ARIZONA HOUSE OF REPRESENTATIVES
Fifty-fifth Legislature - Second Regular Session

FOREST AND WILDFIRE MANAGEMENT HOUSE AD HOC COMMITTEE

Report of Interim Meeting
Monday, November 21, 2022
House Hearing Room 4 (64) -- 2:30 P.M.

Convened 2:38 P.M.
Recessed
Reconvened
Adjourned 4:06 P.M.

Members Present
Representative Cook, Chairman
Representative Dunn
Ms. Stahl Hamilton
Speaker Bowers

Members Absent
Representative Cano
Representative Griffin

Agenda
Original Agenda – Attachment 1

Request to Speak
None

Committee Attendance
Report – Attachment 2

Presentations

Name	Organization	Attachments (Handouts)
Dr. Melanie Colavito	Northern Arizona University	3, 4, 5, 6, 7, 8, 9, 10
Jeff Eisenberg	University of Arizona Agricultural Extension	No Handouts Given
Michael Martinez and Chandler Mundy	U.S. Forest Service	11
		12

Caitlin Tillis, Committee Secretary
November 21, 2022

(Original attachments on file in the Office of the Chief Clerk; video archives available at http://www.azleg.gov)

REVISED - 11/21/22 REVISED - 11/21/22 REVISED - 11/21/22

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ARIZONA HOUSE OF REPRESENTATIVES

INTERIM MEETING NOTICE
OPEN TO THE PUBLIC

FOREST AND WILDFIRE MANAGEMENT HOUSE AD HOC COMMITTEE

Date: **Monday, November 21, 2022**

Time: **2:30 P.M.**

Place: **HHR 4**

Members of the public can access a livestream of the meeting here:
https://www.azleg.gov/videoplayer/?clientID=6361162879&eventID=2022111003

AGENDA

1. Call to Order
2. Presentations:
   - Schultz Fire Study
     - Dr. Melanie Colavito and Dr. Andrew Sánchez Meador, Northern Arizona University
   - Wildfires
     - Dr. George Ruyle Jeff Eisenberg of the University of Arizona
   - Update on the Telegraph Fire Range Infrastructure
     - Michael Martinez and Chandler Mundy, U.S. Forest Service
3. Discussion of Committee Recommendations & Final Report
4. Adjournment

Members:

Representative David L. Cook, Chair
Representative Russell "Rusty" Bowers
Representative Andres Cano
Representative Timothy M. Dunn
Representative Gail Griffin

Senator Stephanie Stahl Hamilton

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People with disabilities may request reasonable accommodations such as interpreters, alternative formats, or assistance with physical accessibility. If you require accommodations, please contact the Chief Clerk's Office at (602) 926-3032 or through Arizona Relay Service 7-1-1.

