecological and socioeconomic conditions there are common throughout the arid West; thus, this case may shed light on policy opportunities for NIPF owners in fire-prone areas elsewhere.

2. Nonindustrial private forest owners and Oregon's fire-prone ponderosa pine ecosystem

NIPF owners are a heterogeneous population that researchers have struggled to understand for more than half a century (Amacher et al., 2003; Beach et al., 2005). Few characteristics bind together these individuals, married couples, family estates and trusts, and unincorporated groups who own forest land (Fischer et al., 2010). Once thought to be driven by profit like industrial timber companies (Amacher et al., 2003), NIPF owners are now recognized to hold forestland for diverse reasons, among them recreation, monetary gain (e.g., investment and income generation), residential values (e.g., homesite, privacy, scenery), family legacy (e.g., maintaining family bonds, passing assets on to heirs) and environmental protection (e.g., open space, wildlife habitat, ecosystem services) (Bengston et al., 2011; Butler, 2008). NIPF

* Tel.: +1 541 758 7793; fax: +1 541 758 7760.
E-mail address: paigefischer@fs.fed.us.

1389-9341/$ – see front matter. Published by Elsevier B.V.
http://dx.doi.org/10.1016/j.forpol.2012.08.008

owners sometimes manage land for competing goals. For example, the opportunity to harvest timber is often important for amenity-oriented owners and may be a consideration when they weigh decisions (Butler, 2008; Kline et al., 2000b).

NIPF lands comprise about 1/6th of the ponderosa pine ecosystem east of Oregon's Cascade Mountains (Oregon Department of Forestry, 2006a). The population of NIPF owners in this region is especially diverse because of its long history of timber and grazing and recent trend of in-migration of ex-urbanites (Kline and Azuma, 2007). This population includes long-time ranch and timberland owners, more recent residential owners, and absentee recreational owners. Similar to other dry forests in the West, the ponderosa pine ecosystem historically experienced frequent fire return intervals. Years of fire suppression, grazing, and repeated selection-cutting have led to an accumulation of hazardous fuel and thus, fire risk in ponderosa pine forests (Hessburg et al., 2005). Because NIPF lands are mostly located at the interface of federal wildlands and populated areas (i.e., the wildland–urban interface, or WUI) they are vulnerable to natural and human-induced wildfires and influence the connectivity of hazardous fuel and potential movement of fire across the landscape (Ager et al., 2012).

A variety of public policy instruments are used to encourage fuel reduction on NIPF lands. The National Fire Plan of the U.S. Department of Agriculture Forest Service and the U.S. Department of the Interior makes financial assistance available to landowners and communities in WUI areas. Financial assistance is also available through the Natural Resource Conservation Service's Environmental Quality Incentives Program. Technical assistance is available through the Forest Service's Forest Stewardship Program, which helps landowners develop forest management plans that include fuel reduction, and Community Wildfire Protection Plans authorized by the Healthy Forests Restoration Act. Regulatory approaches are also used, such as Oregon's Forestland–Urban Interface Fire Protection Act (SB360), which requires property owners located in WUI areas to reduce fuel around structures and along driveways.

Given the heterogeneity of NIPF owners in the area, reducing hazardous fuel, restoring ecosystems, and garnering amenity and financial benefits from forests may not be simultaneously feasible or desirable goals for landowners. Fuel reduction activities are expensive—often hundreds of dollars per hectare (Calkin and Gebert, 2006; Hartsough et al., 2008)—and, on large scales, require heavy investments in equipment and labor. Fuel reduction can also diminish amenity and ecological values such as privacy offered by thick stands of trees and animal forage and cover provided by understory vegetation. Thus, the challenge for policymakers is to encourage owners to adopt practices that yield public goods such as the mitigation of fire risk while also furthering their private interests.

3. Heterogeneous target groups and policy design

Pioneered by Kuuluvainen et al. (1996), numerous studies have attempted to segment owners into more homogeneous subgroups for the purpose of developing more optimal policies and programs. Such studies have commonly used principle components factor analysis and *k*-means cluster analysis to reduce and categorize quantitative data, producing classifications based on broad management objectives, approaches and intentions and policy dispositions (Butler et al., 2007; Finley et al., 2006; Kendra and Hull, 2005; Kline et al., 2000a; Kluender and Walkingstick, 2000; Kuuluvainen et al., 1996; Majumdar et al., 2008; Serbruyns and Luyssaert, 2006).

The variables that these and other segmentation studies have employed include many well-studied socio-demographic predictors of NIPF management behavior. For example, absenteeism is associated with reduced likelihood for engaging in all sorts of forest management activities including harvesting timber and managing for nontimber uses (Conway et al., 2003; Joshi and Arano, 2009; Vokoun et al., 2006). Income and education are positively associated with likelihood of thinning and reforestation and negatively associated with harvesting timber (Alig et al., 1990; Joshi and Arano, 2009). Length of property ownership is positively associated with harvesting timber and negatively associated with thinning, herbicide application and creating wildlife habitat and recreation values (Conway et al., 2003; Joshi and Arano, 2009; Vokoun et al., 2006). Parcel and ownership size are positively associated with harvesting timber, thinning and having forest management plans (Alig et al., 1990; Amacher et al., 2003; Beach et al., 2005; Butler, 2008). Risk perception has also been recognized as an important influence on how NIPF owners manage. Owners are more likely to reduce fuel when they are aware of the probability of fire, have direct experiences with fire and feel vulnerable (Amacher et al., 2005; Fischer, 2011; Fried et al., 1999; Jarrett et al., 2009; Fischer and Charnley, 2012).

Criticisms have been made of the use of exclusively objective socio-demographic characteristics in segmentation studies rather than subjective attitudinal or psychic constructs that reflect people's perceptions and motivations. Two studies address this concern by basing their analyses on owners' subjective motivations for management: Kendra and Hull (2005) through the use of survey data about attitudes and Carroll et al. (2004) through the use of interview data about wildfire risk perception. Nevertheless, these and other segmentation studies classify owners using very similar schemes: owners who are financially motivated, owners who are amenity motivated, owners who are both financially and amenity motivated, and owners who are neither financially and amenity motivated (Bengston et al., 2011). Such schemes fall short because they are not specific enough to indicate which policy strategies (e.g., market-based vs. public incentives, technical assistance vs. education) are suitable for target groups given their motivations.

Schneider and Ingram (1990) offer a framework for identifying policy strategies that are appropriate for harnessing the motivations of target groups. The framework is a set of assumptions—to be tested as part of the policy design process—about the beliefs and endowments of target groups that would cause them to do the things governments want: 1) people with loyalty to duty, trust in institutions and commitment to obey laws and regulations without the aid of tangible incentives will respond to authority tools (e.g., rules and regulations); 2) people who seek to maximize utility and have adequate information and decision making skills to make choices that will lead to tangible payoffs will respond to financial incentives; 3) people who lack information, skills, or other resources yet are receptive to learning will respond to capacity-building programs; 4) people who engage in behavior on moral grounds will respond to symbolic campaigns; and 5) in cases where policy goals and the behaviors required to attain them are poorly understood and people are willing to explore and learn, learning tools are appropriate.

