

# THE COST OF INACTION: Flagstaff Watershed Protection Project Cost Avoidance Study

Wayne R. Fox\*

## I. OVERVIEW<sup>1</sup>

This study estimates the potential financial damages mitigated by the implementation of the Flagstaff Watershed Protection Project (FWPP). The goal of FWPP is to reduce the threat of catastrophic wildfire and post-fire flood impacts by conducting fuel-reduction forest treatments in two watersheds critical to the City of Flagstaff—the Dry Lake Hills (Rio de Flag) and Mormon Mountain (Lake Mary). By thinning unnaturally dense vegetation and using prescribed fire in these areas, the risk of intense wildfire and post-fire impacts will be significantly reduced.

The primary risks of wildfire are two-fold: damage from fire and damage from resulting floods. Severe, uncharacteristic fire destroys trees, wildlife, and recreation value and threatens homes and infrastructure in its path. Floods occur in the areas downstream of burns and can cause severe damage miles from the fire itself. According to the University of Wyoming College of Agriculture and Natural Resources, increased runoff and erosion after intense wildfires on steep hillsides can increase peak runoff by up to 100 times the average flow.<sup>2</sup> This happens after moderate to severe fires that burn the soil to the point that it is hydrophobic, and can no longer absorb water.<sup>3</sup> After the

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\* Director, Arizona Rural Policy Institute; Assistant Dean, W.A. Franke College of Business at Northern Arizona University; Director, Alliance Bank Business Outreach Center (ABBOC).

1. The following is a summary of a presentation made by Wayne R. Fox on May 7, 2015, during a symposium entitled *The Wildfire Menace: Will the West Learn or Burn?* in Tempe, Arizona. See Wayne R. Fox, Dir., Ariz. Rural Policy Inst., Address at the Arizona State University Law Review Symposium: The Wildfire Menace (May 7, 2015). The content of the presentation was based on two recent studies conducted by ABBOC. See generally ARIZ. RURAL POLICY INST. ET AL., FLAGSTAFF WATERSHED PROTECTION PROJECT COST AVOIDANCE STUDY (2014), [http://franke.nau.edu/images/uploads/rpi/FWPP%20Final%20Cost%20Avoidance%20Study\(1\).pdf](http://franke.nau.edu/images/uploads/rpi/FWPP%20Final%20Cost%20Avoidance%20Study(1).pdf); THOMAS COMBRINK ET AL., ECOLOGICAL RESTORATION INST. N. ARIZ. UNIV., A FULL COST ACCOUNTING OF THE 2010 SCHULTZ FIRE (Tayloe Dubay ed., 2013), <http://www.idahoforests.org/img/pdf/FullCostAccounting2010SchultzFire.pdf>.

2. Ginger Paige & Jennifer Zygmunt, *The Science Behind Wildfire Effects on Water Quality, Erosion*, in LIVING WITH WILDFIRE IN WYOMING 31, 31 (Jennifer Thompson & Steve L. Miller eds., 2013), [http://www.uwo.edu/barnbackyard/\\_files/documents/resources/wildfire2013/wildfire\\_web.pdf](http://www.uwo.edu/barnbackyard/_files/documents/resources/wildfire2013/wildfire_web.pdf).

3. *Id.*

2010 Schultz Fire, which burned adjacent to the City of Flagstaff, flooding caused millions of dollars in damages to property in downstream neighborhoods. This study assumes that post-fire flooding would be similar to a 500-year flood event in the drainages below the Dry Lake Hills.

A. *Dry Lake Hills*

The Dry Lake Hills area is located north and uphill from Flagstaff's cultural, political, tourist, university, and retail core. Heavily used for recreation and unnaturally dense with ponderosa pine and mixed-conifer forests, this area is vulnerable to intense fire that would devastate its scenic and recreational value. Based on the example of the Schultz Fire, hydrophobic soils are likely to impair a slope's ability to retain moisture, funneling previously unseen amounts of storm runoff through downtown Flagstaff, Northern Arizona University, and many of the city's neighborhoods. The initial flows would be laden with ash and mud and would threaten hundreds of homes, businesses, and government buildings. Subsequent floods would continue to interrupt traffic and retail activity, stifling both citizens' daily routines and the area's essential flow of visitors.

B. *Mormon Mountain*

Mormon Mountain, located approximately 30 miles south of Flagstaff, is also unnaturally overstocked with trees, leaving it vulnerable to catastrophic fire. The mountain lies at the head of the basin above Upper Lake Mary, a reservoir providing roughly 50% of the city's drinking water.<sup>4</sup> As with the Dry Lake Hills area, the initial damage to scenery and recreation would likely be overshadowed by the resulting floods and debris flows following a severe fire.<sup>5</sup> Burned hillsides would no longer absorb monsoon rains, polluting the reservoir's waters with silt, ash, and mud, and reducing storage capacity. The result would be a water supply no longer useable until the reservoir is dredged to remove sediment, and the treatment plant is re-engineered/upgraded to handle the known chemical changes to the water itself. Both of these processes would be expensive. The immediate solution would be the costly process of drilling 11 new wells.

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4. CITY OF FLAGSTAFF & U.S. FOREST SERV., FLAGSTAFF WATERSHED PROTECTION PROJECT EXECUTIVE SUMMARY & IMPLEMENTATION PLAN 2 (2012), <http://www.flagstaff.az.gov/DocumentCenter/View/41236>.

5. *Id.*

Nearly three quarters of Flagstaff voters (74%), aware of the risks to these areas, voted to fund the \$10 million FWPP in a 2012 election, through sale of municipal bonds.<sup>6</sup> These funds will be used to treat (through thinning and prescribed burning) 10,544 acres of National Forest—7,569 acres in the Dry Lake Hills and 2,975 acres on Mormon Mountain—and another 3,000 acres of state, city, and private lands throughout the Rio de Flag watershed.<sup>7</sup>

This study uses data from the Army Corps of Engineers' *Rio De Flag, Flagstaff, Arizona, Economic Reevaluation Report*,<sup>8</sup> and the Ecological Restoration Institute's *A Full Cost Accounting of the 2010 Schultz Fire*.<sup>9</sup> The former study includes in-depth estimates of assets at risk downstream of the Dry Lake Hills. The latter estimates the costs associated with the Schultz Fire, including response and mitigation, loss of property values, and specific flood damage to property.

The Arizona Rural Policy Institute (RPI) prepared this cost avoidance study at the request of the FWPP Monitoring Team. It will demonstrate to the voters of Flagstaff the scale of the potential benefit of the investment they supported. Conversely, it will show the potential cost if the work was not completed.