Attachment 1

ARIZONA STATE LEGISLATURE

Fifty-fifth Legislature - Second Regular Session

COMMITTEE ATTENDANCE RECORD

HOUSE AD HOC STUDY COMMITTEE ON **FOREST AND WILDFIRE MANAGEMENT**

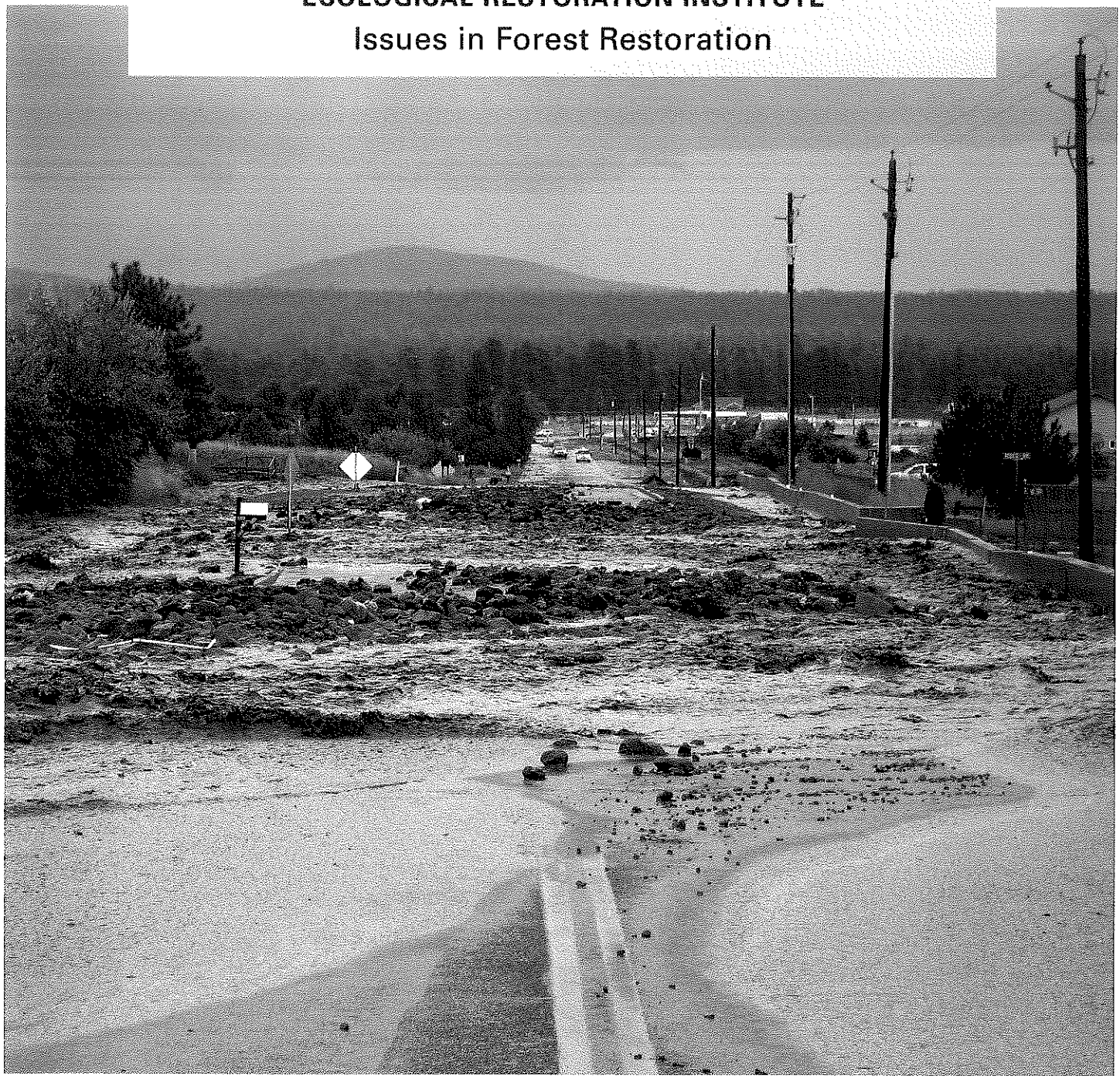
CHAIRMAN: David Cook VICE-CHAIRMAN: Gail Griffin

DATE	11/21/22
CONVENED	2:38p
RECESSED	
RECONVENED	
ADJOURNED	4:06p
MEMBERS	
Bowers	✓
Cano	
Dunn	✓
Stahl Hamilton	✓
Griffin, Vice-Chairman	
Cook, Chairman	✓

√ Present --- Absent exc Excused

Attachment 2

ECOLOGICAL RESTORATION INSTITUTE
Issues in Forest Restoration



Full-Cost Accounting Remeasurement of the 2010 Schultz Fire: Understanding the Long-term Socio-Economic Implications of High-Severity Wildfire and Post-Wildfire Flooding

August 2021

NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute

Attachment 3

The Ecological Restoration Institute

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of dry, frequent-fire forests in the Intermountain West. These forests have been significantly altered during the last century, with decreased ecological and recreational values, near-elimination of natural low-intensity fire regimes, and greatly increased risk of large-scale fires. The ERI is working with public agencies and other partners to restore these forests to a more ecologically healthy condition and trajectory—in the process helping to significantly reduce the threat of catastrophic wildfire and its effects on human, animal, and plant communities.

Cover photo: Post-fire flooding on Campbell Avenue, summer 2010. *Photo courtesy of Coconino County*

NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute

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Publication date: August 2021

Authors: Melanie Colavito, Thomas Combrink, Evan Hjerpe, Catrin Edgeley, Jack Burnett, Andrew Sánchez Meador

Reviewers: Kimiko Barrett, Headwaters Economics; Yeon-Su Kim, Professor of Ecological Economics, School of Forestry, Northern Arizona University; Diane Vosick, retired, former director of Policy and Partnerships, Ecological Restoration Institute; Eric White, Research Social Scientist, Forest Service, Pacific Northwest Research Station

Series Editor: Tayloe Dubay

Please use the following citation when referring to this paper:
Colavito, M.M., T. Combrink, E. Hjerpe, C. Edgeley, J. Burnett, and A.J. Sánchez Meador. 2021. Full-Cost Accounting Remeasurement of the 2010 Schultz Fire: Understanding the Long-term Socio-Economic Implications of High-Severity Wildfire and Post-Wildfire Flooding. ERI White Paper—Issues in Forest Restoration. Ecological Restoration Institute, Northern Arizona University. 45 p.

This research was funded by a grant from the USDA Forest Service. A portion of the research was also supported by funding provided by the Arizona Board of Regents through the Technology, Research and Innovation Fund (TRIF).

Table of Contents

Executive Summary

The Schultz Fire was ignited by an abandoned campfire on June 20, 2010, and burned 15,075 acres northeast of Flagstaff, Arizona. Following the fire, intense monsoon rains over the burned area produced heavy flooding that resulted in extensive damage to properties in neighborhoods downstream from the fire, as well as one death.