Schneider and Ingram's framework is one of many that have emerged from the field of policy studies (e.g., Cushman, 1941; Hood, 1983; Linder and Peters, 1989; Lowi, 1966). It is still considered among the most useful approaches because it allows for simultaneous consideration of both the capacities of the state to administer tools effectively and the beliefs that compel a target group to respond (Hood, 2007). In addition, Schneider and Ingram's framework accommodates the increasing emphasis of policy design scholars on designing optimal mixes of tools in complex decision-making contexts (Eliadis et al., 2005; Howlett, 2011) including forestry (Cubbage et al., 2007). Nevertheless, it is important to keep in mind that to provide implications for actual policies Schneider and Ingram's (1990) framework must be adapted to local contexts (Howlett, 2011; Linder and Peters, 1989). Information about the complex mix of values, beliefs, attitudes, information, skills and resources that motivate people to behave and respond to different policy instruments can aid this process (Fischer, 2003). This study seeks to improve upon past segmentation studies by combining statistical analysis of socio-demographic variables with qualitative analysis about target groups' motivations.

4. Methods

4.1. Data collection

Two parallel approaches were used to collect the data: a mail survey and qualitative interviews. The survey was administered by Oregon State University and Oregon Department of Forestry using the total design method (Dillman, 1978) in September 2008 to owners of a random sample of NIPF parcels in Oregon's ponderosa pine ecosystem. The parcels were selected by casting points onto the NIPF portions of a GIS polygon generated with four layers: (1) all pixels that were predicted to support >13 m^2/ha of ponderosa pine basal area (Ohmann and Gregory, 2002), the amount characteristic of historical ponderosa pine forests (Wright and Agee, 2004; Youngblood et al., 2004); (2) all pixels with conditions that could support ecological systems in which ponderosa pine would be a major component (Grossmann et al., 2008; Kagan et al., 2008); (3) a forest/nonforest mask; and (4) an ownership layer (Fig. 1). The polygon comprised about 1.2 million hectares of NIPF land, about 50% of all NIPF land and 15% of all forest land on Oregon's east side.

The 8-page survey asked whether owners had used 16 forest management practices that can have the result of fuel reduction in the past 5 years and how likely they were to use these practices in the future. Questions also addressed influences on NIPF owners' management approaches according to the literature (e.g., management goals, demographic characteristics, concern about fire risk, policy barriers and preferences). Respondents were asked to respond in reference to the parcel associated with the tax lot number on their surveys. The survey was reviewed by 20 natural resource professionals, landowners, and social scientists and approved by the Oregon State University Institutional Review Board. Of the 1,010 surveys that were delivered to valid addresses, 505 valid responses were received, yielding a response rate of 50%. Because of this high response rate, a follow-up survey of non-respondents was not conducted.

The survey sample consisted mostly of retirement-age males, similar to NIPF owners in the West, but more had obtained bachelor's degrees, earned above the national median household income ($50 K) and were absentee (Butler and Leatherberry, 2004). Also, a greater proportion of the sample had treated some portion of their parcel to reduce the risk of wildfire compared to owners in the West (Brett Butler, unpublished National Woodland Owner Survey data, 2006). They also owned relatively large holdings compared to owners in the West (Butler and Leatherberry, 2004). These disparities reflect the sampling approach (based on forestland, not forest owners), and the social and biophysical conditions in eastern Oregon (i.e., land use rules that set large minimum tax lot sizes, arid climate that limits productivity and therefore favors forestry and grazing on large areas.).

Semi-structured key informant interviews were conducted in 2007 and 2008 with 60 owners in three watersheds in the study area that are considered high priority for hazardous fuel reduction

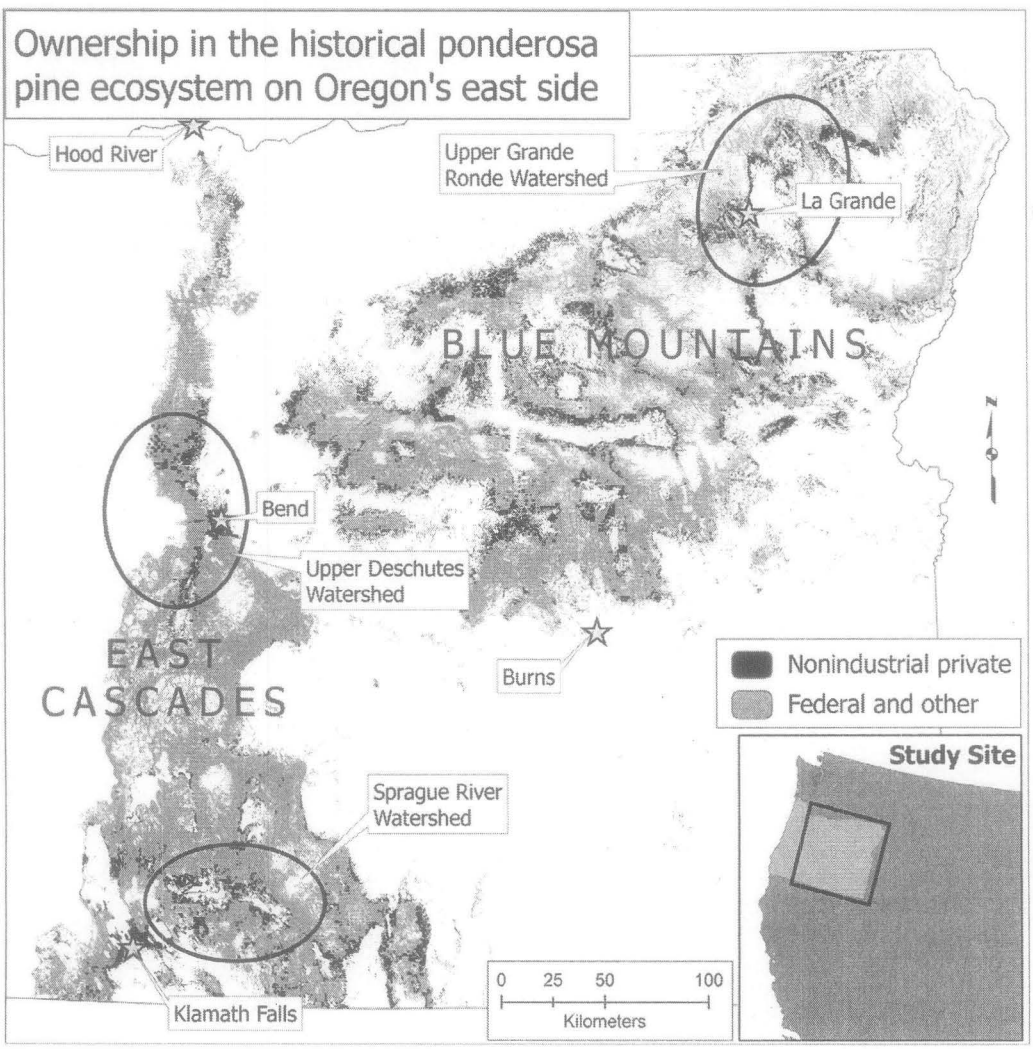

Fig. 1. Study area.

(Oregon Department of Forestry, 2006b): the Sprague, Upper Deschutes and Upper Grande Ronde River watersheds (Fig. 1). I identified owners with diverse fire experiences, management intensities, and ownership characteristics with help from local natural resource agencies and organizations. The interview sample conformed to similar demographic characteristics as the survey sample, although most interview informants had treated some portion of their parcel to reduce the risk of wildfire.

