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The Community Economic Impacts of Large Wildfires: A Case Study from Trinity County, California

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Wildfires are increasing in severity and frequency in the American West, but there is limited understanding of their economic effects at the community level. We conducted a case study of the impacts of large wildfires in 2008 in Trinity County, California, by examining labor market, suppression spending, and qualitative interview data. We found that the 2008 fires had interrelated effects on several economic sectors in the county. Labor market data indicated a decrease in total private-sector employment and wages and an increase in public-sector employment and wages during the summer of 2008 compared to the previous year, while interviews captured more nuanced impacts for individual businesses.

Keywords economic impacts, forest communities, labor markets, large wildfires, suppression spending

As wildfire severity and frequency increase in the American West, economic impacts may also grow. Although research has examined the social impacts of large fires on communities (McCaffrey et al. 2012; Carroll et al. 2005), relatively little

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information exists about local economic effects (but see Gebert et al. 2007; Prestemon et al. 2008) and about how suppression spending may mediate them. In addition, there is little evidence of how fires may intersect with broader economic conditions, perhaps acting as pulses or fast-moving variables, with the background of long-term economic downturn as a more slowly moving variable (Gunderson and Holling 2002). To address this gap in understanding, this article presents a mixed-methods case study of how large, long-duration wildfires can affect different sectors in a rural community.

The Economic Impacts of Natural Hazards

Research suggests that economic effects of natural hazards are dynamic over time and differentially positive and negative in various sectors before returning to pre-event levels (Belasen and Polachek 2008; Ewing et al. 2007). Agriculture- and natural resource-based counties may face fewer negative employment impacts than industrialized counties where there can be substantial impacts to the built environment (Belasen and Polachek 2008), although impacts on natural resources and crops can also affect employment. Heavily settled or industrialized areas may experience immediate growth in construction and service sectors from reconstruction (Burrus et al. 2002; Belasen and Polachek 2008; Xiao 2008). Tourism tends to suffer following natural disasters, as visitors may be slow to return (Butry et al. 2001; Kent et al. 2003). Disasters of high intensity or long duration can result in outflows of human resources and geographical redistribution of wealth (Garber et al. 2006).

The Economic Impacts of Wildfires Versus Other Disasters

Unlike natural disasters that occur in a few minutes or days (e.g., tornadoes, earthquakes, and hurricanes), wildfires often last weeks or months. There can be negative and positive effects during and after fires. Negative effects might include short-term shocks in employment or wages in natural resource management and tourism sectors if these activities are restricted by fire closures or smoke (Butry et al. 2001; Kent et al. 2003). There might also be disruption of utilities, decreased business sales and revenue, and lost work hours (Webb et al. 2000; Burrus et al. 2002; Rose and Lim 2002). In the longer term, affected sectors may bounce back, or there may be a sustained period of poor economic conditions.

A second difference between wildfires and short-duration hazard events is that during a fire, state and federal agencies may spend millions of dollars managing the wildfire. Suppression spending can include contracted services, federal personnel, flying contracts, agreements with states, and supplies and materials. Contracted services can include direct suppression, postfire cleanup, or fire-camp provisioning such as sanitation and catering. This may have local economic impacts if businesses in nearby communities provide these services and goods. Yet there is little understanding of the impacts of this spending on communities that experience a fire.

Community Wildfire Impacts

Literature on the community impacts of wildfires largely examines health outcomes, losses of property and life, and disparities in who is affected (Carroll and Cohn 2003; Graham 2003; Hoffman 1999). A few studies have considered how local businesses

that are seasonal, agricultural, or have perishable stock can suffer the most (Carroll et al. 2000; Carroll et al. 2005). Other impacts may include loss of tax revenues (Graham 2003). However, most research does not explicitly examine the local labor market impacts of wildfires, particularly as they intersect with existing economic conditions, or consider the effects of suppression spending.

Methods

As part of a larger study on economic impacts of large wildfires, we conducted a case study of the 2008 Trinity County, California, wildfires. We used Forest Service financial transaction information, labor market data, and in-depth interviews. We examined suppression transactions from the Forest Service's Foundation Financial Information System (FFIS) to understand types and distribution of fire suppression expenses. For the labor market analysis, we applied a difference-in-difference regression model to Trinity County employment and wage growth (for a detailed description of the regression model and specification see Nielsen-Pincus, Moseley, and Davis 2011). This regression model uses a generalized autoregressive conditional heteroskedasticity estimation technique that simultaneously estimates the mean and variance of employment and wage rate growth per quarter. In addition to a model structure that controls for serial autocorrelation and nonconstant variance in growth rates, we examine the effects of wildfire and employment and wage growth in California's economy. We apply the model to the total labor market and specific economic sectors within Trinity County.