A full-cost accounting of the 2010 Schultz Fire and post-fire flooding was conducted in 2013 (Combrink et al. 2013) to capture initial damage over a three-year period. At that time, costs were estimated to be between $133 million and $147 million. This analysis builds on and revises the 2013 study to derive a ten-year full-cost accounting. This multi-year analysis is a unique contribution to the understanding of the long-term economic, ecological, and social effects of a major fire and post-fire flooding.

The original study (Combrink et al. 2013) estimated a loss in personal wealth due to reduced assessed property values in the amount of $59.4 million. The new analysis revealed the difficulty of attributing losses of property value to the fire and flooding. After analyzing assessed property values over time, we concluded that the changes in value were similar to those in the greater Flagstaff area that were not impacted by the fire and flooding. We als found that average assessed property values in the study area had rebounded 51.5% from 2010. Thus, we did not include property value changes in our updated full-cost accounting. Removing assessed property values from the amount estimated in the original study (Combrink et al. 2013) would have resulted in an estimate of full costs in 2013 dollars between $73.6 million and $87.6 million.

Costs associated with the Schultz Fire and flooding continued to accrue over ten years, although at a slower rate tha during the first analysis. In the current study, the total cost of the Schultz Fire for the ten-year assessment period wa conservatively estimated to be between $95.8 million and $100.7 million in 2021 dollars, including the fire response and post-fire flooding response and mitigation, but excluding all losses and gains related to assessed property values. This represents a 30%–15% increase in the respective range of costs from 2013, excluding property values.

The largest costs were incurred by government and utility entities in the amount of $73.4 million over ten years. Coconino County and the US Department of Agriculture Forest Service bore the largest expenses. At the same time, survey respondents indicated high support and satisfaction related to flood mitigation conducted by both Coconino County and the Coconino National Forest, among other agencies. The government and utility expenses were largely incurred between 2010 and 2015, which demonstrates that the pace of expenses decreases over time. Nonetheless, the most expensive mitigation projects for the post-fire flooding from the 2010 Schultz Fire were incurred in 2015.

The reanalysis of costs associated with habitat loss of Mexican spotted owls benefited from 10 years of data collection. Although MSO habitat was severely burned, we learned that no MSO were lost, but rather there was reduction in total habitat and a displacement of the existing owls to nearby suitable habitat. Using three separate valuation approaches, the value of the lost MSO habitat is estimated to be between $546,000 to $1,615,000 for the 10-year period.

Surveyed households in 2020, a decade after the fire, indicated that they were still experiencing long-term well-being and mental health effects. Namely, 25% of respondents shared that the Schultz Fire and subsequent flooding has caused significant stress, while just under 20% agreed that their mental health has suffered because fire or flooding.

Individual costs from the updated household survey were estimated to range between $4.6 million to $6.6 million for insurance-related costs (i.e., insurance, claims, damages) and between $3.4 million to $5.3 million for prevention and mitigation measures (i.e., initial costs and upkeep), which represent a range of approximately

8% to 12% of the post-fire flooding-related costs. There was also a decline in respondents who said they were purchasing flood insurance over time.

Events like the 2010 Schultz Fire and post-fire flooding can have long-lasting effects that often go undocumented. These include long-term financial costs, but also effects that are more difficult to quantify, such as those to local ecosystem services and societal costs like community well-being. Long-term studies, such as this one, that provide a unique look at the ongoing costs of a major wildfire are important to understand the true scope and scale of the effects of uncharacteristic wildfire and post-fire flooding. Studies such as this can provide further justification for the importance of proactive forest restoration and fuel reduction treatments to reduce the risk of uncharacteristic wildfire to ecosystems and communities.

Introduction

The Schultz Fire was ignited by an abandoned campfire on June 20, 2010 and burned 15,075 acres northeast of Flagstaff, Arizona. Following the fire, intense monsoon rains over the burned area produced heavy flooding that resulted in extensive damage to properties in neighborhoods downstream from the fire, as well as one death. The flooding continued to a lesser degree in the summers immediately following the fire as flood mitigation projects were designed and constructed. In 2013, the total costs of the Schultz Fire were conservatively estimated to be between $133 million and $147 million, including the fire response, post-fire flooding response, and mitigation costs, as well as assessed property value decreases (Combrink et al. 2013).

Shortly after the fire, engineering studies and flood mitigation projects were initiated to address post-fire flooding (Figures 1 and 2). Since 2013, when the original Combrink et al. (2013) study was published, additional flood mitigation projects were completed, which were jointly funded by the Coconino County Flood Control District and partner agencies like the US Department of Agriculture Forest Service, Federal Emergency Management Agency (FEMA), the US Geological Survey (USGS), the Arizona Department of Emergency and Military Affairs (AZ DEMA), the Natural Resource Conservation Service (NRCS), and the Federal Highway Administration (FHWA).

