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Research Paper

Willingness to pay for forest restoration as a function of proximity and viewshed

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ABSTRACT

While numerous studies investigate the non-market value of wildfire suppression and ecological restoration, less research exists examining the spatial dimension of Willingness to Pay (WTP) for forest restoration, including distance to restoration and changes in viewshed. We estimate WTP for forest restoration in Flagstaff, AZ, US (pop. 70,000) using dichotomous-choice Contingent Valuation. Flagstaff, AZ is in a high-altitude, arid region in the Southwestern US surrounded by publicly managed forests with views of mountain peaks. Large-scale forest restoration is proposed within proximity to Flagstaff's city limits. We explicitly model distance to potential treatment area as a determinant of WTP to examine the impact of distance to forest restoration. We further incorporate viewshed into our WTP estimates by controlling for whether a respondent has a mountain peak view. After controlling for viewshed, we find policy-relevant results associated with distance and viewshed. WTP increases as distance to proposed treatment area decreases. However, holding distance constant, respondents with prime mountain peak views are less likely to be WTP for forest restoration. Our results indicate that careful consideration of the complex relationship between distance, viewshed, and WTP is necessary for efficient restoration management decisions.

1. Introduction

Forest restoration reduces the probability of catastrophic wildfire and post-wildfire flooding and therefore provides significant non-market benefits to residents living near restoration projects. The Flagstaff Watershed Protection Project (FWPP) is a forest restoration project funded by a $10 Million ballot initiative to treat ponderosa pine forests in the watershed that provides municipal water for residents of Flagstaff, Arizona (pop. 70,000), a small city in the arid southwestern United States. Treatment plans include timber sales, hand thinning, prescribed burning, and other habitat restoration methods (Four Forest Restoration Initiative, 2017). The FWPP is part of a larger scale forest restoration program in the western United States called the Four Forest Restoration Initiative (4FRI). 4FRI is the largest forest restoration project in the United States to date and is part of the Collaborative Forest Landscape Restoration Program, which proposes to restore millions of acres of landscape across the US (USDA, 2015a). Flagstaff residents are key beneficiaries of the FWPP restoration through potential increases in the quantity and quality of their municipal water supply. Flagstaff residents will also benefit from reduced catastrophic wildfire and post-wildfire flood risk. Our study investigates the potential variation in benefits of restoration for Flagstaff residents as a function of distance to treatment area and viewshed.

Forest restoration reduces the probability of catastrophic wildfire (Fulé, Waltz, Covington, & Heinlein, 2001) and therefore provides a host of non-market benefits. Many researchers estimate the non-market values of wildfires, wildfire risk, and reduction. For example, Donovan, Champ, and Butry (2007) apply a hedonic property model to estimate the impact of wildfire risk on home values. They examine differences in house prices before and after information on wildfire risk is provided online for 35,000 homes in Colorado Springs, CO. House and property characteristics associated with wildfire risk have a positive correlation with price before the information is provided, however, the correlation does not remain after information provision. In hedonic property analyses of impacts of wildfires on house prices, Mueller, Loomis, and González-Cabán (2009) and Stetler, Venn, and Calkin (2010) both find a statistically significant decrease in sale price of homes, whereas Hansen and Naughton (2013) find the direction of the impact varies with wildfire size.

Contingent Valuation (CV) methods have also been used to estimate

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values of wildfire reduction (Loomis, Hung, & González-Cabán, 2009), values for different treatment options (Walker, Rideout, Loomis, & Reich, 2007), and prescribed fire (Kaval, Loomis, & Seidl, 2007). In addition, previous work by Mueller, Swaffar, Nielsen, Springer, and Masek Lopez (2013) and Mueller (2014) show positive Willingness to Pay (WTP) in Arizona for forested watershed restoration. Our study adds to current CV research by incorporating distance to watershed treatment area and viewshed.

Viewshed management and planning is important to the land use decision making processes of the City of Flagstaff, Coconino County, and the Coconino National Forest. Coconino County has specific goals and policies in its comprehensive plan to address viewsheds (Coconino County Comprehensive Plan, 2015). Scenic viewsheds are considered an important environmental feature that provides quality-of-life values for residents. One policy from the plan reads "The County will work with private landowners, public land managers, tribal entities, and the Arizona State Land Department to protect open lands for the purposes of maintaining scenic viewsheds…" The final environmental impact statement of the Flagstaff Watershed Protection Project addressed the impacts to viewsheds from forest restoration as a short-term unavoidable adverse impact that would be reduced to the extent possible while still achieving project objectives (USDA, 2015b).

While a significant body of research exists investigating the non-market values of catastrophic wildfire and the values of reduction in wildfire risk in high-risk areas, less attention is paid to potential non-market benefits of forested watershed restoration, and none of the CV studies listed above explicitly control for location of restoration or viewshed within their estimations. Policymakers face significant constraints when deciding the location of restoration, and it is likely that restoration benefits vary with location. For example, mechanical thinning can result in undesirable noise. Prescribed burning results in smoke as well as potential road closures. Alternatively, treated areas are less likely to burn in catastrophic wildfire (Fulé et al., 2001), and therefore nearby restoration may be positively capitalized in home values. We estimate WTP for forest restoration from dichotomous choice CV data using a Bayesian probit incorporating spatial information in the explanatory variables including viewshed and distance to restoration. We find respondents living closer to proposed watershed treatment areas are more likely to be WTP for restoration. However, respondents with a prime mountain view are less likely to be WTP. Our results are significant to policy-makers and managers in understanding public benefits and perceptions of forest restoration.