Each interview included a walking tour of the owners' property and averaged 2 hours. My questions addressed their management approaches, experiences and concerns with fire, ecological knowledge and values about fire and forest conditions, and perceptions of opportunities and constraints for hazardous fuel reduction. Digital recordings of the interviews were transcribed verbatim and entered into Atlas.ti, a software program that aids qualitative data analysis by providing ways to categorize, organize and comment on interview text.

4.2. Data analysis

Fig. 2 depicts the related processes of quantitative and qualitative data analysis. First, I conducted exploratory principal components factor analysis with Varimax rotation on variables representing owners' stated likelihoods to use the 16 management practices. Factor analysis explains the variation among the data via latent variables. The loadings that exceeded the limit of 0.4 were used in the interpretation of the principal components. Second, I conducted a series of *k*-means cluster analyses to group the survey respondents on mean indices of their likelihoods for conducting the practices that loaded together in the latent factors (Tabachnick and Fidell, 1996). Third, I used Chi-square tests and analysis of variance (ANOVA) to examine how the variables representing owners' likelihoods for using the practices and the socio-demographic variables from the literature differed among the cluster groups and assigned the groups descriptive labels based on these patterns. Fourth, I used logistic regression to identify whether cluster group membership or any of the socio-demographic variables from the literature helped explain whether survey respondents reported treating fuel on their parcels.

Fifth, I sorted the interview informants into the categories identified through the cluster analysis and analyzed their interview transcripts to understand how the groups were motivated by the factors in the logistic regression analyses. The process of sorting the interview informants into the groups was subjective and based on whether they exhibited characteristics on which the cluster groups differed (e.g., management approaches, management goals, whether they lived on their parcels). This process was a legacy of the study design, which did not initially include a segmentation analysis drawing concurrently on survey and interview data. A better way to do this in the future would be to administer the survey to the interview informants as well so that I could assign them to the groups based on their answers to the same questions as the survey respondents. I followed a standard protocol (Patton, 2002) to examine the interview transcripts. I identified and coded quotations that provided evidence for how owners were motivated to reduce fuel (e.g., residential owners feel especially vulnerable to wildfire because of their attachment to their personal effects and homes). Finally I identified policy tools

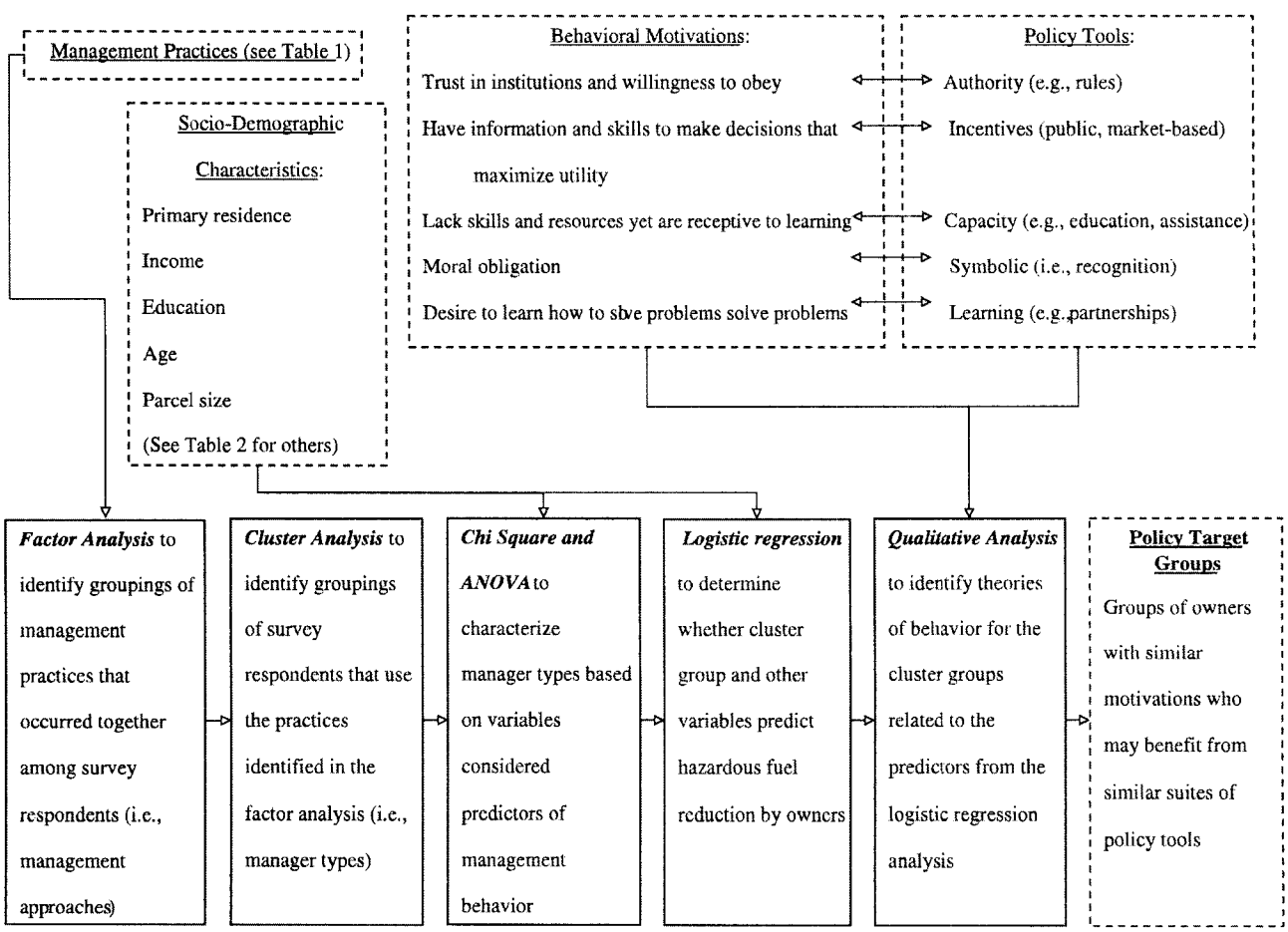

Fig. 2. Analysis methods.

that would be appropriate for targeting the subgroups on the basis of these motivations using Schneider and Ingram's framework.

5. Results

5.1. Subgroups of nonindustrial private forest owners

The factor analysis loaded the 16 forest management practices in five groupings that made sense on face value because they comprised unique management approaches. I gave these groupings of practices the following descriptive labels: HARVEST, FIREWISE, THIN, CULTIVATE and GRAZE. The practices in these groupings are presented in Table 1. The first four groupings were reliable ($\alpha \geq 0.6$). The fifth grouping did not meet the Cronbach's alpha threshold, perhaps because grazing and herbicide is common to most owners, and therefore was not used in the cluster analysis.

In the cluster analysis, the four-group solution provided the best fit for the data because each group had a different mean stated likelihood for following the management approaches represented by the latent factors. The groups also differed on the variables considered important predictors of NIPF behavior in the literature. Based on these patterns I gave the groups the following descriptive labels: commodity managers, amenity managers, recreational managers and passive managers. The variables are presented in Table 2 and the Chi-square and F statistics are provided in Table 3.

Commodity managers (26% of the survey sample) said they "probably will" harvest and sell timber (the HARVEST practices) in the 5 years following the survey. Although only half of commodity managers treated their parcels specifically to reduce hazardous fuel in the five years prior to the survey, they treated, on average, the greatest areas. They own large properties that they do not live on, and are very concerned about fire risk. In addition to timber production and grazing, commodity managers also frequently identify family legacy and privacy as very important goals. They earn income from forestry and identified funding and markets for wood products as significant barriers to fuel reduction far more frequently that the other groups. A majority of commodity managers report they would be more likely to manage if incentives were available.