## II. COST SUMMARY

Table 1 lists the high and low estimated damages that the Flagstaff Watershed Protection Project hopes to mitigate. The estimates have been adjusted to 2014 dollars and they are divided between the two watersheds. In the Dry Lake Hills they are estimated between \$489 and \$986 million. In the Mormon Mountain area, they are estimated between \$84 and \$215 million. Between the two treatment areas, potential financial damages range from \$573 million to \$1.2 billion. Details of each cost estimate will be discussed below.

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6. ANNE MOTTEK LUCAS, FLAGSTAFF WATERSHED PROTECTION PROJECT: ISSUES IN FOREST RESTORATION 5 (Tayloe Dubay ed., 2015), <http://www.flagstaffwatershedprotection.org/wp-content/uploads/2015/11/FWPP-Creating-Solutions-Through-Community-Partnerships.pdf>.

7. *Id.*

8. U.S. ARMY CORPS OF ENGINEERS, RIO DE FLAG, FLAGSTAFF, ARIZONA, ECONOMIC REEVALUATION REPORT (2011).

9. *See generally* COMBRINK ET AL., *supra* note 1.

**Table 1 – Summary of Potential Impacts**

Source	Low	High
	(\$ millions)	(\$ millions)
<b>Dry Lake Hills</b>		
Response and Remediation	43	43
Structures and Contents	132	286
Property Value	256	524
Habitat	0.4	15
Communication Towers	30	80
BNSF Railroad Interruption	12	23
Retail Sales	15	15
<b>Dry Lake Hills Total</b>	<b>\$489 million</b>	<b>\$986 million</b>
<b>Mormon Mountain</b>		
Response and Remediation	12	12
City Water Supply	17	37
Habitat	1	22
Communication Towers	54	144
<b>Mormon Mountain Total</b>	<b>\$84 million</b>	<b>\$215 million</b>
<b>Total, Both Areas</b>	<b>\$573 million</b>	<b>\$1,201 million</b>

Several of these costs show no difference between high and low estimates. For those categories, only one figure was identified.

#### A. *Response and Remediation Costs*

The response to a fire would incur immediate expenses, including suppression, post-fire rehabilitation, evacuation, and repair costs. A simple estimate of this comes from records of costs incurred during and after the Schultz Fire in 2010. Approximately \$61 million was spent by state, county, city, and federal government agencies, and a variety of utilities, after the Schultz Fire and flood.<sup>10</sup> These figures include actual expenditures for fire suppression and flood mitigation in 2010–2012, and planned flood mitigation efforts in 2013 and 2014.

The Schultz burn area is adjacent to the Dry Lake Hills area, and the two share similar weather, geography, flora, and fire regime. Therefore, these

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10. Dollar amounts have been inflated to 2014 dollars.

costs are used to estimate response and remediation costs for the FWPP. As Table 2 shows, dividing the Schultz costs by the fire's 15,000-acre footprint yields expenditures of just over \$4,000 per acre. Applying this rate to the estimated footprints of the FWPP indicates response and remediation estimates of \$43 million for the Dry Lake Hills area and \$12 million for the Mormon Mountain treatment area.<sup>11</sup> Total costs for both areas are estimated to be \$55 million.

These estimates assume that the areas would burn with an intensity similar to that of the Schultz Fire, and the response would be comparable.

**Table 2 – Estimate of Response and Remediation Costs**

<b>Schultz Response and Remediation Costs (2014)</b>	\$61,169,000
Approximate Acreage	15,000
<b>Cost Per Acre</b>	<b>\$4,078</b>
<b>Dry Lake Hills</b>	
Treatment Acreage (National Forest, State, City, Private)	10,569
<b>Estimated Cost</b>	<b>\$43,100,000</b>
<b>Mormon Mountain</b>	
Treatment Acreage	2,975
<b>Estimated Cost</b>	<b>\$12,100,000</b>
<b>Total Estimated Response and Remediation Costs</b>	<b>\$55,200,000</b>

Estimates are rounded. Dry Lake Hills Area includes 7,569 acres of National Forest and 3,000 acres of state, city, and private land.

### III. ARMY CORPS OF ENGINEERS AND ASSETS AT RISK

Many of the assets at risk of flooding were valued by the Army Corps of Engineers (ACE), in 2011, as part of the Rio De Flag Flood Control Project. The ACE planned to mitigate the damage potential of severe flooding through downtown Flagstaff. Because of its enormous cost, much of the project has stalled in the planning stages, but the plans provide valuable data for this report. The ACE's 2011 Economic Reevaluation Report shows estimates of damages that would occur during 100- and 500-year floods. The same

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11. The Dry Lake Hills treatment area estimated here includes 7,569 acres of national forest as well as 3,000 acres of state, city, and private land.

footprint of these potential flood events informed the floodplain used for FWPP cost avoidance projections.

Using the ACE footprint for this analysis is considered appropriate, assuming that in the aftermath of a catastrophic fire the steep, hydrophobic slopes would cause very common storms to produce intense flooding similar to extremely rare (such as 100-or 500-year) storm events.

Only portions of the 500-year floodplain footprint used for the Rio de Flag Flood Control Project were used in this study because that project also includes a significant portion of Clay Avenue Wash, which would not be affected by fire in the Dry Lake Hills. The estimates in this report correct for areas not included in the FWPP flood footprint.

Table 3 below lists the structures located in the floodplain, as determined by the ACE in 2011. It is important to note that between the writing of the Economic Reevaluation Report, in 2011, and today (2014), Northern Arizona University has invested tens of millions of dollars in new construction within the flood footprint. Portions of downtown Flagstaff have also experienced significant commercial growth in those years.

Table 3 also lists the depreciable value of the structures and the value of their contents, in the floodplain below the Dry Lake Hills.<sup>12</sup>

**Table 3 – Structure and Content Value of Floodplain<sup>13</sup>**

Residential	947
Commercial	71
Public	32
Industrial	84
Total Structures	1,134
<b>Structure and Content Value</b>	<b>\$766 million</b>
<b>Adjusted to 2014 dollars</b>	<b>\$811 million</b>

The total value of the structures in the floodplain and their contents in 2011 was estimated to be approximately \$766 million. Adjusted to 2014 dollars, this would grow to \$811 million. As mentioned above, this number is conservative; it omits new construction—largely on the NAU campus—over

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12. The Army Corps of Engineers calculated the depreciable value of structures using square footage multipliers obtained from the Marshall & Swift Valuation services. The value of contents was developed through surveys sent to the actual property owners. For a more detailed explanation of the Army Corps of Engineers' methodology, see the ECONOMIC REEVALUATION REPORT, *supra* note 8.