We reviewed newspapers and agency reports about the 2008 wildfires and conducted in-person semistructured interviews in May 2010. We used open-ended questions about local effects of the fires to capture consistent data while retaining flexibility to explore unanticipated topics (Schoenberger 1991). We interviewed 21 individuals, including citizens, business owners, elected officials and government employees, nonprofit organization members, and Forest Service staff. Participants were selected using purposeful sampling for their knowledge of wildfire and forest management (Lindlof and Taylor 2002). We initially identified key informants from previous research experience in Trinity County. Others were identified via snowball sampling, wherein interviewees suggested others who could explain impacts that we had not yet learned about in detail.

Interviews were transcribed and coded to identify a master list of repeated or highly stressed themes (Weiss 1995). We then used this master list to conduct focused coding to gather data that supported or contradicted key themes. We integrated the interview data with suppression spending and labor market data to produce a comprehensive account of impacts (Bryman 2006).

Case Study Background

Trinity County covers 3,179 square miles in mountainous northwestern California. The Shasta–Trinity National Forest (STNF) and the Bureau of Land Management (BLM) manage more than 80% of the county's land. Forest types are diverse, depending on elevation, aspect, soils, and disturbance, and are primarily Klamath mixed conifer with oak woodlands and chaparral shrublands. Fuel accumulations in these historically fire-adapted forests have increased the risk of uncharacteristically high-severity fires.

Trinity County has a population of approximately 13,500, mostly in five small communities. Weaverville, the county seat, also has recreation, tourism, and service businesses. From 2002 to 2009, employment in Trinity County ranged between approximately 2,600 and 3,300 (not including self-employed and agricultural labor), with average annual wages ranging between $25,000 and $31,000 over the 8-year period. Almost half of all employment is in the public sector, largely in local government establishments such as schools. Public-sector wages were nearly double those of private-sector wages, ranging from 70% to 95% better from 2002 to 2009. Forest products manufacturing was formerly the major industry in the county; one sawmill remains operational today and employs 130 people. Manufacturing in general employed approximately 6% to 8% of Trinity County's labor force, but paid up to nearly 40% more than the county's average wages between 2002 and 2009. During the same time period, between 4% and 8% of the county's labor force was employed in the natural resource and construction sectors, both of which also tend to pay better than the county average wage (42% to 47%). In contrast, nearly 16% to 18% of Trinity County's labor force was employed in leisure, hospitality, and other services, which paid on average less than half of the average wage. Marijuana cultivation, although not officially recorded in government labor statistics, is one of the county's most substantial sources of economic activity and often occurs on public lands. In 2008, Trinity's poverty rate was 19.2%, and in 2009, unemployment averaged 19.3%.

Wildfire has occurred in Trinity County with regularity. Between 2004 and 2007, there were five wildfires that each cost more than $1 million in federal suppression. On the night of June 20, 2008, thunderstorms moved across northern California, sparking more than 100 wildfires (*Redding Record Searchlight* 2008a). By June 29, President Bush declared a federal emergency (*Redding Record Searchlight* 2008b). The national Incident Command (IC) team system allows federal, state, and local agencies to coordinate nationally organized fire response teams. Three fire camps were established, at the Hayfork Fairgrounds, Junction City, and Hyampom. At each camp, IC teams worked for 14 days and rotated out to ensure fresh personnel. For much of the summer, there were more than 1000 people per day working in direct fire suppression as well as administration and camp services. The national forest also acquired a National Area Command Team, which coordinated between the Forest Supervisor and IC teams. IC teams included Type I, II, III, and State of California teams. Team types indicate the level of complexity, skills required, and scale of an incident. Type I teams manage the most complex and demanding incidents, and as the intensity of an incident declines, team type changes accordingly. IC teams usually contain a group of firefighters from a specific region who travel around the nation as needed. By late August, the major Lime and Iron-Alps complexes were largely contained, but several other fires were not contained until late September. Although these fires covered large areas of land, they did not directly threaten property or lives in Weaverville or Hayfork, the county's larger communities. Overall, the 13 largest fires in Trinity County in the summer of 2008 burned nearly 241,050 acres and incurred more than $150 million in federal suppression expenditures.