Events at this scale can have long-lasting effects that often go undocumented. These include long-term financial costs, but also effects that are more difficult to quantify such as those to local ecosystem services and societal costs like community well-being. This study provides a remeasurement of the full costs of the 2010 Schultz Fire and post-fire flooding, as well as an assessment of its effects on local communities and ecosystem services in the decade that followed. It is a unique look into the ongoing costs of a major wildfire.

The original Schultz Fire full-cost accounting study by Combrink et al. (2013), was conducted in collaboration between the Ecological Restoration Institute (ERI) and the Alliance Bank Economic Policy Institute (EPI), formerly the Alliance Bank Business Outreach Center. Combrink et al. (2013) conducted a full-cost accounting of the Schultz Fire using an analysis of Coconino County Assessor's records, a survey of residents in the area affected by

Broader Community Impacts from the Schultz Fire

The Schultz Fire was significant because it emphasized the need for forest restoration treatments to protect Flagstaff's municipal watershed, in particular, the Dry Lake Hills north of Flagstaff, which feeds into the Rio de Flag watershed, and Mormon Mountain south of Flagstaff, which feeds into Lake Mary—the main reservoir for the city. In November 2012, a $10 million bond measure was approved by 73.6% of voters in Flagstaff to fund the Flagstaff Watershed Protection Project (FWPP), a fuel reduction project designed to protect those key watersheds. The Arizona Rural Policy Institute conducted a cost-avoidance study for the City of Flagstaff's FWPP Monitoring Team and estimated potential damage associated with wildfire and flooding ranged between $489 and $986 million for the Dry Lake Hills and between $84 and $215 million for Mormon Mountain in 2014 dollars (Arizona Rural Policy Institute 2014). In 2019, the Museum Fire started in the Dry Lake Hills, where fuel reduction work was underway but not complete, and burned 1,961 acres near the Schultz Fire burn scar. he predicted post-fire flooding from the Museum Fire did not occur due to lack of monsoon moisture in 2019 or 2020. However, flood risk remained in the area, and in July 2021, high intensity monsoon storms over the burn scar produced significant flooding and damage. Although FWPP and the Museum Fire are important events with respect to the Schultz Fire, they are not included as part of the full-cost accounting of the Schultz Fire itself.

the fire and subsequent flooding, and the perceived values of endangered species habitat and human life. In an effort to build upon the previous study, an ERI-led team of researchers revisited the 2010 Schultz Fire full-cost accounting to document the long-term socio-economic (10 years) costs of the fire and post-fire flooding. This updated full-cost accounting incorporates costs from the original study, as well as updates costs where appropriate. It includes a summary of local government expenditures through 2019, an analysis of the impacts to ecosystem services, results from a second survey of households in the affected area exploring long-term economic and social effects, and lessons learned and considerations for accounting for the full costs of wildfire over time.

Study Overview

This remeasurement of the 2010 Schultz Fire full-cost accounting contains four primary sections and three appendices. The first section is the updated "Reported Government and Utility Costs from 2010 to 2019" and was led by Thomas Combrink at the EPI. The second section is the "Economic Valuation of Mexican Spotted Owl Habitat Impacts from Uncharacteristic Wildfire" and was led by Evan Hjerpe at the Conservation Economics Institute. This section estimates costs for non-market values, or ecosystem services, for Mexican spotted owl (MSO) habitat. Ecological monitoring of MSO since the Schultz Fire indicates that the existing owls within the fire footprint were displaced but not lost; thus, there was a reduction in suitable MSO habitat. This section includes a comparison of three economic approaches to measuring non-market values using MSO habitat as an example. The third section of the study is the "Household Survey" and was led by Catrin Edgeley and Jack Burnett of Northern Arizona University's School of Forestry. This section provides findings from a 2020 survey of households in the fire and flood footprint area that aimed to understand experiences with the Schultz Fire and subsequent flooding; long-term effects of post-fire flooding at the household level; response to flood risk, management, and remediation efforts; and perceptions of flood risk reduction efforts at different scales. Section 4 provides an updated estimate of the total costs of the 2010 Schultz Fire. We also provide lessons learned and considerations for calculating the full costs of wildfire over time. Similar to the original Combrink et al. (2013) study, this remeasurement provides a comprehensive but conservative estimate of the financial costs and social effects of the Schultz Fire. These methods, although they have not yet been peer-reviewed, may be applied to other fires, but the costs captured here are specific to the 2010 Schultz Fire and subsequent post-fire flooding.