13. *Id.* (corrected to Exclude Clay Avenue Wash).

the past three years. Note that this number is not a damage estimate; it is shown here to demonstrate value of at-risk structures and their contents.

#### IV. STRUCTURE AND CONTENT DAMAGES

The projected flood damages in these areas were derived using the Army Corps of Engineers' Hydrological Engineering Center's Flood Damage Reduction Analysis Model (HEC-FDA), which computes expected damages according to given parameters. The ACE used the expected flows, and the values of the structures and their contents to estimate these damages. Table 4 below lists the damage estimates the ACE has predicted for a 100- and a 500-year flood event.

**Table 4 – Expected Damages to Structures and Contents**

<b>Expected Damages</b>	<b>Total Damages</b>	<b>Adjusted to 2014 dollars</b>
100-Year Event	\$ 124,800,000	\$ 132,000,000
500-Year Event	\$ 270,900,000	\$ 286,000,000

The total projected damages equal almost \$125 million, and almost \$271 million for 100-year and 500-year events, respectively. As stated above, these damage estimates exclude any new construction between 2011 and 2014. Inflating these numbers to 2014 dollars suggests possible damages of \$132 million and \$286 million.

#### V. RAILROAD DAMAGES

The ACE Economic Reevaluation Study also projected costs incurred by the Burlington Northern Santa Fe Railway if its tracks were damaged by the volume and flow of floodwater. Between physical damages and the costs of delayed rail traffic, a total financial impact to the BNSF Railway was estimated between \$11 million during a 100-year flood, and \$22 million during a 500-year flood. These numbers were estimated by a consultant hired by the City of Flagstaff (for publication in the Economic Reevaluation Study). Table 5 shows these values adjusted to 2014 dollars, and suggests a damage range between \$12 million and \$23 million.

**Table 5 – Estimated Cost to Railroad**

Estimate	2011 dollars	2014 dollars
Low (100-Year Event)	11,000,000	11,600,000
High (500-Year Event)	22,000,000	23,300,000

As with many of the figures borrowed from the ACE, this range indicates expectations during one flood event. Experience suggests that following catastrophic fires, such events would potentially occur sporadically and with high-intensity during the monsoon season.

## VI. LOSS OF PROPERTY VALUE

Perhaps the largest financial consequence of a wildfire in the Dry Lake Hills area would be the subsequent loss of property values. Residents, businesses, institutions, and governments would feel these impacts and losses throughout the city. Multiple factors, ranging from water damage to the loss of a forested backdrop, would depress what is one of the more expensive real estate markets in the state. The resulting loss in property owners' personal wealth would be staggering. For many residents, home equity is a major portion of net worth and the same is true of many businesses. The value of government and university assets is also important, impacting cost of borrowing and the ability to acquire new assets.

Because Flagstaff property values include a premium based on intangibles such as natural beauty and access to adjacent forest land, all parcels in the city would likely see some loss of value. The overall percentage of loss conservatively assumed in this analysis is 6.7%. This rate was calculated using the drop experienced by homeowners in the neighborhoods north of Flagstaff affected by the 2010 Schultz Fire and floods. It is an average built both on properties inundated and damaged, and those in the region that lost value due to intangible commodities such as degraded views and buyer uncertainty.<sup>14</sup>

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14. See THOMAS C. BROWN & TERRY C. DANIEL, U.S. FOREST SERV., MODELING FOREST SCENIC BEAUTY: CONCEPTS AND APPLICATION TO PONDEROSA PINE 3 (1984); Yeon-Su Kim & Aaron Well, *The Impact of Forest Density on Property Values*, 103 J. FORESTRY 146, 146 (2005); Julie Mueller et al., *Do Repeated Wildfires Change Homebuyers' Demand for Homes in High-Risk Areas? A Hedonic Analysis of the Short and Long-Term Effects of Repeated Wildfires on House Prices in Southern California*, 38 J. REAL EST. FIN. & ECON. 155, 156–57 (2009).



*A. Methodology: Determine FCV of Region*

According to records provided by the Coconino County Assessor's Office (2014), the aggregate full cash value (FCV) of properties in Flagstaff is \$5.6 billion. As stated above, decreases within all city properties are very likely. However, to provide a more conservative comparison, impacts on a smaller footprint—within a quarter mile of the floodplain—are also projected here. Within that reach sit approximately 10,300 parcels, with an aggregate FCV of \$2.7 billion.

*B. Adjust for Market Value*

The county reports the FCV of properties for tax purposes. However, these figures are usually lower than actual market value. To translate FCV to market value, we first identified sales that occurred during the time period used to value property for tax year 2014 (January 2011–October 2012). Within the floodplain, seventy-two properties were sold during that time. The aggregate FCV of those properties was \$15.6 million, and the sum of their sales prices was \$21 million. This indicates that the market value of these properties is approximately 135% of their full cash value (\$21 million = 135% X \$15.6 million).

Under these assumptions, the aggregate market value of properties in the city (tax year 2014) is an estimated \$7.5 billion (\$5.6 billion X 135%). Within the smaller footprint, that value is \$3.6 billion (\$2.7 billion X 135%). These numbers represent all properties within these footprints on the county tax roll, both public and private.

*C. Calculate Drop in Value*

The expected drop in property value used here is borrowed from *A Full Cost Accounting of the 2010 Schultz Fire*. That study estimated that property in select neighborhoods north of town had lost an average of 6.7% of their value after the fire and subsequent flooding. This number included corrections for an overall market decline at the time.

The 6.7% estimate is considered conservative. It should be noted that the area damaged by the Schultz flooding was exclusively residential. Significant damages to business and government property would likely have even greater repercussions.

Table 6 shows the calculations for estimated value loss both for the entire City of Flagstaff and for the quarter mile footprint.

**Table 6 – Estimate of Lost Market Value**

Area	FCV	Market Value	Loss (6.7%)	Adjusted to 2014 dollars
Within 1/4 mile of floodplain (lower estimate)	\$2,727,786,162	\$3,682,511,319	\$246,728,258	\$255,602,000
City of Flagstaff (upper estimate)	\$5,580,660,655	\$7,533,891,884	\$504,770,756	\$522,925,000

According to these calculations, the total loss in equity attributable to catastrophic fire and flooding in the Dry Lake Hills is between \$247 million and \$505 million. These values reflect tax year 2014, which considers the value of property between January, 2011 and October, 2012. These values were adjusted to 2014 dollars, raising the impacts to between \$256 million and \$523 million.