Results

Impacts of Suppression Spending

Nearly half of the $150 million of suppression expenditures for the 2008 wildfires was for contracted services. Companies that received contracts were diverse and

Table 1. Forest Service suppression expenditures, Trinity County, 2008

	Expenditures				
Forest Service expenditure category	Expenditure (% of total)	Local[a] (%)	Regional[b] (%)	Outside the region[c] (%)	Unknown (%)
Contracted services[d]	$73,087,972 (47)	7	33	60	<1
Federal personnel	$33,577,770 (22)	7	12	69	12
Cooperative agreements	$23,729,526 (15)	1	1	97	1
Flying contracts	$13,864,798 (9)	0	3	97	0
Other (e.g., supplies, travel)	$11,317,806 (7)	10	23	39	28
Total	$155,577,872 (100)	5	18	74	3

[a]Only expenditures in Trinity County.
[b]All expenditures in counties adjacent to Trinity County (Humboldt, Mendocino, Shasta, Siskiyou, or Tehama counties).
[c]All expenditures outside of Trinity County and its adjacent counties.
[d]All contracted services except for flying contracts.

had names that included keywords like private fire suppression, logging, trucking, equipment, construction, logistics, food and sanitary services, energy, and others. Federal personnel costs constituted a quarter of total federal expenditures. More than half of federal personnel costs were incurred for overtime, hazard pay, and contract personnel paid only when their services are needed. Cooperative agreements with state agencies accounted for another 15% of spending (Table 1).

Although the economic value from wildfire suppression contracting for these wildfires was distributed across the country, it was most concentrated in Trinity and surrounding counties. Local capture of expenditures was highest for contracted services (7% local) and federal personnel (7% local) (Table 1). Vendors from Shasta County, California, Deschutes County, Oregon, and Jackson County, Oregon, provided the largest share of the private nonaircraft suppression services, whereas more specialized flying contracts were mostly awarded to vendors from three counties in Oregon.

Interviewees had mixed perceptions of local benefits from suppression activity. Most interviewees mentioned that the Forest Service did attempt to purchase services and supplies from local businesses. One Forest Service employee described local purchases for the Hyampom fire camp at Hayfork restaurants and grocers for items such as food and cutlery. Approximately half of the interviewees indicated that opportunities for local businesses to support response teams varied throughout the season. Their perception was that Type I and Type II teams did obtain some food and resources such as ice locally, but that they tended to be "self-contained," with much of their infrastructure such as sanitation services and many of their personnel coming from outside the county. When Type III and State of California teams took over in the last weeks of the fire suppression effort, interviewees

reported, they were more likely to use local businesses for lodging and post-fire cleanup.

> In terms of the cleanup and stuff, the locals probably picked up a higher percentage of that, but in terms of what happened during the active fires, a lot of those locals didn't get on until very late. [I–6]

Another interviewee, a county employee, acknowledged the potential for firefighters to generate local economic benefits by spending locally when off the job.

> To the credit of the [Incident Command] Teams, they strongly encouraged their folks to go out and shop locally, to help the economy . . . So, the guys would go get a haircut downtown, or go out to dinner. [I–2]

But one local recreation business owner described barriers to firefighter spending in the local economy:

> For me one of the most discouraging things, we actually had some firefighters booked for a rafting trip, [. . .] And then the Incident Commander comes out and says nobody's allowed to go to the river . . . the one little economic benefit we could have received got totally taken away. [I–16]

All of the interviewees who did not work for the Forest Service or as local contractors also perceived a lack of local suppression expenditures for goods and services. Their understanding was that the National Fire Plan and subsequent fire suppression contracting policy changes had reduced local access to suppression contracts. One local business owner explained:

> So historically, what would happen is the locals would make all the sandwiches and stuff like that . . . There was a lot of dissatisfaction because there was a statewide list in terms of registering equipment . . . And there wasn't any preference given to locals at all. [I–18]

Impacts on Labor Market and Employment

Analysis of Bureau of Labor Statistics employment and wage data for Trinity County for large fires between 2004 and 2008 shows that quarterly employment growth and average wage growth both increased by about 4% more than expected (t value = 1.79, $p = .09$, t value = 2.42, $p = .03$, respectively) during periods when wildfires suppression activities were taking place (Figure 1). Although we found no significant effect of wildfires on federal employment growth (t value = 1.68; $p = .11$), quarterly average wage growth for federal employees was nearly 22% greater than expected during quarters that experienced wildfires (t value = 2.24; $p = .04$). Private-sector employment in natural resource firms increased by nearly 30% more than expected during periods with wildfire (t value = 2.03; $p = .06$), while average wages in natural resource firms fell by 19% more than expected (t value = −1.78;