Appendix A provides an analysis of assessed property value changes in the Schultz Fire and flood footprint area over the last ten years, including neighborhood-level analyses. The original Combrink et al. (2013) study estimated a loss in personal wealth due to reduced assessed property values in the amount of $59,353,523. It is important to note that the timing of the 2010 Schultz Fire coincided with national-level decreases in property values following the Great Recession of 2008 and the subprime mortgage crisis. Within the study area, parcel values were already dropping between 2009 and 2010, the period before the fire and the first flooding event. When the original Combrink et al. (2013) study was published, the property values in the area were only just beginning to recover. By 2020, average property values in the study area had rebounded 51.5% from an average assessed value of $214,940 in 2010 to $325,580 in 2020. This highlights that undertaking a wildfire full-cost accounting is complicated by the effects of macro-level events that compound local micro-economic events. Macro-economic effects, such as the Great Recession and housing crisis that progressed into 2012, put additional pressure on the micro-level economic pressures associated with the Schultz Fire and flooding in 2010 to 2012. These macro-level events compound local trends and are difficult to tease apart from assessed housing values in the study area. Thus, our total cost calculation (Table 21) does not include changes in assessed property values, as was done in the original Combrink et al. (2013) study.

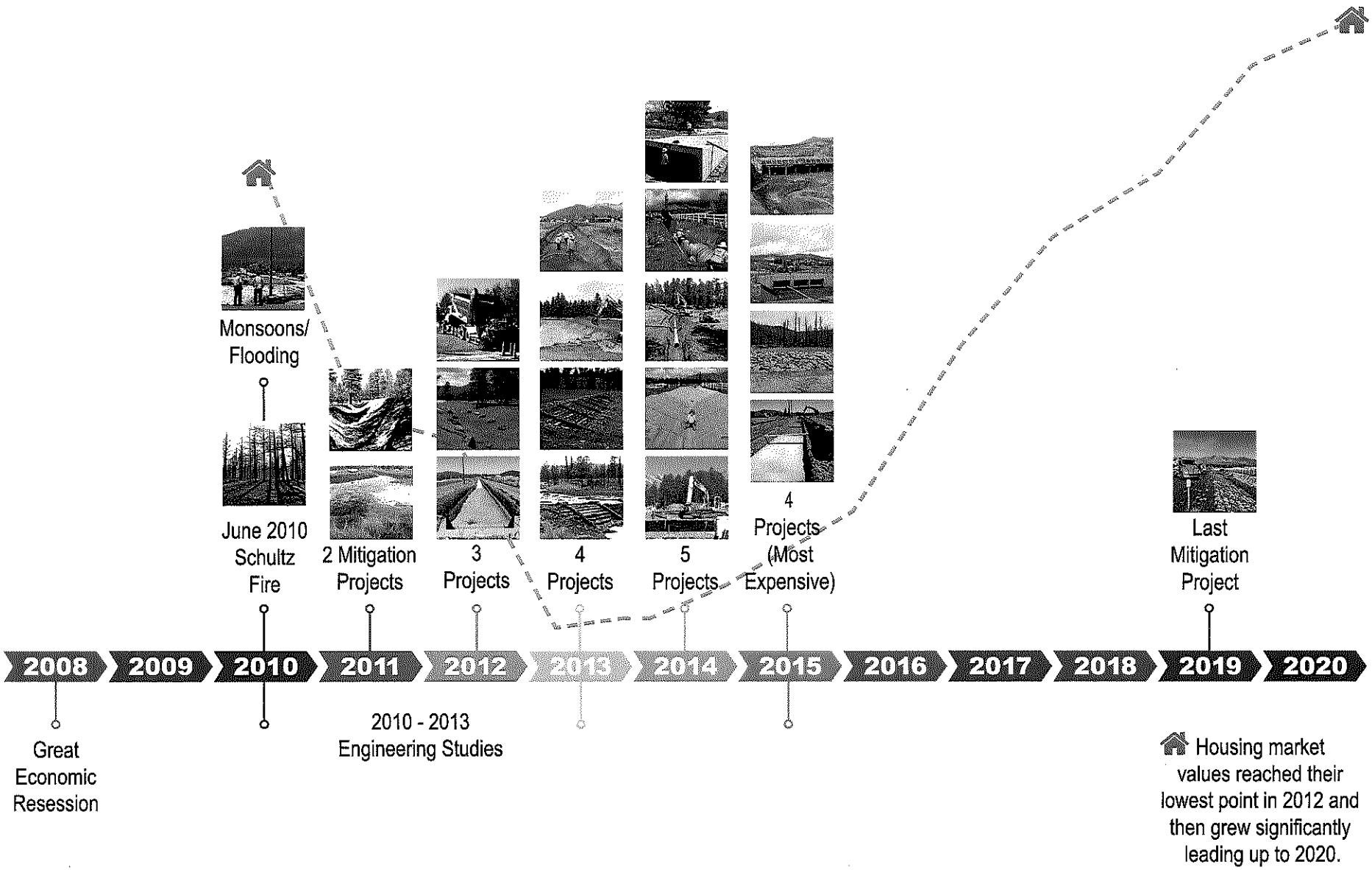


Figure 1. Timeline of events surrounding the Schultz Fire and post-fire flooding mitigation efforts.

Appendix B provides additional background, a literature review, and methodological details on the "Economic Valuation of Mexican Spotted Owl Habitat Impacts from Uncharacteristic Wildfire." And, Appendix C is the 2020 survey instrument that informed the "Household Survey" study section.