As mentioned above, despite the large numbers, these estimates are most likely conservative for several reasons. Even high-end estimates omit county properties that border the city. The market values of these parcels are affected by the same factors as those in the city. Also, the 6.7% figure was taken from the Schultz flood area, which was a purely residential zone. As was shown above, the core of the city is at risk below the Dry Lake Hills. The effects of flooding in this area on the factors that determine property values would almost certainly be more extreme. Since this area contains the university, historic downtown, railroad, schools, and access to the hospital and other health care facilities, the primary components of the community infrastructure would be disrupted. In addition, many of the events that make Flagstaff attractive, such as festivals, parades, and nightlife, would be disrupted during the summers for several years after a flood.

## VII. CITY OF FLAGSTAFF WATER SUPPLY

The primary motivation for the southern portion of the FWPP—the western slope of Mormon Mountain—is the protection of Upper Lake Mary. Historically, this reservoir has provided about half of the city’s potable water. A burdensome side effect of many fires in recent years has been the pollution of water sources by post-fire runoff and loss of reservoir storage capacity.

For example, the aftermath of two Colorado wildfires—1996’s Buffalo Creek Fire and 2002’s Hayman Fire—sent over one million cubic yards of sediment into the Strontia Springs Reservoir, a major municipal water source

for the cities of Denver and Aurora. Dredging the reservoir in order to restore it to a useable state cost the city of Denver \$26 million.<sup>15</sup>

According to Brad Hill, City of Flagstaff Utilities Director, a similar disaster in the Upper Lake Mary Watershed would require either drilling 11 new wells, dredging Lake Mary and expanding the capacity of the water treatment facility, or both. As shown in Table 7, the cost of these processes would be between \$17 million and \$37 million.<sup>16</sup>

**Table 7 – Cost to Flagstaff’s Water Supply**

Low Estimate	\$17,000,000
High Estimate	\$37,000,000

These estimates are conservative; they do not reflect the time required to make the changes, borrowing costs, or increased production costs (such as pumping water from one quarter mile below the surface).

#### VIII. MEXICAN SPOTTED OWL HABITAT

A value is also placed on the habitat of the threatened Mexican spotted owl. The treatment area of the FWPP includes all or portions of ten protected activity centers (PACs), for a total of approximately 3,955 acres of protected habitat within the project area.<sup>17</sup>

Economists use various methods to attach a dollar amount to habitat. The two referenced here include:

- *Funds spent in conservation efforts.* If the United States Fish and Wildlife Service (USFWS) will spend \$100 million<sup>18</sup> on spotted owl recovery projects, and 1,000 units of owl habitat exist, then the value per unit of owl habitat, according to USFWS policy, is \$100,000.

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15. Neil LaRubbio, *Communities Help Pay for Ecosystem Services Provided by Forests*, HIGH COUNTRY NEWS (Feb. 22, 2012), <http://www.hcn.org/issues/44.3/communities-help-pay-for-ecosystem-services-provided-by-forests>.

16. Brad Hill’s Lake Mary cleanup estimates were based on conversations with officials in Denver and Fort Collins, Colorado, regarding their past experiences. The cost estimates for re-designing the water treatment facility were based on adjustments made by Salt River Project after the Rodeo-Chediski fire in 2002. Then, many cities in Maricopa County were forced to make design changes in their filtration processes.

17. See generally U.S. DEP’T OF AGRIC., FOUR-FOREST RESTORATIVE INITIATIVE COCONINO NF AND KAIBAB NF DRAFT ENVIRONMENTAL IMPACT STATEMENT APP.1 (2010), [https://fs.usda.gov/Internet/FSE\\_DOCUMENTS/stelprdb5383655.pdf](https://fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5383655.pdf).

18. COMBRINK ET AL., *supra* note 1, at 19.

- *Willingness to pay.* A random survey of American households solicited respondents' willingness to pay on an annual basis for conservation efforts specific to the Mexican spotted owl. In a 1997 paper, economists John Loomis and Earl Ekstrand reported this amount to be \$2.6 million (\$3.66 million in 2014 dollars).<sup>19</sup>

Elaboration of both of these methods can be found on page nineteen of *A Full Cost Accounting of the 2010 Schultz Fire*, in an analysis by Dr. Gary Snider.<sup>20</sup> The findings of this analysis provide a range of value per PAC. The low, based on the USFWS recovery efforts, is \$100,000 per PAC.<sup>21</sup> The high, based on the 1997 survey results, is \$3.66 million per PAC.<sup>22</sup>

Assuming the range of loss per PAC is between \$100,000 and \$3,660,000, and assuming that damage to any portion of a PAC incurs these losses, the total cost of ten lost Mexican spotted owl PACs would be between \$1 million and \$36 million.

## IX. COMMUNICATION TOWERS

The communication towers located atop both Mormon Mountain and Mount Elden are vulnerable to uncharacteristic, stand-replacing wildfires. A precedent for the destruction of these facilities was set in June 1977, when the Radio Fire burned on Mount Elden's peak, destroying millions of dollars' worth of equipment and interrupting regional communications.<sup>23</sup>

Although the towers on the western high point of Mount Elden are likely no longer in danger, after the Radio Fire left that area mostly devoid of trees, the southeastern portion of the mountain, known as Devil's Head, holds ten communications structures—towers and buildings—surrounded by ponderosa pines.

Similarly, the top of Mormon Mountain holds eight towers and ten buildings. Among the users of these facilities are television stations, FM radio broadcasters, cellular phone service providers, 2-way radio users (including county law enforcement), telephone providers, and internet providers.

Jonathan Koger, President of the Mormon Mountain Users' Group, estimates that the replacement costs of these structures and their contents would be in the range of \$3 million to \$8 million per structure (tower or

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19. John Loomis & Earl Ekstrand, *Economic Benefits of Critical Habitat for the Mexican Spotted Owl: A Scope Test Using a Multiple-Bounded Contingent Valuation Survey*, 22 J. AGRIC. & RESOURCE ECON. 356, 365 (1997).

20. COMBRINK ET AL., *supra* note 1.

21. *Id.*

22. *Id.*

23. DONNA ASHWORTH, *BIOGRAPHY OF A SMALL MOUNTAIN* 347 (1991).

building). This suggests that replacement alone would incur costs of between \$54 million and \$144 million on Mormon Mountain (eighteen structures) and \$30 million to \$80 million on the Devil's Head area of Mount Elden (ten structures). The estimated total cost of these areas burning is between \$84 million and \$224 million.

