

Summary of goals and methods

In September 2008 we conducted a survey of owners of a random sample of private non-industrial forest parcels to learn how they manage and perceive wildland fire risks. Our population was owners in the area of Eastern Oregon that was historically dominated by ponderosa pine, an ecotype that is out of its historical range of variability in terms of species composition, structural conditions and fire regime.

We created the sampling frame by first generating a GIS layer of the study area. Using models from the LEMMA (Landscape Ecology Modeling Mapping and Analysis) group we created and overlaid GIS layers of predicted ponderosa pine forest cover (all pixels with *Pinus ponderosa* basal area of $>13 \text{ m}^2/\text{ha}$) and potential ponderosa pine vegetation (represented by the ecological systems “Northern Rocky Mt. ponderosa pine woodland and savanna” and “Mediterranean California dry-mesic conifer forest”). Then we overlaid a forest/non-forest mask and an ownership layer, and eliminated areas that were not forestlands in non-industrial private ownership. The non-industrial private forestlands in the study area of comprise about 1.2 million acres. Finally we selected the sample by casting random points on the non-industrial private lands in the polygon and obtaining the associated taxlot numbers and owners’ mailing addresses.

To design the survey we drew on data we had gathered from qualitative interviews with landowners (i.e. language, answer choices). We followed Dillman’s Tailored Design Method to administer the survey. We sent out an announcement card followed by the 8-page survey, a thank you/reminder card, a second survey to non-respondents, and a non-respondent query. The survey questions addressed people’s goals, practices, experiences and perspectives on forest management, wildland fire and invasive species specifically on the parcels associated with the taxlots upon which our GIS points fell. The response rate was 50%.

Preliminary distributions and central tendency statistics are provided for every question in the survey in a separate frequency report. A summary of descriptive statistics and the results of several inferential statistical tests is provided here.

Descriptive statistics

Demographics

The sample consists mostly of males (78%) and retirement age individuals (mean=63 years). The sample members are highly educated (49% with a bachelor’s degree or more) and most earn above the national median household income (62%). A minority of sample members belongs to natural resource-related organizations; most of those that do belong are members of hunting and fishing clubs, fire protection groups and property owners’ associations. They own relatively large holdings (median = 625 acres) and individual parcel sizes (median=392 acres). Few use the parcels we were asking about as their primary residence (26%) and many live a great distance from the parcels (median=75 miles).

Management goals

The goals that at least 1/3rd of respondents consider “very important” on their parcel include privacy (50%), beauty and/or scenery (43%), family legacy (42%), wildlife habitat and/or

biological diversity (37%) and residence (34%). When asked to identify their most important goal 20% of respondents chose residence, 18% chose grazing, 16% chose family legacy, 11% chose timber and wood production and 11% chose habitat.

Past practices

Between 2003 and 2008 the respondents treated a total of 86,000 acres on the parcels we inquired about. A quarter of the respondents treated one or fewer acres and 50% treated between 20 and 5550 acres. They used a wide variety of practices from pruning (63%) and hand thinning (66%) to mechanized thinning (39%), harvesting timber for profit (30%) and understory burning (23%). The owners used a variety of arrangements to do the work from working on their own or with family members (31%), cooperating with neighbors (7%), hiring contractors (23%), and cooperating with public agencies (6%) and non-profit groups (3%).

Risk perception

The sample members are motivated by perceptions of risk from wildfire; 67% are more than moderately concerned about a wildfire occurring on their parcel. Many have experienced fire directly; 63% have had a fire burn near their parcel, 40% have had a fire burn on their parcel, 22% have lost trees on their parcel to a fire, 3% have lost structures and 3% have lost a home. They are most concerned about a wildfire affecting the timber value (42%) and scenic beauty (41%) on their parcels in addition to human life (38%), land value (38%) and ecological values (35%). The hazards they are “very concerned” about include lightning (45%), conditions on nearby public lands (33%), drought (24%), and insects and plant diseases (24%).

Ecological knowledge

The respondents are knowledgeable and hold positive attitudes about the ecology of ponderosa pine systems. Seventy percent agree that wildfire played a beneficial role in ponderosa pine forests in the past and 66% believe wildfire can help to maintain open park-like conditions that are characteristic of the ecosystem. Only 33% view wildfire as detrimental and believe it should be suppressed. The majority believe wildfire can improve tree growth (64%) and reduce insect and disease problems (74%) in ponderosa pine forests.