Assessing the Full Costs of Wildfire

In recent decades, there have been numerous efforts to determine the full costs of wildfire. One of the challenges of predicting these costs before fires is that every fire is different in terms of weather, fuel conditions, suppression activities, values at risk, and other factors, so costs can range widely across time and space. Furthermore, reporting on wildfire costs can include varying levels of detail or different types of costs. The Combrink et al. (2013) study was a unique effort to expand the financial accounting of a single fire beyond commonly reported costs from city, county, state, and federal governments to include more long-lasting and complex costs such as potential changes in assessed property values, habitat impacts, loss of life, structural damage, cleanup, unpaid labor, armoring against flooding, fire evacuation costs, and flood insurance premiums. The Combrink et al. (2013) study demonstrates that the full costs of fire may far exceed the suppression costs. In the case of the Schultz Fire, fire suppression accounted for approximately 6–7% of the costs. Other reports have similarly found that the full costs can range from 2 to 30 times the cost of fire suppression alone (Western Forestry Leadership Coalition 2010).

The full costs of wildfire can be explored at different geographic and temporal scales. The Combrink et al. (2013) study looked at a single wildfire. Other studies have explored costs across communities. As Headwaters Economics (2018) demonstrated, nearly half of wildfire costs are incurred by the local community due to long-term damages, with the other half being incurred by state or federal entities. They found that suppression accounts for 9% of full costs, short-term costs account for 35%, and long-term damages can account for up to 65% of total costs (Headwaters Economics 2018). Wildfire costs can also be examined within a single jurisdiction. For example, Wang et al. (2021) estimated that economic damages from the 2018 wildfires in California resulted in $148.5 billion in costs to the state, 19% of which were capital losses, 22% of which were health costs, and 59% of which came from indirect losses. The costs of wildfire can also be examined across the entire country. Thomas et al. (2017) determined that the annualized cost of wildfire in 2016 in the US was between $71.1 billion to $347.8 billion. Lastly, wildfire costs can be explored with respect to their impact on ecosystem services, like clean air and water, habitat, or recreational opportunities. Vukomanovic and Steelman (2019) looked at the effects of wildfires on ecosystem services and found largely negative effects with increasingly uncharacteristic fires.

There are also efforts to understand the potential cost savings of forest restoration and fuel reduction treatments versus the costs of wildfire suppression and mitigation. In the ponderosa pine forests of northern Arizona, treatment costs can range from $471 to $2,100 per acre for mechanical thinning and $12 to $600 per acre for prescribed fire (Taylor et al. 2015). The potential cost savings of proactive, preventative forest restoration and fuels reduction treatments can be explored using specific cases. For example, Wildish et al. (2020) estimated that planned fuel treatments in the Greater Santa Fe Fireshed would generate between $1.44–$1.67 in benefits for every dollar invested, with 74% of benefits directly impacting the Santa Fe, New Mexico community.

In the case of the Schultz Fire, a fuels reduction project called the Jack Smith/Schultz Fuels Reduction and Forest Health Project had been planned but not implemented prior to the 2010 fire. Had the 9,662 acres of planned mechanical thinning been implemented, it could have cost between $471 and $2,100 per acre (Taylor et al. 2015) potentially totaling between $4.8 and $20.3 million in treatment costs for the Jack Smith/Schultz Project. These estimates only include treatment costs, not the costs of doing NEPA, personnel, administration of programs, and contract oversight. There is also no guarantee that had the Jack Smith/Schultz Project been implemented it would have reduced damages from the 2010 Schultz Fire. Nonetheless, the costs of implementing treatments in the area could have potentially resulted in millions of dollars in cost savings.