However, this range does not reflect the impacts of communications losses in the area. Were these facilities to burn, many services including cell phone service, Internet, radio, and public safety (law enforcement, fire, emergency medical service) communications would cease. The results would be disastrous across the community, from business operations to fire suppression efforts.

#### X. BUSINESS REVENUE/TAX COLLECTIONS

The area at risk of flooding includes the city's downtown commercial center and roadways to much of the region's tourist destinations, including Historic Route 66 and the Grand Canyon. Table 8 below lists the annual gross revenue in 2013 for the areas that include downtown Flagstaff and the 4th Street corridor, both of which lie within the floodplain and include major commercial districts.

**Table 8 – Retail Business Revenue at Risk<sup>24</sup>**

	June	July	August	September	Average
Gross Revenue	\$15,862,000	\$17,481,000	\$15,202,000	\$17,412,000	\$16,489,000
Tax Revenue	\$275,000	\$288,000	\$275,000	\$314,000	\$288,000
Daily Gross Revenue	\$529,000	\$564,000	\$490,000	\$580,000	\$541,000
Daily Tax Revenue	\$9,174	\$9,289	\$8,866	\$10,457	\$9,447

During June, when many major fires begin, these two districts generate over \$500,000 in sales each day. The evacuations and reduced tourism traffic that would result from a wildfire in the Dry Lake Hills would severely disrupt business. During the next three months, the region tends to experience monsoonal weather patterns with regular strong rainstorm events. Post-fire flooding would disrupt transportation arteries and would dramatically affect daily sales of a similar amount during those months.

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24. Cf. *Monthly Sales Tax Statistics*, CITY FLAGSTAFF (2013), <http://www.flagstaff.az.gov/index.aspx?NID=2769> (compiling the tax revenue for the City of Flagstaff for each month in which it is received).

In 2013, the average daily gross revenue between June and September was \$541,000. The city's share of the daily income tax generated through these sales is approximately \$9,447.

For purposes of estimating total impact of business losses after fire, the following assumptions are used:

- Year 1, ten days of flooding
- Years 2–5, five days of flooding
- Each day of flooding equals a loss of one average day's revenue in the area.

Under those assumptions, the loss of retail sales is estimated to be \$15 million over five years. Included in this figure is a loss of tax revenue equaling nearly \$100,000 the first year and \$50,000 annually for the next five years.

The \$15 million figure reflects lost revenue at the retail level. It does not include jobs that would be lost as a result of the ripple effects of taking those dollars out of the community.

#### SUMMARY

While total costs identified in this document range from \$573 million to \$1.2 billion (\$84–\$215 million in the Mormon Mountain area and \$489–\$986 million in the Dry Lake Hills area), many costs have not been accounted for in this study. Several of the omissions that would surely carry costs include:

- Increased travel time for residents and visitors
- Increased potable water pumping and treatment costs
- Damage to utilities (electrical, sewer, water, etc.)
- Health problems, both physical and mental
- Evacuation costs during both fires and flooding
- Negative impact on tourism
- Negative impact on outdoor recreation
- Negative impact on air quality
- Damages to residential streets
- Vehicles damaged and destroyed

These costs and many others could be calculated and added to the total, but the impact as shown now makes the case that the \$10 million pledged by city voters, versus upwards of \$1 billion in after-fire costs, is a wise investment.

A FULL-COST ACCOUNTING OF THE 2010 SCHULTZ FIRE<sup>25</sup>*Summary*

The Schultz Fire of 2010 burned just over 15,000 forested acres and caused the evacuation of hundreds of homes. Heavy floods followed the fire, causing extensive damage to property that lay downstream from the charred hillsides. Nearly three years later, seasonal flooding is still a concern and residents continue to live under the threat of swift floodwaters that may carve unanticipated pathways through their sloping neighborhoods.

Official reports from city, county, state, and federal governments have listed response and mitigation costs of the fire and flood at nearly \$60 million. This study adds to those costs, exploring the impacts on private property owners, as well as societal costs that are often overlooked when quantifying the full impact of disasters.

Through analysis of Coconino County Assessor's records, a survey of residents in the fire/flood impact area, and the perceived value of both endangered species habitat and human life, this study conservatively estimates the total impact of the Schultz Fire at between \$133 million and \$147 million. The major costs and drivers explored are the following:

- Loss in personal wealth due to reduced property values: \$59,353,523
- Official expenditures of government agencies and utilities: \$59,104,394
- Destruction of habitat: \$400,000–\$14,200,000
- Loss of life: \$6,000,000
- Structural damage: \$3,097,978
- Cleanup: \$1,825,127
- Unpaid labor: \$1,516,103
- Armoring against flooding: \$823,100
- Fire evacuation costs: \$223,572
- Flood Insurance Premiums: \$198,034

The total impact is considered conservative because it excludes measures such as volunteer work by nonprofits; destruction of recreation areas, timber, and archaeological sites; physical and mental health costs; the degraded

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25. COMBRINK ET AL., *supra* note 1. This study was performed by the Alliance Bank Business Outreach Center at Northern Arizona University's W. A. Franke College of Business upon the request of the Ecological Restoration Institute. Invaluable support was provided by many in northern Arizona, including Coconino County staff and the many area residents who offered their personal stories.

viewshed (beyond effects on property values), and the long-term impacts to the region's amenity-based economy.

In addition to the cost accounting, this study reports on some non-financial impacts as reported by the survey responses. The mental, physical, and financial tolls taken on residents of the flood area are immeasurable.

#### SCHULTZ FIRE FULL COST ACCOUNTING

The true financial impact of wildfire is elusive. The government dollars spent containing fires are easily accountable, as are mitigation costs when efforts are the work of auditable agencies and utility companies. Similarly, personal damages that result in insurance claims are quantifiable, although often difficult to obtain due to their private nature. These commonly identified losses and expenditures are often reported after particularly devastating fires, but they do not tell the entire story. Extending beyond economics—psychological implications are particularly disturbing—the full financial damages of fire dwarf the numbers that appear in the wake of catastrophic burns.

A full cost accounting of wildfire's impact is an essential tool for the purposes of policy decisions. In addition to more fully describing the destruction in terms of dollars, this information could ideally inform cost-benefit analyses of preventative actions. The Ecological Restoration Institute (ERI) at Northern Arizona University (NAU) solicited the Alliance Bank Business Outreach Center (ABBOC) at NAU's W. A. Franke College of Business for this study, which seeks to quantify the full financial impact of 2010's Schultz Fire, which burned 15,000 acres north and west of the City of Flagstaff and adjacent communities. Although no private residences were destroyed during the three-week event, over 700 properties were evacuated during the initial, wind-blown spread of the fire. After the charring of steep slopes on the eastern San Francisco Peaks, several neighborhoods were subject to severe floods which have repeated every summer since the event.