Amenity managers (21% of the sample) said they "probably will" conduct the FIREWISE and THIN practices. They frequently live on their properties and are very concerned about fire risk. A majority of amenity managers reported that they had treated their parcels to reduce fire risk in the past, although they treated fewer hectares than commodity managers. The goals that amenity managers most frequently identified as very important were residence, privacy, aesthetics and habitat. A majority of amenity managers said they would be more likely to manage if incentives were available.

Recreational managers (28% of the sample) said they "might" conduct FIREWISE practices. Fewer recreational managers were very concerned about fire risk than amenity managers yet a similar proportion had treated their parcels to reduce fire risk in the five years before the survey. Recreational managers did not often live on their properties but held amenity goals as very important (e.g., privacy, aesthetics and family legacy), suggesting they may be recreational or second home owners. Similar to amenity managers, recreational managers said they were more likely to manage in response to incentives.

Passive managers (25% of the sample) said they were unlikely to conduct any practices. Nevertheless, half treated their parcels to reduce fire risk in the past—slightly more than commodity managers—though they treated on average the least number of hectares. Few passive managers were concerned about fire risk and few maintained primary residences on their properties. Few passive managers identified any of the goals as very important. A minority of passive managers said they would be more likely to manage if incentives were available.

5.2. Management motivations of the subgroups

The logistic regression tests indicated that segmentation matters in the case of NIPF owners in Oregon's ponderosa pine zone. In the logistic regression model that did not include the cluster group variables (Table 4, model 1) the only variables that helped to explain whether owners treated their parcels to reduce fire risk at $p \leq .10$ were whether owners maintained their primary residence on their parcels (RESIDENCE) or held timber production as a very important goal (TIMBER); other variables commonly used to predict NIPF management behavior (e.g., PARCEL_SIZE, OWNERSHIP_SIZE, EDUCATION, INCOME, and TENURE) were not statistically significant. When the cluster group variables were included (Table 4, model 2), the model was improved based on a log likelihood ratio test ($p \leq .001$). The cluster group variables explained survey respondents' fuel behavior: holding all other variables in the model constant, being a commodity, recreational or amenity manager was associated with a greater likelihood ($p \leq .05$) of treating one's parcel than being a passive manager. Again, with the exception of RESIDENCE, the traditional variables were not significant ($p \geq .10$). When the non-significant variables were removed individually through a manual backward step-wise process only the cluster group variables, RESIDENCE, TIMBER and LEGACY (whether owners held family legacy as a very important goal) remained (Table 4, model 3). Holding all other variables in the model constant,

Table 1
Loadings of the practices on the five main principal component axes ($N = 505$).

	HARVEST	FIREWISE	THIN	CULTIVATE	GRAZE
Likelihood to harvest timber for profit	**.938**	.012	.080	.036	.068
Likelihood to sell logs or other wood products	**.933**	−.001	.098	.054	.098
Likelihood to prune or limb up trees	−.070	**.773**	.399	.045	.041
Likelihood to thin by hand or with a chainsaw	.112	**.774**	.371	−.009	.099
Likelihood to pull plants, brush or trees by hand	−.099	**.622**	.251	.216	.002
Likelihood to clear around structures	−.012	**.788**	−.004	.354	−.016
Likelihood to make structures more fire-proof	.002	**.752**	−.092	.418	.012
Likelihood to create fuel breaks	.105	**.738**	.157	.361	.042
Likelihood to burn slash piles	.396	**.615**	.085	−.111	.381
Likelihood to thin with mechanized equipment	.388	.178	**.756**	.101	.140
Likelihood to mow, crush, grind or chip trees or brush	−.007	.276	**.799**	.164	.042
Likelihood to plant trees that are resistant to fire	.042	.290	.130	**.774**	.090
Likelihood to shade out plants, brush or trees	.049	.196	.119	**.819**	.075
Likelihood to apply herbicides	−.106	.149	.223	.227	**.730**
Likelihood to graze livestock	.215	−.106	−.076	−.026	**.802**
Likelihood to conduct understory or controlled burn	.308	.395	.124	.044	.411
Eigenvalue	2.397	5.732	1.151	1.205	1.020
Proportion Explained (%)	14.980	35.823	7.195	7.531	6.375
Cronbach's alpha	0.935	0.886	0.718	0.754	.464

Loadings ≥0.4 (printed in bold) were used in the interpretation of the principal component.

Table 2
Variables used in the cluster and regresion analyses.

Variable	Type	Definition
HARVEST_LIKELY	Continuous	Mean of respondent's stated likelihood of conducting HARVEST practices (see Table 1) on the parcel; 5-point Likert scale from "definitely will not" to "definitely will"
FIREWISE_LIKELY	Continuous	Mean of respondent's stated likelihood of conducting FIREWISE practices (see Table 1) on the parcel; 5-point Likert scale from "definitely will not" to "definitely will"
THIN_LIKELY	Continuous	Mean of respondent's stated likelihood of conducting THIN practices (see Table 1) on the parcel; 5-point Likert scale from "definitely will not" to "definitely will"
CULTIVATE_LIKELY	Continuous	Mean of respondent's stated likelihood of conducting CULTIVATE practices (see Table 1) on the parcel; 5-point Likert scale from "definitely will not" to "definitely will"
GRAZE_LIKELY	Continuous	Mean of respondents' stated likelihood of conducting GRAZE practices (see Table 1) on the parcel; 5-point Likert scale from "definitely will not" to "definitely will"
TREATED_AREA	Continuous	Hectares respondent reported treating on the parcel to reduce the risk of wildfire
PARCEL_SIZE	Continuous	Size of respondent's parcel in hectares
OWNERSHIP_SIZE	Continuous	Size of respondent's ownership in hectares
TREAT	Binary	Whether respondent reported treating any portion of the parcel to reduce the risk of wildfire: 1 if respondent treated more than 0 acres; 0 otherwise
CONCERNED	Binary	Whether respondent reported being "very concerned" (5 on a 5-point Likert scale from "not at all concerned" to "very concerned") about a wildfire on the parcel: 1 if "very concerned"; 0 otherwise
RESIDENT	Binary	Whether respondent reported maintained his/her primary residence on the parcel; 1 if yes; 0 otherwise
TIMBER	Binary	Whether respondent indicated that timber production was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise
GRAZING	Binary	Whether respondent indicated that livestock grazing was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise
RESIDENCE	Binary	Whether respondent indicated that residence was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise
REAL_ESTATE	Binary	Whether respondent indicated that real estate was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise
RECREATION	Binary	Whether respondent indicated that recreation was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise
HABITAT	Binary	Whether respondent indicated that wildlife habitat was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise
AESTHETICS	Binary	Whether respondent indicated that beauty or scenery was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise
PRIVACY	Binary	Whether respondent indicated that privacy was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise
LEGACY	Binary	Whether respondent indicated that family legacy was a "very important goal" (5 on a 5-point Likert scale from "not at all important" to "very important") on the parcel: 1 if "very important"; 0 otherwise.
INCOME_FORESTRY	Binary	Whether respondent reported receiving income from timber sales or other forestry activities; 1 if yes; 0 otherwise
MARKETS_BARRIER	Binary	Whether respondent indicated that lack of log markets was a "very significant barrier" (5 on a 5-point Likert scale from "not at all significant" to "very significant") to fuel reduction on the parcel: 1 if "very significant"; 0 otherwise
FUNDING_BARRIER	Binary	Whether respondent indicated that lack of public funding was a "very significant barrier" (5 on a 5-point Likert scale from "not at all significant" to "very significant") to fuel reduction on the parcel: 1 if "very significant"; 0 otherwise
CAPACITY_BARRIER	Binary	Whether respondent indicated that lack of knowledge, skills and abilities was a "very significant barrier" (5 on a 5-point Likert scale from "not at all significant" to "very significant") to fuel reduction on the parcel: 1 if "very significant"; 0 otherwise
INCENTIVES	Binary	Whether respondent indicated greater likelihood to conduct any of the practices in Table 1 if incentives were available: 1 if "more likely"; 0 otherwise