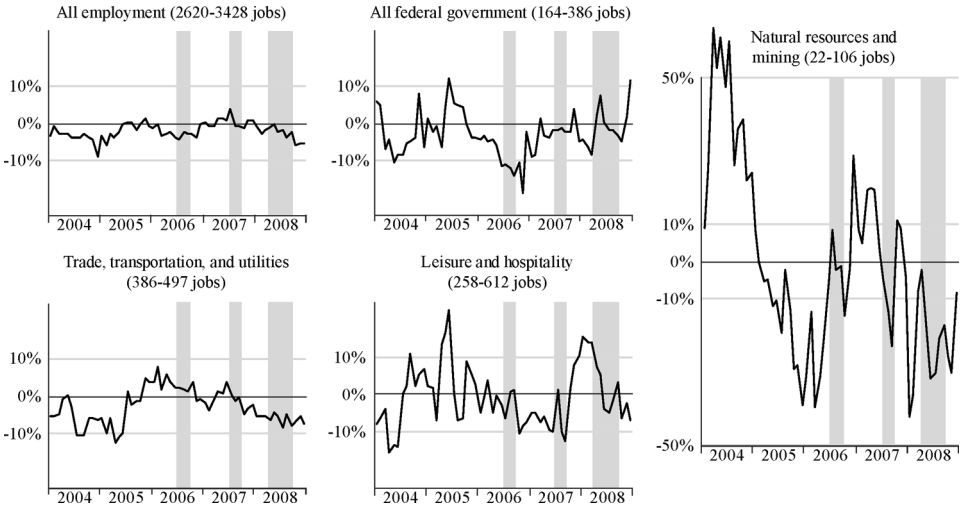

Figure 1. Third-quarter wages and employment for selected sectors of the Trinity County economy.

$p = 0.10$). Employment growth in firms dealing in the trade, transportation, and utilities sector and the leisure and hospitality sector was not significantly affected (t value $= 1.70$; $p = .11$, t value $= -0.49$; $p = .63$, respectively) by the presence of wildfire suppression activities; however, average wages in both sectors grew by nearly 9% and 11% more than expected (t value $= 2.12$; $p = .05$, t value $= 2.33$; $p = .03$, respectively).

Although it is difficult to generalize about the economic impacts of a wildfire from examining a single case study, our Trinity County interview data corroborate much of our statistical findings and highlight the complexity of the effects across a local economy.

Residents experienced the changes in wages and employment suggested in the labor market data, and attributed many of those changes to the fires and fire suppression. Perceptions of impacts were mixed and varied by sector. All interviewees identified negative impacts to land management and wood products that they felt lasted long after the fires. During the wildfires, the STNF was closed to public access. This put forest management projects on hold, affecting work for contractors who were also unable to join the suppression effort.

> So if you weren't able to get on the fire, which you of course weren't, until they ran out of all the people who were signed up, you then also [were not allowed to] log. [I–15]

These restrictions seemed to add to existing economic challenges. Almost all interviewees remarked that the fires were part of a longer pattern of troubles that included a structure fire at the sawmill in Weaverville and ongoing economic downturn.

> Really, we've had three really crushing years in Trinity County. The '08 fire was by far the worst. I mean as far as the loss . . . And of course then the economy tanked, and I mean, when is enough, enough? [I–12]

However, the fires also provided work that was significant to several local contractors living on the economic edge.

> Many displaced loggers were on the verge of losing everything they had, had their houses mortgaged up to the hilt, and [work related to the fire] pulled 'em out. [The fire] was actually a saving grace for those small businesses. Some of my friends, it got 'em out of debt for about a year or so . . . we did pretty well as a community, overall. [I–12]

> In fact, we actually made money on the deal! We actually had two crews signed up, and chippers for doing defensible space work . . . we provided some mapping. [I–4]

There were also long-term positive impacts for one of the interviewees, who saw increased resources for their hazardous fuels reduction work in the following years.