Future practices

The practices respondents said they would most likely conduct in the future include pruning and limbing, thinning by hand or with a chainsaw, grazing livestock and burning slash piles. Only 22% said they will probably or definitely harvest timber and 26% said they will probably or definitely sell logs and other wood products. Nineteen percent said they will probably or definitely conduct understory controlled burns. Respondents indicated they would be willing to cooperate with other ownership groups to reduce fire risk on their parcels in the future when the circumstances benefit them. At least half the sample said they would be willing to cooperate with their private or public land-owning neighbors when it reduces their share of the cost, makes more equipment available, makes more public funding available and releases them from liability for escaped fires.

Policy attitudes

The sample members identified numerous barriers to reducing fire risk on their parcels. The barriers that the respondents view as “very significant” include personal funds, cost of

transporting logs or wood products, markets for logs, markets for wood products and time. Sixty-six percent of respondents said they would be more likely to conduct future work if incentives were available. Incentives they said would help the most include tax cost-share funding, direct payments, tax credits, state or federal grants, liability waivers for fires escaping while doing work, technical assistance, reduced insurance costs and training and education.

Inferential statistics

Management factor groups

To better understand respondents' management approaches we conducted a factor analysis with Varimax rotation on the practices the respondents used to treat and deal with material on their parcels between 2003 and 2008. The analysis identified four categories of practices with Cronbach's alphas of .6 or more indicating they were reliable groupings. A fifth category ("grazing and understory burning") did not meet this threshold. The table below presents the four groups and the practices with factor loadings of .4 or greater that comprise them.

Factor and reliability analyses of management practices

Factor Group	Practices with factor loadings of $\geq .4$	Cronbach's Alpha
Low intensity	Prune or limb up trees Thin by hand or with chainsaw Pull by hand Clear around structures Make structures more fire-proof	0.886
Passive	Plant fire-adapted trees Shaded out vegetation	0.754
Mechanized	Thin with mechanized equipment Mow, crush, grind or chip	0.718
Forestry	Harvest timber for profit Sell logs or other wood products	0.935

Manager cluster groups

We conducted a K-means cluster analysis to group the sample members based on how likely they said they were to conduct the management activities in the factor groups. Incidentally, stated likelihood was highly correlated with stated past practices. This exploratory analysis helped us identify manager types. These groupings of people may share similar goals, motivations and management styles, perhaps constituting policy target groups.

Chi Square and F-statistic tests indicate significant differences between the cluster groups on some variables: primary residence, concern level, age, tenure length and income. A few notable observations about the cluster groups include:

1. Forestry managers (those who said they would likely harvest and sell forestry products) treat the highest median number of acres.
2. Non-managers (those who did not say they were likely to conduct any of the practices) are more female, older, less educated, more absentee, more focused on grazing and much less concerned about fire risk.
3. Active managers (those who said they would likely conduct the practices in the "low intensity" and "mechanized" factor groups) are more often primary residents, higher

income earners, younger, more recent owners and more often cite residence as their primary goal.

- Potential managers (those who said they might conduct the practices in the “low intensity” factor group) were an enigma. They did not say they were likely to conduct any practices yet the number of acres they treated to reduce fire risk on their parcels was above the median number of acres treated by the entire sample. They more often cited residence as their most important goal and owned larger parcels and ownerships than the active managers. This non-committal group of landowners may be an opportunity group for policy

	Sample	Cluster groups				x2
		Forestry	Non-	Potential	Active	
% of sample		26.5	24.6	27.8	21.1	
Female (%)	20.4	19.3	27.4	16.8	18.3	4.454
Bachelor's degree (%)	51.7	54.7	41.5	54.5	55.9	5.884
Primary residence (%)	25.5	22.8	12.7	25.2	44.6	27.477***
Earn \$50K (%)	73.5	63.4	72.4	78.6	81.6	9.335*
Very concerned (%)	44	52.6	25.5	43	59.3	62.729***
						F
Age (mean)	63.1	64.2	65.2	63.0	59.6	4.698**
Tenure (mean)	21.7	27.8	26.7	17.1	15.1	13.146**
Parcel acreage (median)	392	840	317	320	202	
Ownership acreage (median)	625	1959	800	500	362	
Acres treated (median)	20	90	0	30	40	
Most important goal		Timber	Grazing	Residence		
<i>*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001</i>						

Logistic regression: Demographic and risk perception variables on to treat/not treat acres

We conducted a logistic regression of some basic demographic and theoretical variables on the binary variable “acres you worked on to reduce chance of wildfire in the past 5 years, 0 or >0”. Parcel size and ownership size, while commonly cited in the literature as an influences on management, were not significant variables; neither were the variables educational attainment or level of knowledge about ponderosa pine fire ecology. Two noteworthy significant explanatory variables were use of parcel as primary residence and level of concern about wildfire.