commodity managers were 5 times as likely to treat than passive managers ($p \leq .05$), recreational managers were 7.5 and times as likely to treat as passive managers ($p \leq .05$), and amenity managers were 51.5 times as likely to treated as passive managers ($p \leq .001$). Owners who maintained their primary residences on their parcels were 6 times as likely to treat as non-resident owners and owners who held timber and family legacy as a very important goals were respectively 4.5 and 2.2 times as likely to treat as owners who did not hold these goals as important ($p \leq .05$).

These logistic regression tests suggest that the likelihood of owners treating fuel depends more on timber production and family legacy goals, and group membership than on more commonly used predictors like parcel size, age and income. However, quantitative analysis alone does not provide insight about why these factors are important among this sample of NIPF owners. Qualitative analysis of the interview transcripts describes the influence of these factors on owners' fuel reduction behavior.

5.2.1. Timber production as a very important goal

Interview informants who were commodity managers (14 of the 60 interview informants) explained how holding timber as a very important goal—an attribute that characterized this group more than any other group—compelled them to reduce fuel. Not surprisingly owners of large parcels who harvested and sold timber were compelled to protect their timber assets from fire risk. "If a fire came through the timber I would lose 50% of its value today," said an owner of 700 acres in the Sprague River watershed. "And I would lose all my baby trees...it's going to take another 80 years to get some trees on it."

Commodity managers also described how in eastern Oregon where dry conditions in most cases require selection cutting rather than even-aged management (i.e., clearcutting), timber harvest provides the benefit of fuel reduction even when mitigating fire risk isn't the goal. An owner near Bend explained: "When we logged, we took the bigger trees and tried to select the best that you had to leave there. That took care of the thinning part...you kind of killed two birds with one stone." Commodity managers also explained the importance of markets to fuel reduction. "We don't thin when the markets are low," explained an owner of a 243-hectare parcel in Union County. "It's not an option because even a nice marketable log is going to cost you to get rid of it," said the timberland owner near Bend. When markets are not available, cost-share funding makes fuel reduction possible according to many commodity managers including an owner of 243 hectares outside of La Grande: "[Without markets] these are not merchantable; they're pulp. It

Table 3
Cluster groups and the variables on which they differ.

	Sample	COMMODITY	AMENITY	RECREATIONAL	PASSIVE	
Percentage of sample	100.0	26.5	21.1	27.8	24.6	
Percentage of sample area	100.0	39.7	10.5	26.3	23.5	
						F (3, 442)
HARVEST_LIKELY	2.6	4.3	2.2	1.8	1.7	256.711***
FIREWISE_LIKELY	3.3	3.3	4.4	3.7	1.9	253.013***
THIN_LIKELY	2.8	3.1	4.1	2.2	1.7	199.137***
GRAZE_LIKELY	3.4	3.7	3.1	3.1	2.8	3.270*
TREATED_AREA	75.7	132.3	59.3	70.8	36.4	3.964**
PARCEL_SIZE	502.4	799.1	297.9	496.3	364.3	6.147***
OWNERSHIP_SIZE	1046.7	1632.6	496.3	974.4	1041.1	5.279**
						X^2 (3)
TREAT	68.9	49.3	83.8	82.6	53.5	66.106***
CONCERNED	44.0	52.6	59.3	43.0	25.5	62.729***
RESIDENT	22.5	22.8	44.6	25.2	12.7	27.477***
TIMBER	21.8	44.8	16.5	13.3	10.5	41.660***
GRAZING	29.3	47.0	17.8	21.5	29.0	26.032***
RESIDENCE	32.3	25.0	48.3	39.3	17.2	26.825***
RECREATION	26.6	24.8	30.0	36.7	14.3	15.804***
HABITAT	37.5	36.3	47.8	43.4	23.1	15.737***
AESTHETICS	42.5	34.2	52.2	49.6	35.0	11.622**
PRIVACY	50.0	44.3	63.0	57.0	36.5	17.835***
LEGACY	40.6	45.2	42.2	45.8	27.9	9.757*
INCOME_FORESTRY	33.0	61.0	25.5	18.5	25.5	57.08***
MARKETS_BARRIER	23.4	46.2	16.3	12.8	15.8	43.607***
FUNDING_BARRIER	17.5	23.4	15.6	16.8	13.7	3.847
CAPACITY_BARRIER	13.6	14.9	13.6	9.8	17.0	2.714
INCENTIVES	73.2	85.6	83.7	76.6	48.1	45.768***

*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$.
Degrees of freedom in parentheses.

would not pay to [remove the small trees] without cost-share money...So next year I will not do any."

5.2.2. Family legacy as an important goal

Many commodity, amenity and recreational managers managed their parcels to perpetuate their family legacy. They viewed their parcels as financial assets and things of sentimental and cultural value for their children to enjoy in the future. When asked about the values on his parcel that he wanted to protect from wildfire an owner in the Sprague River watershed said: "What I am wanting is something to leave my grandchildren and my children." This owner, who I classified as a commodity manager, explained that fuel reduction is important to his ability to ensure that future generations will have a chance to enjoy his forestland. "You have to harvest the trees to keep a healthy forest," he said, referring to the benefits of timber harvest for reducing a stand's vulnerability to stress from drought and bark beetle infestations as well as fire. Commodity managers considered harvesting and selling timber a more satisfactory means to mitigating fire risk than non-commercial fuel reduction approaches such as chipping vegetation and leaving it on the forest floor or piling and burning it because it maintains a tradition of working the land, perpetuating a family legacy.

Interview informants who were recreational managers (4 of the 60 interview informants) also viewed family legacy in terms of future time spent recreating as a family on their land. An owner of 120 acres west of Bend said his goal for reducing fire risk on his parcel was:

> To pass on to the kids an area that is beautiful and safe and something that you can use, not to grow timber...for cross-country skiing and hiking in the summer time...and snowmobiling in the winter.

5.2.3. Living on one's parcel

Amenity managers (41 of the 60 interview informants), who most frequently were resident landowners, said maintaining one's primary residence on a parcel heightens one's sense of vulnerability to wildfire and provides a greater capacity to reduce its risks compared to people who do not live on their parcels. This sense of vulnerability is related to potential loss of things of sentimental value. When asked about his greatest concern about wildfire an owner of a 405-hectare parcel near the Sprague River said:

> Losing your home is the biggest thing, and losing a forest: the resource, the habitat for the animals...Losing half of my life and a place that would just break my heart to have destroyed. To manage it is OK, but to have it destroyed would be disastrous.