> After the 2008 fires, there was a special pot of money to deal with the counties most affected. And we did really well in Trinity County, we were the number one or number two recipients, by county, of California Fire Safe Council grants in 2009. [I–4]

Interviewees in the recreation and hospitality sectors identified more negative impacts. Thick smoke led to many camping and rafting reservation cancelations. In the Trinity River corridor, Highway 299 was periodically closed. The immediate effect was a substantial fall in profits, but business owners also feared that there would be a longer term effect:

> You have regular clients that come up year, after year, and it's kinda like their family vacation . . . well, [when] they can't come up here they go someplace else, if someplace else turns out to be new and fresh and different, so "Let's not go back to the Trinity." [I–5]

The duration and timing of the fires challenged recreation businesses during their primary business season.

> This was different in that its duration was just the entire summer . . . I mean, it's pretty critical, 'cause our money-making window is June, July, and August . . . And if we don't make it, there's no replacing it. [I–5]

Tourism-affiliated interviewees, like natural resource interviewees, noted that a drought, low water levels, and the economy in general had hurt tourism in Trinity County before the fires.

Discussion

This study suggests that the local economic impacts of wildfires are dynamic and vary by sector. Wildfires can displace some economic activity, but suppression efforts can increase economic activity, especially when suppression efforts utilize

local resources. This is important to understand because the interplay of these effects is largely not discussed in literature on community wildfire impacts to date.

Suppression Spending

Businesses, local government, nonprofit organizations, and other entities in Trinity County received about 5% of the 2008 suppression spending. Local residents had varying perceptions of how that spending affected the community. Many placed their experiences with local suppression spending within a broader narrative of low local capture and an ongoing trend toward fewer opportunities to work on fires as a result of federal policy changes.

But local businesses did capture at least $7.8 million (we could not determine where approximately $4.6 million, 3% of the total suppression expenses, was spent). A large, long-duration fire in a sparsely populated county can provide substantial opportunities for some local businesses and government employees. For example, local spending helped some Trinity County businesses temporarily improve their financial situations and avoid bankruptcy—an important impact not visible in aggregate labor-market data. This suggests that suppression spending can create some short-term positive impacts for local businesses and economies, and suggests the need to integrate analysis of suppression spending and local economic impacts, which have typically not been considered together in past studies (Butry et al. 2001; Kent et al. 2003).

Labor Markets and Employment

Our labor-market data analysis showed that overall, county employment and wages increased by about 4% more than expected during periods when wildfires were occurring in Trinity County, but there was considerable variation by sector. For example, federal government employment did not increase, while government wages grew 22% during wildfires. This suggests that during the wildfires, the federal government paid its employees more, likely in overtime and hazard pay, but that when wildfire suppression demanded additional human resources, the federal government turned to contractors or nonlocal federal employees rather than taking on new local employees. By contrast, employment was unchanged in several other sectors such as trade, transportation, and utilities. Many sectors experienced declines in average wage growth during wildfires. Additional employment in those sectors may consist of short-duration jobs or low-wage workers.

The interviews told a similar but more detailed story. For example, in the natural-resource sector, they confirmed "shutting down" of forestry activity due to the fires. But interviewees also described suppression opportunities for some local forestry businesses. Further, natural-resource labor-market data may show a mixture of fire-related increases in wages and employment declines related to deterioration in the larger economy. Similarly, interviewees attributed declines in natural resource wages to both the broader economy and the fires, with fire suppression allowing some businesses to stave off their financial crises.

Although natural-resource wages dropped more than leisure and hospitality wages and no change in employment was recorded in this sector, interviews revealed substantial negative impacts to recreational businesses. Interviewees also discussed how loss of one summer's income or depressed future turnout in this industry can cause businesses to close. This reinforces other findings that tourism can suffer many

years after a natural disaster due to uncertainty about the condition of a landscape and amenities (Butry 2001; Kent et al. 2003). Interviewees attributed negative impacts on recreation to persistent smoke, but also noted challenges prior to the fires from existing drought and the national economic downturn.

Conclusions

This research has suggested that large wildfires may have extensive, interrelated local economic effects that interact with broader economic conditions in ways that are difficult to untangle. We might conceive of these effects, including suppression spending in the short term, as intersecting fast and slow variables with variation by sector or business. These intersections may magnify or compound the overall economic impact of wildfires, particularly from the perspectives of those who directly experience wildfire events in their communities. A long-duration wildfire, for example, may directly affect businesses, as well as posing lasting challenges in recovery, yet poor economic conditions prior to the fire create an environment wherein multiple vulnerabilities are interwoven. Integrating findings from multiple data sources can enhance understanding of this range and interaction of wildfire impacts.

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