Two Units of the ABBOC, the Arizona Hospitality Research and Resource Center (AHRRC) and the RPI, provided the bulk of the research. A survey was created and disseminated by the AHRRC to residents of the areas affected by evacuation and flooding, under the guidance of Coconino County Supervisors Mandy Metzger and Liz Archuleta. The survey response rate of 24% provided a confidence rate of 95% and a margin of error of +/- 5%. These responses were analyzed and the answers extrapolated to the entire population, resulting in a picture of the personal losses experienced by the residents of the evacuation and flood areas.



Researchers worked closely with the Coconino County Assessor's Office to draw an estimate of loss of personal wealth resulting from property devaluation caused by both flood damage and diminished aesthetic value stemming from the blackening of the mountainside.

Other quantifiable financial impacts are traced to the loss of endangered species habitat, two deaths resulting from the fire's impact, and the costs of social services. All of these numbers are added to the reported costs of fire/flood response and mitigation as reported by the city, county, state, and federal governments, as well as utilities and several non-profit organizations.

This study is intended to provide a comprehensive yet conservative estimate of the overall financial impact of the Schultz Fire. Although these methods may be reproduced for other fires, the results are specific to a fire footprint adjacent to a metropolitan area with resultant heavy flooding.

#### FINANCIAL CONSEQUENCES OF WILDFIRE

As stated, the traditionally reported costs come from government agencies and utilities with strict reporting standards. In the case of the Schultz Fire these were associated with fire and flood response and ongoing flood mitigation. Initial estimates indicated that \$59 million was spent on these efforts, primarily by Coconino County (\$14.8 million), the U.S. Forest Service (\$14.4 million), the National Resources Conservation Service (\$7.7 million), Federal Highway Administration (\$6.2 million), Federal Emergency Management Agency (\$5.7 million), City of Flagstaff (\$5.5 million), Arizona Department of Transportation (\$3 million), and Arizona Division of Emergency Management (\$1.1 million).

Efforts to determine the full costs of wildfire are not new; many such studies have been published in recent years. Each fire has different impacts, as each takes place in a unique time and space. Various cost drivers are more or less identifiable depending on the details of the fire, so no two studies are alike. The following list shows six catastrophic fires that burned in the western states early in the century, and the calculated ratio of suppression costs to full costs:

- Canyon Ferry Complex, Montana, 2000: 53%
- Cerro Grande, New Mexico, 2000: 3%
- Hayman, Colorado, 2002: 20%
- Missionary Ridge, Colorado, 2002: 25%
- Rodeo-Chedeski, Arizona 2002: 15%

- Old, Grand Prix, Padua, California 2003: 5%<sup>26</sup>

According to the findings of this study, the suppression costs of the Schultz Fire were approximately 6–7% of the total computed cost. Each of these fires had unique characteristics. Although the Shultz fire burned out of control adjacent to a major city, private property was successfully saved through the quick action of fire crews. The major cost drivers were response and mitigation costs, and the loss of property value. By comparison, the Rodeo-Chedeski Fire burned hundreds of homes in several communities, driving up the private costs.<sup>27</sup> The Cerro Grande Fire of 2000 burned through 400 homes as well as the Los Alamos National Laboratory.<sup>28</sup>

### FULL ACCOUNTING

The costs considered below supplement the previously reported government and utility funds to provide a more complete picture of the costs of the Schultz Fire. These included diminished property values, fire evacuation costs, flood insurance premiums, home content replacement costs, armoring against future flooding, unpaid labor, property cleanup, structural damage, loss of life, and loss of habitat.

#### A. *Diminished Property Values*

One of the largest financial impacts of the fire was the loss of personal wealth through reduced property values. This analysis indicates that the fire directly and indirectly contributed to a loss of approximately \$60 million in the personal wealth of local property owners.

The affected area, as defined for this study, includes the following neighborhoods:

Timberline	Macann	Fernwood
Sunset Crater	Anasazi Trail	Koch Field
Stardust	Frontier Hills	Slayton Ranch
Sunset Vista	Pioneer Valley	Rio Rancho
Aspen Glen	Wapatki Trail	Hutchison Acres
Forest Survey Tract	North Peak Area	Pine Mountain

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26. W. FORESTRY LEADERSHIP COAL., *THE TRUE COST OF WILDFIRE IN THE WESTERN U.S.* 6–11 (2010), [http://www.blm.gov/or/districts/roseburg/plans/collab\\_forestry/files/TrueCostOfWilfire.pdf](http://www.blm.gov/or/districts/roseburg/plans/collab_forestry/files/TrueCostOfWilfire.pdf).

27. *Id.* at 10.

28. *Id.* at 7.

The properties that fall along the estimated flood zone were re-valued by the county during the summer of 2010 in order to reflect the immediate damage done to property and rights-of-way. This analysis used 2011 for post-fire values, assuming that an accelerated decrease in value would take more time to become apparent.

### B. *Changes in Property Values*

In 2011, the affected areas collectively included approximately 3,200 parcels. Each parcel has a parcel number assigned by the county and, in order to determine the change in value between years, RPI staff isolated parcels that were identified by a consistent parcel number in 2009 and in 2011. Just over one thousand (1,073) properties were assigned a constant number across these years, and this sample, representing approximately one-third of the total population, was used to estimate the change in property values experienced in the affected area.

Based on value data provided by the Coconino County Assessor's Office, the FCV of these properties was 20% less in 2011 than in 2009. The average value of a parcel in 2009 was \$312,274; in 2011 it was \$249,645.<sup>29</sup> The sample area lost an estimated \$67 million in value during that time. Table 9 indicates the changes in value demonstrated by the selected sample.

**Table 9 – The Change in Full Cash Value of Parcels in Affected Neighborhoods Between 2009 and 2011**

	Full Cash Value 2009	Full Cash Value 2011	Change in Value, 2009–2011	Change in Value as a %, 2009–2011
Average	\$312,274	\$249,645	-\$62,629	-20%
Median	\$283,460	\$221,790	-\$61,670	-22%
Aggregate	\$335,069,540	\$267,868,865	-\$67,200,675	-20%

### C. *Correcting for Overall Market Decline*

The value of properties throughout the region was declining during the period between 2009 and 2011 due to a declining housing market. Therefore, it is necessary to adjust for the overall decrease when quantifying the effects of the fire. Decreases in both the City of Flagstaff and Coconino County were

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29. This sample includes both developed and vacant parcels.

calculated, indicating an overall fall of 12% in the city and 13.4% in the county. Table 10 shows the aggregate FCV in each of these geographies in both years.