Table 4
Three logistic regression models predicting influences on TREAT.

	Model 1[a]		Model 2[b]		Model 3[c]	
Variables	Sig.	Exp(B)	Sig.	Exp(B)	Sig.	Exp(B)
PASSIVE			.467	2.821	.000	.349
COMMODITY			.013	3.286	.000	5.121
RECREATIONAL			.002	4.660	.000	7.563
AMENITY			.000	20.98	.000	51.530
RESIDENT	.005	7.547	.016	9.057	.000	6.078
PARCEL_SIZE	.106	1.000	.165	1.000		
OWNERSHIP_SIZE	.300	1.000	.398	1.000		
CONCERNED	.305	1.452	.607	1.232		
TIMBER	.027	3.007	.026	3.297	.001	4.531
GRAZING	.388	1.423	.543	1.318		
RESIDENCE	.313	1.749	.665	1.306		
RECREATION	.777	1.122	.933	.962		
REAL_ESTATE	.790	.887	.414	.660		
HABITAT	.823	1.107	.827	1.118		
AESTHETICS	.710	1.200	.946	1.037		
PRIVACY	.724	.853	.770	1.161		
LEGACY	.238	1.540	.305	1.514	.017	2.156
AGE	.123	.973	.158	.972		
EDUCATION	.425	1.322	.998	.999		
INCOME	.417	.694	.782	.868		
TENURE	.264	.989	.864	1.002		
CONSTANT	.070	9.543				

[a] Includes variables considered important predictors in literature.
[b] Includes variables from literature and cluster groups.
[c] Includes significant variables after manual backwards step-wise regression.

Although amenity managers were concerned about the risks of wildfire to their timber and the scenic beauty, recreational opportunities and wildlife habitat they enjoy, these values are ultimately replaceable according to many of them, whereas things of sentimental values are not. "Even with good insurance there is still going to be losses you can't recover," said an owner of a 7-hectare parcel, referring to his home and family heirlooms. "[But] in the long run, the forest is resilient and the wildlife is resilient," he explained.

Living on one's parcel makes it convenient to observe the accumulation of fuel and take incremental steps toward reducing them, claimed several amenity managers. A doctor who lives with his family on 689 hectares outside of La Grande explained:

> [The resident owner] has a greater awareness of what happens and a greater ability to deal with his concerns because he lives there. A nonresident owner may have the same concerns but he can't go out after supper and deal with them.

Amenity managers also said living on their parcels compelled them to use more diverse practices than nonresident owners such as commodity managers who mainly harvested timber. Amenity managers used firewise practices around their homes, thinned and harvested trees in outlying areas where scenic beauty and privacy were not as important, and left thickets intact in areas where wildlife such as elk frequent. "Big equipment is not going to individualize," explained a resident owner of 100 hectares outside of Bend about why she thinned by hand instead of with mechanized equipment in the areas around her house. "It's not going to take into consideration the small pine trees that are growing and should be left [near the house]." A self-described tree farmer who lives on his 99-hectare parcel in Central Oregon provided a similar explanation for why he used mechanized thinning techniques to treat fuel on the parcel where he lives rather than the timber harvesting practices he uses on his other properties: "I am scaling the equipment to the manpower and to the job by using tools that fit...small machines that can get around, underneath, and in between the trees."

Commodity managers said that their tendency to own numerous large parcels great distances from where they lived worked against fine-scale manual and mechanized fuel reduction practices. An owner of hundreds of hectares south of Bend described the challenge of reducing fuel through means other than timber harvesting on large remote parcels.

> It's a daunting task...If we had one [hectare] we could go in there and in two weekends do what needed to be done, but when you have hundreds of them it's hard to get hundreds of weekends.

Passive managers (3 of the 60 interview informants), who did not live on their parcels or hold timber production or family legacy as very important goals, apparently lacked strong rationales for fuel reduction. Passive managers frequently held livestock grazing as an important goal. They were generally not concerned enough about fire to warrant addressing it. A rancher who owns of 405 hectares north of La Grande explained how grazing reduces grass height and crushes branches, obviating the need for removal of brush and other small diameter vegetation:

> Our cattle control it. They lay a lot of that stuff down, and when it is little and tender they just nip it off. If we didn't have the cows we would be more concerned.

Passive managers exhibited high tolerance for risk, in some cases to the point of abdication. "The risk is high but probability is low," one owner said. "If it starts, it's going to go. But how much prevention do you want to do?"

6. Discussion of target groups and policy implications

In this study the purpose of the quantitative data was to identify subgroups of NIPF owners, describe their management behavior and socio-demographic characteristics, and identify which characteristics are factors in their hazardous fuel reduction behavior; the purpose of the qualitative data was reveal why these factors compel the subgroups to treat hazardous fuel (i.e., theories of behavior) (Fig. 2). Here I draw on both the quantitative and qualitative data to propose policy strategies that are appropriate for harnessing the motivations of the subgroups using Schneider and Ingram's framework.

6.1. Commodity managers

Given that commodity managers comprise a quarter of the survey sample and control almost 40% of NIPF land in Oregon's ponderosa pine zone harnessing their contributions to fuel reduction through public policy is extremely important. These owners of large properties who perceive great fire risk are motivated to harvest and sell timber by the opportunity to receive income and protect assets. Thus, incentives—the type of policy tool that assumes a target group is motivated to maximize utility and has the skills and resources to make decisions that lead to tangible payoffs (Schneider and Ingram, 1990)—is an appropriate policy tool for this group. This finding is notable in light of research that suggests most NIPF owners in the United States manage for amenities (Butler 2008). However, it is important to note that commodity owners are not motivated by financial reward alone. They also desire to perpetuate a family legacy of working forestry. Thus, they may also benefit from symbolic tools, which are appropriate for people who act on the basis of their beliefs and values. Policies that link fuels reduction with the reinvigoration of markets for small-diameter wood products could provide economic justification for reducing fuel in a way that is consistent with commodity managers' beliefs and values about managing forests as a family legacy. Where markets are not feasible, tax credits and cost-share programs could provide alternative streams of revenue, since commodity owners also indicate that they would be more likely to manage if public incentives were available to offset the costs of fuel reduction. Capacity-building tools are not a solution to the problem of how to entice this group to engage in more fuel reduction this group. Commodity managers have demonstrated that they are capable of reducing fuel by harvesting timber, and few claimed knowledge, skills and abilities as barriers to fuel reduction (Table 3). The data we collected do not provide insight into whether commodity managers would benefit from learning tools, although there may be opportunities for engaging this group in learning activities, for example, around how to stimulate markets and leverage supply.