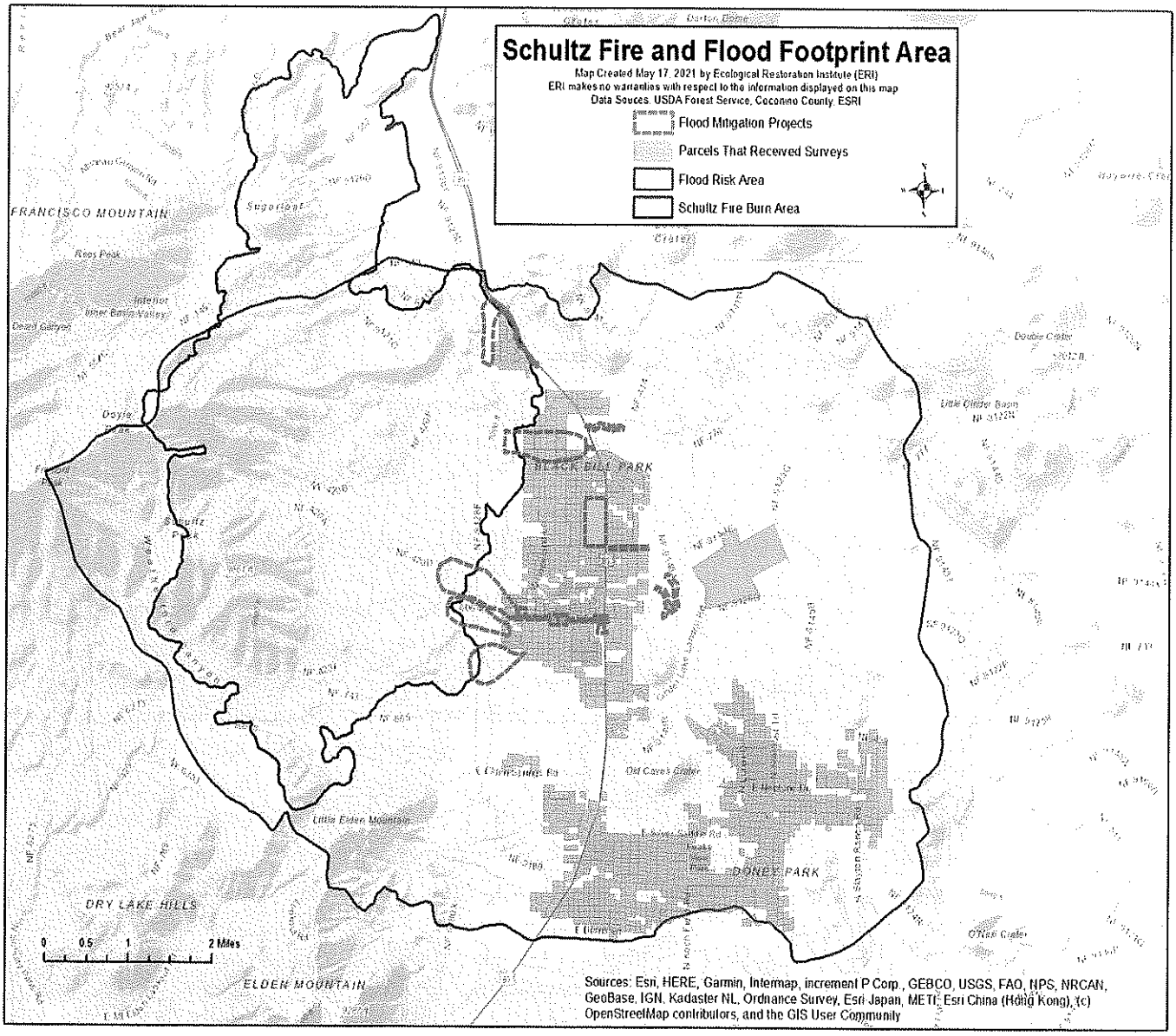


Figure 2. Map of 2010 Schultz Fire perimeter (red), the projected 100-year flood risk area (blue), and flood mitigation projects (hashed blue).

There are numerous studies that explore these long-term costs, but this remeasurement of the full costs of the 2010 Schultz Fire after ten years is a unique look into the ongoing costs and continuing costs of a major wildfire. This study provides insights into continued government and utility costs, impacts on ecosystem services and habitat, effects on community well-being, and lessons learned and considerations for wildfire cost accounting. This white paper provides important information for policy makers about the long-term effects of wildfire to support actions that proactively reduce wildfire risk.

Demographic Characteristics in the Schultz Fire and Flood Footprint

The fire and flood risk area is located within the larger Coconino County Census Tract 13.01. The tract includes neighborhoods affected by the fire and floods, as well as the neighborhoods that were not affected. The tract-level data are only available in the American Community Survey five-year data series. We explored how Tract 13.01 has changed for two comparison periods—2006–2010 and 2015–2019—to understand the broader demographic context for the fire and flood footprint area.

Census Tract 13.01 is changing in household composition with fewer children under age 18 and more adults over age 65 than in 2010 (Table 1).