**Table 10 – The Change in Full Cash Value of Parcels in the City of Flagstaff and Coconino County Between 2009 and 2011<sup>30</sup>**

Total FCV	2009	2011	Change in FCV 2009–2011
City of Flagstaff	\$7,697,683,416	\$6,773,784,531	-12.0%
Coconino County	\$17,790,931,957	\$15,413,415,042	-13.4%

The market adjustment used in this analysis was based on the county decline of 13.4%. Although the affected area is located adjacent to Flagstaff city limits and experiences many of the real estate trends of the city, the county number was chosen because it would yield a more conservative estimate.

Were the sample affected area to have declined in value at the same pace as the overall county, the loss would have been an average of \$41,731 per parcel and \$44,777,502 over the entire area. Table 11 below compares that estimated reduction in FCV to the actual area reduction as calculated in Table 9. The result is a reduction in value attributable to the fire of 6.7% of 2009 FCV. In terms of dollars, this incremental loss was \$20,898 per parcel on average, and \$22,423,173 across the entire sample.

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30. Coconino Cty. Assessor, *Coconino Parcel Viewer*, COCONINO COUNTY, ARIZ., <https://gismaps.coconino.az.gov/parcelviewer/> (last visited Mar. 3, 2016).

**Table 11 – Calculation of Value Loss Attributable to the Schultz Fire**

	Full Cash Value 2009	Estimated 2011 FCV 13.4% Reduction	Actual 2011 FCV	Variance between estimated and actual 2011 FCV	Variance as % of 2009 FCV
Average	\$312,274	\$270,542	\$249,645	\$ 20,898	6.7%
Median	\$283,460	\$245,579	\$221,790	\$ 23,789	8.4%
Aggregate	\$335,069,540	\$290,292,038	\$267,868,865	\$22,423,173	6.7%

*D. Expansion to Population*

Factors including parcel splits and changes in county operations contributed to most parcels in the population not fitting the same descriptions in 2009 and in 2011. Therefore, the loss in value for the entire affected area must be estimated based on that of the sample. County records of value in 2009 were not obtainable, so the loss was estimated using 2011 values.

The aggregate value of the sample parcels in 2011 was \$267,868,865. The loss attributable to the fire was \$22,423,173—approximately 8.4% of the 2011 FCV. Assuming that the same ratio of loss to FCV applies to the population, this would indicate that the total loss was nearly \$60 million (8.4% of \$709 million). This calculation is shown in Table 12.

**Table 12 – Calculation of Value Reduction Across all Affected Neighborhoods**

	2011 FCV	Value Reduction Attributable to Fire (8.4% of 2011 FCV)
Sample	\$267,868,865	\$ 22,423,173
Population	\$709,041,545	\$ 59,353,523

*E. Survey Findings*

The survey conducted by ABBOC was distributed to residents in the Schultz Fire and Flood area in order to gain an understanding of the impacts of the fire and flood, primarily the out-of-pocket costs incurred by private landowners. While the costs to federal, state, and local governments (Coconino County in particular) had been calculated, the personal costs borne

by the residents of the impacted area had not yet been estimated. This survey was a rare attempt to quantify the costs to residents of this natural disaster.

The initial mailing went to 1,397 households in the affected area; of these, 58 were returned as undeliverable, for a final population of 1,339. Three surveys were not filled out, one was a duplicate form, and twenty were received too late to be included. The final total of 321 completed surveys produces a response rate of 24%, providing a confidence level of 95% and margin of error of +/- 5%.

#### FIRE-RELATED COSTS

Upon the initial flare-up of the fire, authorities evacuated over 700 downwind properties.<sup>31</sup> This evacuation caused residents to incur costs for emergency lodging, meals, and transportation. Additionally, many of the residents in the area keep livestock, and the costs of evacuating these animals, as well as temporarily boarding more common pets, were significant. Table 13 shows the estimated costs incurred by households during the fire.

**Table 13 – Estimated Fire-Related Costs**

Population	Estimated Portion with Expenses	Estimated Number of Properties Affected	Average Cost	Total Estimated Cost
1,339	47%	627	\$356	\$223,572

#### FLOOD-RELATED COSTS

Flooding below the burn area began with the first significant rainfalls shortly after the fire had been contained. Property owners who had not experienced flooding before now found their homes and yards inundated with each heavy rain.

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31. *Up In Smoke: Schultz Fire Chars 5,000 Acres; 750 Homes Evacuated*, AZ DAILY SUN (June 21, 2010, 5:10 AM), [http://azdailysun.com/news/local/up-in-smoke-schultz-fire-chars-acres-homes-evacuated/article\\_b533ea2a-f302-5748-b8b9-e7d966dffde4.html](http://azdailysun.com/news/local/up-in-smoke-schultz-fire-chars-acres-homes-evacuated/article_b533ea2a-f302-5748-b8b9-e7d966dffde4.html).

*A. Flood Insurance*

The vast majority of survey respondents (96%) said their properties had never been damaged by flooding or runoff *prior to the Schultz Flood*; consequently, virtually no one in the area had, or was required to have, flood insurance. In the aftermath of the Schultz Flood, however, fully 50% of those surveyed had obtained flood insurance. Forty-seven percent of respondents indicated whether or not they have maintained this coverage; 83% answered yes, with an annual premium of \$357.

As Table 14 indicates, expanding this response rate to the population suggests that 555 households still pay flood insurance and the estimated aggregate cost of the premiums is nearly \$200,000 annually.

**Table 14 – Estimated Annual Cost of Flood Insurance Premiums**

Population	Proportion with Expense	Proportion Continuing Coverage	Estimated Number of Properties Affected	Average Cost	Total Estimated Cost
1,339	50%	83%	555	\$357	\$198,034

*B. Cleanup*

One of the most common sources of expense and effort was the cleanup of property. Homes were inundated with water as well as mud and ash. Many yards were completely covered in polluted soils. Problems with noxious weeds emerged after the flooding and desirable grasses and other plants were in many cases choked out by the mud. Table 15 shows households' estimated cleanup costs.

**Table 15 – Estimated Cleanup Costs**

Population	Estimated Portion with Expense	Estimated Number of Properties Affected	Average Cost	Total Estimated Cost
1,339	49%	657	\$2,779	\$1,825,127

*C. Home Contents*

Many homes and other buildings were filled with water and mud during the flood. Table 16 shows the estimated cost of damages to homes' contents.