6.2. Amenity managers

These residential owners of smaller properties who manage for amenities and perceive great fire risk reduce fuel out of a desire to protect things of sentimental and amenity value: their homes and the forests that define the places where they live. They are motivated by beliefs and values about land as a place that provides scenic beauty, habitat, privacy and a family legacy. Thus, amenity managers can be expected to respond to symbolic policies. Although amenity managers say they are more likely to manage in response to incentives, they do not seek payoffs in a monetary sense, and they already plan to reduce fuel in the future without the condition of incentives; they do not require incentive tools, although they may respond to them. To the extent that amenity managers are constrained in reducing fuel, it is by their own capacity rather than their need for tangible reward or recognition. Although few amenity managers report that their knowledge, skills and abilities are very significant barriers to

fuel reduction, many view fuel reduction as prohibitively expensive. Therefore, the policy tools that may best help amenity managers conduct more of the diverse fuel treatments they seem to prefer are technical and financial assistance programs such cost-share funding and grants. Delivering these programs in tandem with symbolic campaigns that cast wildfire risk as a threat to home, habitat, scenery and privacy for current owners and future generations may increase their appeal. Although amenity managers' parcels comprise only one-tenth of Oregon's ponderosa pine zone, they are the only group that demonstrates potential for fine-scale management. Thus, harnessing the contributions of this manager group is especially important for areas with delicate ecosystems or diverse topography where fine-scale management is required.

6.3. Recreational managers

These absentee owners of medium sized parcels are motivated to reduce fuel to protect their properties' scenery and privacy for current and future generations. Like commodity and amenity managers, recreational managers are motivated by beliefs and values about land use. Thus, they would benefit from symbolic tools. However, unlike commodity and amenity managers, recreational managers say they are not likely to reduce fuel except perhaps by using practices in the FIREWISE category, even though they have treated their parcels in the past. This indicates they have previously been concerned about fire risk and capable of acting on this concern. The policy tools that recreational managers may benefit from are therefore tangible payoffs to entice them to reduction fuel in the future. Indeed, recreational managers report that they will be more likely to reduce fuel in response to public incentives. That most recreational amenity managers do not live on their properties suggests that doing fuel treatments on their land may be inconvenient. Providing public incentives through third-party contractors or consultants who can help recreational managers plan future fuel reduction, increasing the frequency and scale of their treatments. Complimenting incentives with symbolic campaigns about wildfire as risk to recreational opportunities, scenery and privacy for current owners and future generations may also be helpful. Recreational managers are important because they control one-quarter of the NIPF land in Oregon's ponderosa pine ecosystem.

6.4. Passive managers

These absentee owners for whom few management goals are salient are not overly concerned about the consequences of fire and therefore not motivated to address risk. They do not frequently indicate that they are limited by public funding or their knowledge, skills and abilities, and do not say they are more likely to manage with incentives. Thus, policy strategies based on symbolic, incentive or capacity tools do not appear to be particularly suitable. It may be tempting to assume that passive managers need prodding with policy "sticks" to increase their contributions to fuel reduction. However, the literature suggests that woodland owners and ranchers in the rural U.S. West generally look askance at rules and regulations (Brook et al., 2003; Ellefson, 2000). Thus, authority tools will likely be poorly received by this group. In the absence of more information about the motivations of this subgroup of NIPF owners and the hazardous fuel conditions on their parcels, it may be necessary to allow passive managers to respond to the policies designed for the other groups. More research is needed to determine whether the forest conditions on the lands owned by this group are hazardous, and why owners are not concerned. This information will indicate whether passive managers can be motivated to reduce fuel by increased awareness about fire risk or capacity, or whether policy makers must entice passive managers with incentives or coerce them with regulation to ensure that they mitigate fire risk on their lands.

7. Conclusions

This study demonstrates how segmenting a population can be a useful step in policy design, especially when dealing with heterogeneous groups like NIPF owners in Oregon's fire-prone ponderosa pine ecosystem. This study also demonstrates how incorporating qualitative interview data in a mixed-methods approach provides a more detailed picture than survey data alone of how and why groupings view policy problems such as wildfire differently—in this case, that owners' uses of and goals for their parcels combine to create unique target groups with different motivations to respond to policy tools.

The qualitative data reveal important dimensions of commodity and amenity managers' motivations for reducing fuel; for example, although commodity managers are motivated by tangible reward, they are not looking for any government "carrot"; rather, they desire an opportunity to offset the costs of fuel reduction treatments and to continue participating in an economic system that defines the tradition of working lands in eastern Oregon: harvesting and selling timber. The qualitative data also reveal that although amenity managers indicate that they will respond to incentives, they are not motivated by financial reward. They act primarily on their beliefs and values about home ownership but are constrained by the costs and technical complication of fuel reduction. Thus, they would benefit from increased capacity. Based on the survey results alone, it also might be tempting to conclude that recreational and passive managers must be educated about the risk of wildfire and the need commit to fuel reduction in the future, or coerced to provide this public good. But the qualitative data, although more limited for these groups because of the study design, reveal a more nuanced picture in which absenteeism makes fuel reduction inconvenient and lack of focus on timber, family legacy and residential goals makes it unwarranted.

Although this study focuses on the ponderosa pine zone of eastern Oregon, most western states have arid forested regions with substantial NIPF ownership that are experiencing accumulation of hazardous fuel, increasing wildfires and decreasing markets for logs. Thus, findings from this study may inform the design of policies to encourage management of fire risk by NIPF owners in the West more generally.

Acknowledgments

I sincerely thank the respondents for taking time to participate in the interviews and respond to the surveys. P. Cunningham conducted a statistical review of the paper and provided other helpful statistical advice. J. Kline reviewed the paper and provided advice on segmentation. Advice on the study design was provided by S. Charnley and J. Bliss. K. Olsen provided assistance with GIS and C. Olsen provided statistical assistance. Oregon State University and Oregon Department of Forestry, particularly G. Lettman, helped support and administer the research. T. Gamache and others at Oregon Department of Forestry were responsible for survey logistics and data management. Funding was provided in part by National Fire Plan.

References

Ager, A.A., Vaillant, N.M., Finney, M.A., Preisler, H.K., 2012. Analyzing wildfire exposure and source -sink relationships on a fire prone forest landscape. Forest Ecology and Management 267, 271–283.

Alig, R.J., Lee, K.J., Moulton, R., 1990. Likelihood of management on nonindustrial private forests: evidence from research studies. USDA Forest Service, Southeast Forest Experiment Station, Asheville, NC.

Amacher, G.S., Conway, M.C., Sullivan, J., 2003. Econometric analyses of nonindustrial forest landowners: Is there anything left to study? Journal of Forest Economics 9, 137–164.

Amacher, G.S., Malik, A.S., Haight, R.G., 2005. Not Getting Burned: The Importance of Fire Prevention in Forest Management. Land Economics 81, 284–302.

Beach, R.H., Pattanayak, S.K., Yang, J.C., Murray, B.C., Abt, R.C., 2005. Econometric studies of non-industrial private forest management: a review and synthesis. Forest Policy and Economics 7, 261–281.