Logistic regression: treating acres for fire risk ^a	
Independent Variables	
Constant	1.728
Primary Residence ^b	8.737***
Age	0.975*
Level of Concern	1.718***
Chi-square	67.741***
Cox & Snell R ²	0.139
Nagelkerke R ²	0.215
N =	454
^a Reported values are Exp(B).	
^b Dichotomous variables (1=yes, 0=else).	
<i>*p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001</i>	

For primary residents the odds of treating acres increased by a factor of 8.7 holding other variables constant. The size of this odds ratio indicates that maintaining a primary residence on one's parcel may be associated with greater motivation to reduce the chance of fires, perhaps because of convenience, concern about jeopardizing residence-related attributes or values of the property, or other reasons. For a unit increase in people's level of concern about fire affecting their parcels the odds of treating acres increased by a factor of 1.718 holding other variables constant. The size of this odds ratio justified further exploration into what makes up people's concern about and perception of fire risk.

Parcel size

Although parcel size was not a significant variable in the logistic regression on to treat/not treat acres to reduce fire risk, chi square and f-statistic tests revealed significant differences between the owners in different parcel size categories in terms of their demographic characteristics and management practices. The owners of the smaller parcels more often use their parcels as their primary residence. The owners of the mid-size parcels (80 to 239 acres) have the lowest educational attainment. The owners of the largest parcels are more educated, higher income earners and more concerned about fire than the owners in the other parcel size categories. They have treated more acres but smaller proportions of their parcels. However there is no significant difference between the categories on the proportion that have treated acres to reduce the risk of fire on their parcels.

		Parcel Acreage Size Categories					
	Sample	<10	10 to 79	80 to 239	240 to 479	480 +	x2
N	478	33	79	85	60	221	
% of sample		6.9	16.5	17.8	12.6	46.2	
Female (%)	21.4	31.3	20.5	25.6	27.1	17.0	6.227
Bachelor's degree (%)	50.0	50.0	53.2	37.0	40.7	56.2	11.263*
Primary residence (%)	27.3	56.3	40.5	22.9	18.3	22.6	23.852***
Earn \$50K (%)	72.6	71.4	66.2	68.9	78.4	74.9	3.230
Very concerned (%)	45.8	38.7	39.7	48.8	36.8	50.5	36.318**
Treated acres (% yes)	80.3	78.8	79.7	81.2	78.3	81.0	0.315
		Parcel Acreage Size Categories					
	Sample	<10	10 to 79	80 to 239	240 to 479	480 +	F
N	505	33	79	85	60	221	
% of sample		6.9	16.5	17.8	12.6	46.2	
Age (mean)	63.8	57.2	64.8	63.7	63.8	64.4	3.013*
Tenure (mean)	22.2	14.6	22.5	20.5	22.5	20.4	1.734
Percent of parcel treated (mean)	30.0	71.0	38.0	32.0	26.0	19.8	18.481***
Acres treated (mean)	183.6	2.5	13.8	41.8	94.2	359.8	21.88***

*p = 0.05; **p = 0.01; ***p = 0.001

Also, a greater proportion of the owners of smaller parcels have pruned, thinned by hand, mowed, pulled, cleared around structures, created fuel breaks and disposed of slash at a landfill. A greater proportion of the owners of larger parcels have applied herbicides, grazed, harvested timber for profit, and sold logs and wood products. More of the owners of the smallest and largest parcels have thinned with mechanized equipment than the others. This analysis of parcel

size may shed some light on the characteristics and management behaviors of owners of parcels with different development densities and proximities to populated areas.