**Table 16 – Estimated Damages to Home Contents**

Population	Estimated Portion with Expense	Estimated Number of Properties Affected	Average Cost	Total Estimated Cost
1,339	25%	337	\$1,628	\$548,235

*D. Structural Damage*

The costliest damages were those done to the structures themselves. These were estimated at over \$3 million, as shown in Table 17.

**Table 17 – Structural Damage Applied to Population**

Population	Estimated Portion with Expense	Estimated Number of Properties Affected	Average Cost	Total Estimated Cost
1,339	53%	707	\$4,379	\$3,097,978

*E. Flood Control*

Flagstaff experiences a characteristic summer monsoon as well as runoff during times of quickly melting snow. Residents of the flood zone therefore can expect flooding to occur at certain times every year. To mitigate the damage of the floods, they have armored their homes with an array of materials, including sandbags, concrete barriers, and earthen berms. Much of the work and cost associated with this armoring was incurred by aid organizations, the county, and volunteers. The more drastic measures—involving earth moving equipment and strong barriers—involved significant expenses. Table 18 shows the estimates of these costs.



**Table 18 – Estimated Cost of Armoring Property.**

Population	Estimated Portion with Expense	Estimated Number of Properties Affected	Average Cost	Total Estimated Cost
1,339	20%	266	\$3,089	\$823,100

#### *F. Labor*

Commonly overlooked in disasters like the Schultz Fire is the opportunity cost of time spent on repairing damage and replacing items destroyed by flooding. Each hour spent on these activities can be quantified in financial terms by considering it “volunteer” work. This is commonly referred to in economic terminology as “opportunity cost.” Many thousands of hours of labor were logged by homeowners, friends, family members, volunteers, and others. In terms of economic impact, these hours reduce productivity in other areas and thus have a measurable financial impact.

Survey respondents indicated the unpaid hours of work that were required to repair or replace damaged property. The average time spent on home contents and possessions was twenty-three hours, a cost incurred by 20% of respondents. When expanded to the entire population, this implies that 269 households spent a combined 6,279 hours cleaning or installing new home contents.

More hours were spent repairing structural damages to homes and other buildings. The average of 132 hours per respondent was calculated based on 39% of respondents. Expanding this figure to the total suggests that 535 properties required unpaid working hours for a total of over 70,000 hours. Added to the previous total (damage to contents/possession), this indicates nearly 77,000 hours of unpaid labor need to be accounted for.

A dollar amount can be applied to the value of volunteer work. This was done using the value of volunteer time as described by Independent Sector, a leadership network for nonprofit organizations.<sup>32</sup> This organization estimates that, in 2010, the value of an hour of volunteer work in Arizona was approximately \$19.71. After applying that value to these hours, the total value of unpaid labor was \$1.5 million. These calculations are shown in Table 19.

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32. *The Value of Volunteer Time*, INDEP. SECTOR, [http://independentsector.org/volunteer\\_time](http://independentsector.org/volunteer_time) (last visited Mar. 9, 2016).

**Table 19 – Value of Unpaid Labor Applied to Population**

Estimated Dollar Value of Unpaid Hours Spent for Repair/Rehabilitation/Replacement					
Labor Type	Average Hours	Number of Households	Total Hours	Value of One Hour	Total Value of Volunteer Hours
Damage to home contents/ possessions	23	269	6,279	\$19.71	\$123,759
Structural damage to home, other buildings, & enhancements	132	535	70,642	\$19.71	\$1,392,344
Total			76,920	\$19.71	\$1,516,103

### G. *Habitat*

According to estimates provided by Dr. Gary Snider, an economist in Flagstaff, the value of lost Mexican Spotted Owl habitat can be measured at between \$400,000 and \$14.2 million.

### LOSS OF LIFE

In the month following the fire, a child drowned during severe flooding downstream of the burned area. While the emotional toll taken by such incidents is immeasurable, it is sometimes appropriate to attach a dollar value to the loss of a life.

Attributing a dollar amount to life is difficult, but a number of government agencies routinely do so in order to estimate the value of certain policies, such as pollution controls and transportation regulations. A cost/benefit analysis is conducted, determining the amount that an agency is willing to spend in order to save one life. As this study has the potential to influence policy, a similar approach is appropriate.

The term used for this valuation is *Value of a Statistical Life* (VSL), and the figure varies greatly by agency and from year to year. The U. S. Office of Management and Budget noted in 2012 that the Department of Transportation uses a value of \$6.2 million (in 2011 dollars) while the Environmental

Protection Agency uses \$6.3 million (in 2000 dollars).<sup>33</sup> Rather than determine which agency figure is most analogous to this case, a flat figure of \$6 million will be used for simplicity.

#### TOTAL IMPACT

All of the previously discussed costs of the Schultz Fire and Flood added together yield a conservative impact estimate of between \$133 million and \$147 million, as shown in Table 20.

**Table 20 – Total Estimated Impact of the Schultz Fire/Flood**

Total Impact	
Loss in Property Value	\$59,353,523
Government Agencies	\$59,104,394
Loss of Life	\$6,000,000
Structural damage	\$3,097,978
Cleanup	\$1,825,127
Unpaid Labor	\$1,516,103
Armoring	\$823,100
Home Contents	\$548,235
Fire Evacuation Costs	\$223,572
Flood Insurance Premiums	\$198,034
Habitat	\$400,000–\$14,200,000
<b>Total</b>	<b>\$133,090,066–\$146,890,066</b>

Dividing this total by the number of acres burned during the fire (rounded to 15,000) yields a cost of between \$8,873 and \$9,793 per acre. These numbers, while likely conservative, describe the overwhelming financial toll taken by the Schultz Fire. They are intended to provide a clearer picture of how such fires affect communities, governments, non-profits, and property owners.

Ecological Restoration Institute staff have estimated that treatment costs tend to run between \$500 and \$1,000 per acre, and that typically 30% of a given project area is thinned. Table 21 estimates a range of costs to thin

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33. EXEC. OFFICE OF THE U.S. PRESIDENT, OFFICE OF MGMT. & BUDGET, FISCAL YEAR 2013: ANALYTICAL PERSPECTIVES: BUDGET OF THE U.S. GOVERNMENT 99 (2012), <https://www.whitehouse.gov/sites/default/files/omb/budget/fy2013/assets/spec.pdf>.

15,000 acres, using both low and high numbers. The result is between \$2.25 million and \$15 million.

**Table 21 – Cost Estimates, Treating Burn Area**

Estimate	Acres Thinned	Cost Per Acre	Total Thinning Cost
High	15,000 (100%)	\$1,000	\$15,000,000
Low	4,500 (30%)	\$500	\$2,250,000