Bengston, D., Asah, S., Butler, B., 2011. The diverse values and motivations of family forest owners in the United States: an analysis of an open-ended question in the National Woodland Owner Survey. Small-Scale Forestry 10, 339–355.
Brook, A., Zint, M., Young, R.D., 2003. Landowners' responses to an Endangered Species Act listing and implications for encouraging conservation. Conservation Biology 17, 1638–1649.
Butler, B.J., 2008. Family Forest Owners of the United States, 2006. U.S. Department of Agriculture, Forest Service, Northern Research Station, Newtown Square, PA, p. 72.
Butler, B.J., Leatherberry, E.C., 2004. America's family forest owners. Journal of Forestry 102, 4–9.
Butler, B.J., Tyrrell, M., Feinberg, G., VanManen, S., Wiseman, L., Wallinger, S., 2007. Understanding family forest owners: lessons from social marketing research. Journal of Forestry 105, 348–357.
Calkin, D., Gebert, K., 2006. Modeling fuel treatment costs on forest service lands in the Western United States. Western Journal of Applied Forestry 21, 217–221.
Carroll, M.S., Cohn, P.J., Blatner, K.A., 2004. Private and tribal forest landowners and fire risk: a two-county case study in Washington State. Canadian Journal of Forest Restoration 34, 2148–2158.
Conway, M.C., Amacher, G.S., Sullivan, J., Wear, D., 2003. Decisions nonindustrial forest landowners make: an empirical examination. Journal of Forest Economics 9, 181–203.
Cubbage, F., Harou, P., Sills, E., 2007. Policy instruments to enhance multi-functional forest management. Forest Policy and Economics 9, 833–851.
Cushman, R.E., 1941. The Independent Regulatory Comissions. Oxford University Press, London.
Dillman, D.A., 1978. Mail and Telephone Surveys: The Total Design Method. John Wiley and Sons, New York.
Eliadis, P., Hill, M., Howlett, M., 2005. Designing Government: From Instruments to Governance. McGill-Queen's University Press, Montreal, CA.
Ellefson, P.V., 2000. Has Gifford Pinchot's regulatory vision been realized? Journal of Forestry 98, 15–22.
Finley, A.O., David, B., Kittredge, J., Stevens, T.H., Schweik, C.M., Dennis, D.C., 2006. Interest in cross-boundary cooperation: identification of distinct types of private forest owners. Forest Science 52, 10–22.
Fischer, F., 2003. Reframing Public Policy: Discursive Politics and Deliberative Practices. Oxford University Press, Oxford.
Fischer, A.P., 2011. Reducing hazardous fuels on nonindustrial private forests: factors influencing landowner decisions. Journal of Forestry 109, 260–266.
Fischer, A.P., Bliss, J., Ingemarson, F., Lidestav, G., Lönnstedt, L., 2010. From the small woodland problem to ecosocial systems: the evolution of social research on small-scale forestry in Sweden and the USA. Scandinavian Journal of Forest Research 25, 390–398.
Fischer, A.P., Charnley, S., 2012. Risk and cooperation: managing hazardous fuel in mixed ownership landscapes. Environmental Management 49, 1192–1207.
Fried, J.S., Winter, G., Gilless, K., 1999. Assessing the benefits of reducing fire risk in the wildland–urban interface: a contingent valuation approach. International Journal of Wildland Fire 9, 9–21.
Grossmann, E.B., Kagan, J.S., Ohmann, J.A., May, H., Gregory, M.J., Tobalske, C., 2008. Final Report on Land Cover Mapping Methods, Map Zones 2 and 7, PNW ReGAP. Institute for Natural Resources, Oregon State University, Corvallis, OR.
Hartsough, B.R., Abrams, S., Barbour, R.J., Drews, E.S., McIver, J.D., Moghaddas, J.J., Schwilk, D.W., Stephens, S.L., 2008. The economics of alternative fuel reduction treatments in western United States dry forests: financial and policy implications from the National Fire and Fire Surrogate Study. Forest Policy and Economics 10, 344–354.
Hessburg, P.F., Agee, J.K., Franklin, J.F., 2005. Dry forests and wildland fires of the inland Northwest USA: constrasting the landscape ecology of the pres-settlement and modern eras. Forest Ecology and Management 211, 117–139.
Hood, C., 1983. The Tools of Government. Macmillan, London.
Hood, C., 2007. Intellectual Obsolescence and Intellectual Makeovers: Reflections on the Tools of Government after Two Decades. Governance 20, 127–144.
Howlett, M., 2011. Designing Public Policies: Principles and Instruments. Routledge, Hoboken, NJ.
Jarrett, A., Gan, J., Johnson, C., Munn, I.A., 2009. Landowner awareness and adoption of wildfire programs in the southern United States. Journal of Forestry 107, 113–118.
Joshi, S., Arano, K.G., 2009. Determinants of private forest management decisions: a study on West Virginia NIPF landowners. Forest Policy and Economics 11, 118–125.
Kagan, J.S., Ohmann, J.L., Gregory, M., Tobalske, C., 2008. Land Cover Map for Map Zones 8 and 9 Developed from SAGEMAP, GNN, and SWReGAP: A Pilot for NWGAP. Gap Analysis Bulletin 15.
Kendra, A., Hull, R.B., 2005. Motivations and behaviors of new forest owners in Virginia. Forest Science 51, 142–154.
Kline, J.D., Azuma, D.L., 2007. Evaluating forest land development effects on private forestry in eastern Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR, p. 18.
Kline, D., Alig, J., Johnson, L., 2000a. Fostering The Production Of Nontimber Services Among Forest Owners With Heterogeneous Objectives. Forest Science 46, 302–311.
Kline, J.D., Alig, R.J., Johnson, R.L., 2000b. Forest owner incentives to protect riparian habitat. Ecological Economics 33, 29–43.
Kluender, R.A., Walkingstick, T.L., 2000. Rethinking how nonindustrial landowners view their lands. Southern Journal of Applied Forestry 24, 150–158.
Kuuluvainen, J., Karppinen, H., Ovaskainen, V., 1996. Landowner objectives and nonindustrial private timber supply. Forest Science 42, 300–309.
Lincoln, Y.S., Guba, E.G., 1985. Naturalistic Inquiry. Sage Publications, Newbury Park, CA.
Linder, S.H., Peters, B.G., 1989. Instruments of government: perceptions and contexts. Journal of Public Policy Sciences 9, 35–58.
Lowi, T.J., 1966. Distribution, regulation, redistribution: the functions of government. In: Ripley, R.B. (Ed.), Public Policies and their Politics: Techniques of Government Control. W.W. Norton, New York, pp. 27–40.
Majumdar, I., Teeter, L., Butler, B., 2008. Characterizing Family Forest Owners: A Cluster Analysis Approach. Forest Science 54, 176–184.
Ohmann, J.L., Gregory, M.J., 2002. Predictive mapping of forest composition and structure with direct gradient analysis and nearest-neighbor imputation in coastal Oregon, U.S.A. Canadian Journal of Forest Research 32, 725–741.
Oregon Department of Forestry, 2006a. Oregon Spatial Analysis Project, Salem, OR, p. 29.
Oregon Department of Forestry, 2006b. Oregon's Communities at Risk Assessment. Oregon Department of Forestry, Salem, OR, p. 39.
Patton, M.Q., 2002. Qualitative Research and Evaluation Methods, Third ed. Sage Publications, Thousand Oaks, CA.
Schneider, A., Ingram, H., 1990. Behavioral assumptions of policy tools. Journal of Politics 52, 510–529.
Serbruyns, I., Luyssaert, S., 2006. Acceptance of sticks, carrots and sermons as policy instruments for directing private forest management. Forest Policy and Economics 9, 285–296.
Tabachnick, B., Fidell, G., 1996. Using Multivariate Statistics. Harper Collins, New York, NY.
Vokoun, M., Amacher, G.S., Wear, D.N., 2006. Scale of harvesting by non-industrial private forest landowners. Journal of Forest Economics 11, 223–244.
Wright, C.S., Agee, J.K., 2004. Fire and vegetation history in the eastern Cascade Mountains, Washington. Ecological Applications 14, 443–459.
Youngblood, A., Max, T., Coe, K., 2004. Stand structure in eastside old-growth ponderosa pine forests of Oregon and northern California. Forest Ecology and Management 199, 191–217.