2. Methods

2.1. Dichotomous choice contingent valuation

Non-market valuation involves estimating the value of an environmental amenity or hazard not bought and sold in a market. The CV method is a stated preference method of non-market valuation where respondents are asked to state their preferences for an environmental good or service. Many CV studies, including the one presented here, apply the dichotomous-choice elicitation format as recommended by Carson et al. (2003). The dichotomous-choice CV method involves sampling respondents and asking if they would vote in favor of a referenda and pay a randomly assigned dollar amount.

Similar studies have estimated values of forests using CV. Pattanayak and Kramer (2001) used CV to estimate drought mitigation services provided by tropical forested watersheds in Ruteng Park, Indonesia. Mueller et al. (2013) find irrigators in the Verde Valley in Arizona are WTP approximately \$183 per year for upstream forested watershed restoration. Mueller (2014) found WTP for forest restoration in Flagstaff, AZ to be equal to \$4.83 without accounting for distance or viewshed. This study builds upon previous results in Mueller (2014) by adding spatial variables including distance to restoration and whether the respondent has a prime mountain view from their parcel.

Incorporating distance into WTP estimates is necessary if spatial heterogeneity occurs within the data. Spatial heterogeneity in WTP occurs if WTP is unevenly distributed amongst observations across space. In one of the first efforts to incorporate distance into WTP estimates, Pate and Loomis (1991) account for spatial heterogeneity within their stated preference model by including distance to restoration. A specific focus is paid to "geographical discounting." The authors find WTP for restoration in the wetlands of the San Joaquin Valley in California. Respondents located within the San Joaquin Valley have the highest WTP values for wetland restoration relative to all other respondents. California respondents outside the San Joaquin Valley have the second highest WTP for restoration. Outside the state of California, WTP figures drop considerably. The authors voice concern that underestimating distance effects can limit the benefits and potential policy implications of data. However, incorporating distance effects remains relatively uncommon in the CV literature.

Our study area is Flagstaff, Arizona. Flagstaff is a small mountain town known for its spectacular views of the San Francisco Peaks (Saltonstall, 2014). The San Francisco Peaks rise to an elevation of over 12,000 feet less than 20 miles from downtown Flagstaff (elev. 6910). Wildfire therefore has the potential for direct and visible impacts on scenic views in Flagstaff. Forest restoration in our study area will also impact viewshed, indicating that viewshed should be included in WTP estimates. Much of the focus in the stated preference literature on viewshed relates to wind farms (e.g. Chiang, Keoleian, Moore, & Kelly, 2016; Groothius, Goothius, & Whitehead, 2008; Ladenberg, Termansen, & Hasler, 2013). Incorporating viewshed to estimate benefits of amenities is more common in the revealed preference literature. For example, Bin, Crawford, Kruse, and Landry (2008) were the first to incorporate continuous measures of ocean view in a hedonic property model for coastal housing in North Carolina. Using a spatial econometric specification, they find a positive and statistically significant WTP for ocean view after controlling for other risks associated with proximity to the coastline. Bin et al.'s (2008) results support the importance of using spatial data in quantifying benefits from viewsheds. Most studies incorporating viewshed for wildfire or forest related ecosystem services also use revealed preference methods. Stetler et al. (2010) use a hedonic property model to estimate impacts of wildfires on house prices in Montana. After controlling for distance to wildfire, they find an additional decrease in house prices for homes with a view of a wildfire burn area. Hansen and Naughton (2013) examined the impacts of wildfires and spruce bark beetle outbreaks in Alaska, and found that large wildfires increase house prices, but small wildfires decrease house prices. Hansen and Naughton hypothesize the difference in wildfire effects could be due to changes viewshed. Kim and Wells (2007) use a hedonic property model in our study area of Flagstaff, Arizona to estimate values of forest density. Forest density is a proxy for viewshed because previous research supports that viewers find low-density, park-like settings to be more aesthetically pleasing than high density forests (Kim & Wells, 2007). Kim and Wells (2007) find a positive and statistically significant impact of low forest density on house prices.

Forest restoration provides market benefits such as recreation for public lands users. It also provides benefits for managers by potentially reducing wildfire suppression costs (Fitch, Kim, Waltz, & Crouse, 2018). Our study focuses on the non-market benefits of restoration to nearby residents. To the authors' knowledge, no current studies on forest restoration include viewshed and distance using stated preference methods. Our results indicate that further understanding of the complex relationship between distance, viewshed, and respondents' WTP is essential for efficient restoration planning and management.

2.2. Econometric model

Following Cameron and James (1987), the standard probit model assumes an underlying WTP function