	Sample	Parcel Acreage Size Categories					x2
		<10	10 to 79	80 to 239	240 to 479	480 +	
N	505	33	79	85	60	221	
% of sample		6.9	16.5	17.8	12.6	46.2	
Pruned or limbed up trees	60.9	81.8	75.9	62.4	56.7	52.9	21.077***
Thinned by hand, chainsaw	64.6	78.8	75.9	63.5	60.0	60.2	10.33*
Mechanized thinned	36.4	42.4	21.5	24.1	36.7	41.6	11.463*
Mowed, crushed, ground or chipped	33.5	57.6	34.2	38.8	21.7	30.8	13.881**
Pulled plants, brush or trees by hand	41.0	75.8	54.4	38.8	30.0	34.8	29.049***
Applied herbicides	32.0	30.3	26.6	17.6	28.3	40.7	17.902**
Harvested timber for profit	28.7	3.0	12.7	23.5	28.3	40.3	41.522***
Cleared around structures	50.2	60.6	67.1	50.6	41.7	44.8	14.989**
Made structures more fire-proof	42.1	57.6	48.1	44.7	38.3	37.6	6.824
Created fuel breaks	48.1	66.7	57.0	51.8	41.7	42.5	11.323*
Planted fire-adapted trees	11.1	1.2	5.1	12.9	11.7	11.8	4.470
Shaded out plants, brush or trees with other vegetation	5.9	12.1	3.8	3.5	3.3	7.2	5.011
Grazed livestock	65.5	18.2	34.2	56.5	70.0	86.0	114.378**
Understory burned	21.8	27.3	20.3	18.8	16.7	24.0	2.710
Burned in piles	65.5	54.5	63.3	65.9	58.3	69.7	4.932
Mulched, spread or left in the forest	38.3	39.4	34.2	35.3	31.7	42.5	3.724
Took to landfill	7.5	30.3	15.2	7.1	0.0	3.6	35.442***
Kept for personal use (e.g. firewood, construction)	59.6	60.6	62.0	58.8	46.7	62.4	5.053
Sold logs for profit	19.9	0.0	11.4	16.5	16.7	28.1	28.247***
Sold wood products for profit	12.1	0.0	2.5	7.1	10.0	19.9	31.659***

*p = 0.05; **p = 0.01; ***p = 0.001

Logistic regression: Perceived risks on to treat/not treat acres

We also conducted a logistic regression of perceived risks, or items on respondents' parcels that they were concerned about fire affecting. Two explanatory variables were significant in the reduced model. For a unit increase in level of concern about a fire affecting structures and ecological and wildlife values the odds of treating acres increased 1.548 times and 1.324 times respectively holding other variables constant.

The significance of concern about ecological and wildlife values suggests that people may be motivated to manage by their ecological and wildlife values. It is unclear why concern about structures other than the house might be a significant factor in management, rather than concern about residence for example. Forty-three percent of respondents were at least moderately concerned about a fire affecting their residence and 46% were at least moderately concerned about a fire affecting structures other than their residence.

Logistic regression: treating acres for fire risk ^a	
Independent Variables	
Constant	.501*
Structures other than house	1.548***
Ecological and wildlife values	1.324**
Chi-square	50.402***
Cox & Snell R ²	0.104
Nagelkerke R ²	0.163
N =	422
^a Reported values are Exp(B).	
^b Dichotomous variables (1=yes, 0=else).	
* <i>p</i> ≤ 0.05; ** <i>p</i> ≤ 0.01; *** <i>p</i> ≤ 0.001	

Logistic regression: Perceived hazard on to treat/not treat acres

We also conducted a logistic regression of perceived hazards, or items respondents were concerned about contributing to the risk of fire on their parcels. Two explanatory variables were significant in the final reduced model. For every unit increase in concern about dense stands of trees and conditions on nearby public land the odds of treating acres increased by a factor of 1.45 and 1.287 respectively.

The significance of concern about down trees makes sense given the respondents’ stated concerns and practices: 41% of the sample was concerned or very concerned that dense stands of trees contribute to risk of fire on their parcels, and 66% of the sample had thinned by hand and 39% had thinned using mechanized equipment.

The significance of concern about fire risk on neighboring public land is interesting because it suggests two things: that people are acting on their perception of risk and they are acting on their perception of risks coming from lands not directly under their control. This finding may diverge from the literature which suggests that people act on risks that they perceive controllable.

Logistic regression: treating acres for fire risk ^a	
Independent Variables	
Constant	0.59
Dense stands of trees	1.454***
Conditions on nearby public land	1.287**
Chi-square	38.476***
Cox & Snell R ²	0.07
Nagelkerke R ²	0.121
N =	475
^a Reported values are Exp(B).	
^b Dichotomous variables (1=yes, 0=else).	
* <i>p</i> ≤ 0.05; ** <i>p</i> ≤ 0.01; *** <i>p</i> ≤ 0.001	

That said landowners, as taxpaying citizens, may feel that they have more control over conditions on public lands than other people’s private lands, which may explain why concern about conditions on public lands was a significant factor in respondents’ decisions to treat acres while concern about conditions on nearby private lands was not. This is despite similar levels of concern about conditions on both ownership types; 67% of respondents expressed at least

moderate concern about public lands and 60% expressed at least moderate concern about private lands. Overall, this finding indicates an opportunity for policy, especially policy relating to cross-boundary cooperation and landscape-level planning; owners that think they have high risk neighbors are more likely to manage.