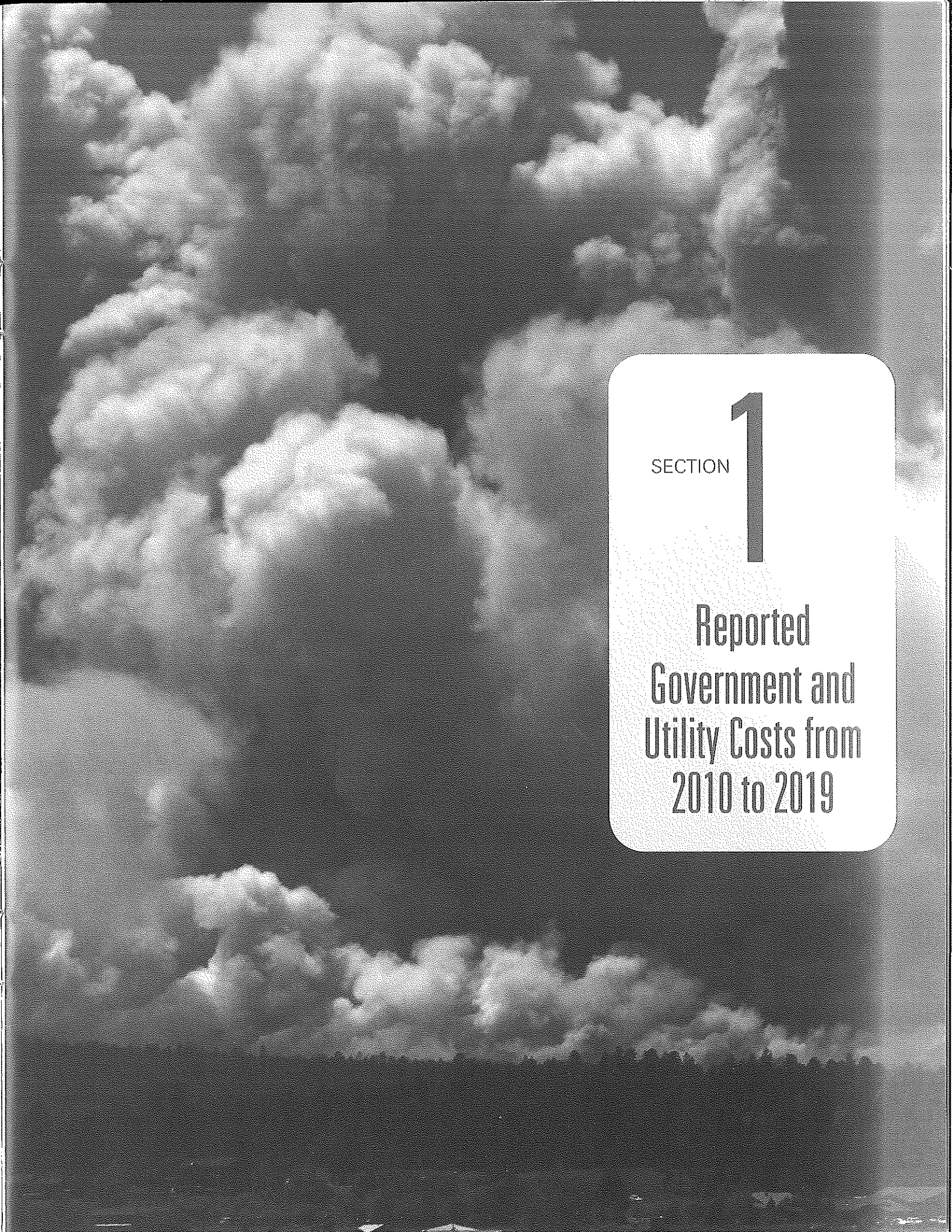
Table 1. Population Characteristics of Census Tract 13.01 (Source: US Census, American Community Survey).

	2006–2010	2015–2019	Percent Change
Total population	6,277	5,317	-15.3%
Total households	2,211	1,798	-18.7%
Family households	1,693	1,398	-17.4%
Married-couple families	1,507	1,204	-20.1%
Male householder, no spouse present	82	87	6.1%
Female householder, no spouse present	104	107	2.9%
Non-family households	518	400	-22.8%
Householder living alone	437	372	-14.9%
65 years and over living alone	79	120	51.9%
Households with one or more people 65 years and over	373	527	41.3%
Average household size	2.84	2.94	
Average family size	3.32	3.42	

While the census tract lost population over the years, the overall economic indicators for those households increased (Table 2). Most notably, the population has not grown, and there appears to have been little change over 10 years in the study area. The total population has slightly decreased with more households 65 years and over.

Table 2. Economic Characteristics of Census Tract 13.01 (Source: US Census, American Community Survey) in nominal dollars.

	2006–2010	2015–2019	Percent Change
Per-capita income	$30,924	$35,403	14.5%
Median household income	$73,897	$92,132	24.7%
Mean household income	$86,667	$101,080	16.6%
Mean household earnings	$75,409	$97,193	28.9%
Median family income	$86,067	$98,313	14.2%
Mean family income	$100,135	$108,091	7.9%

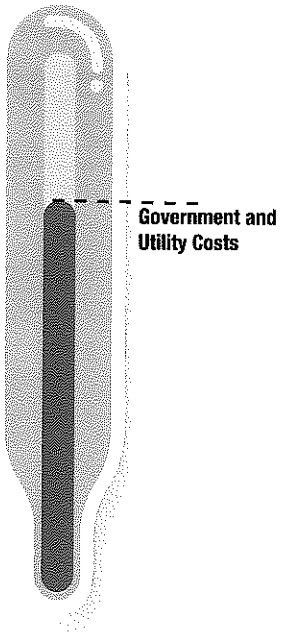


SECTION 1

Reported Government and Utility Costs from 2010 to 2019

An emergency watershed protection project constructed on Brandis Way in 2013. *Photo courtesy of Coconino County*

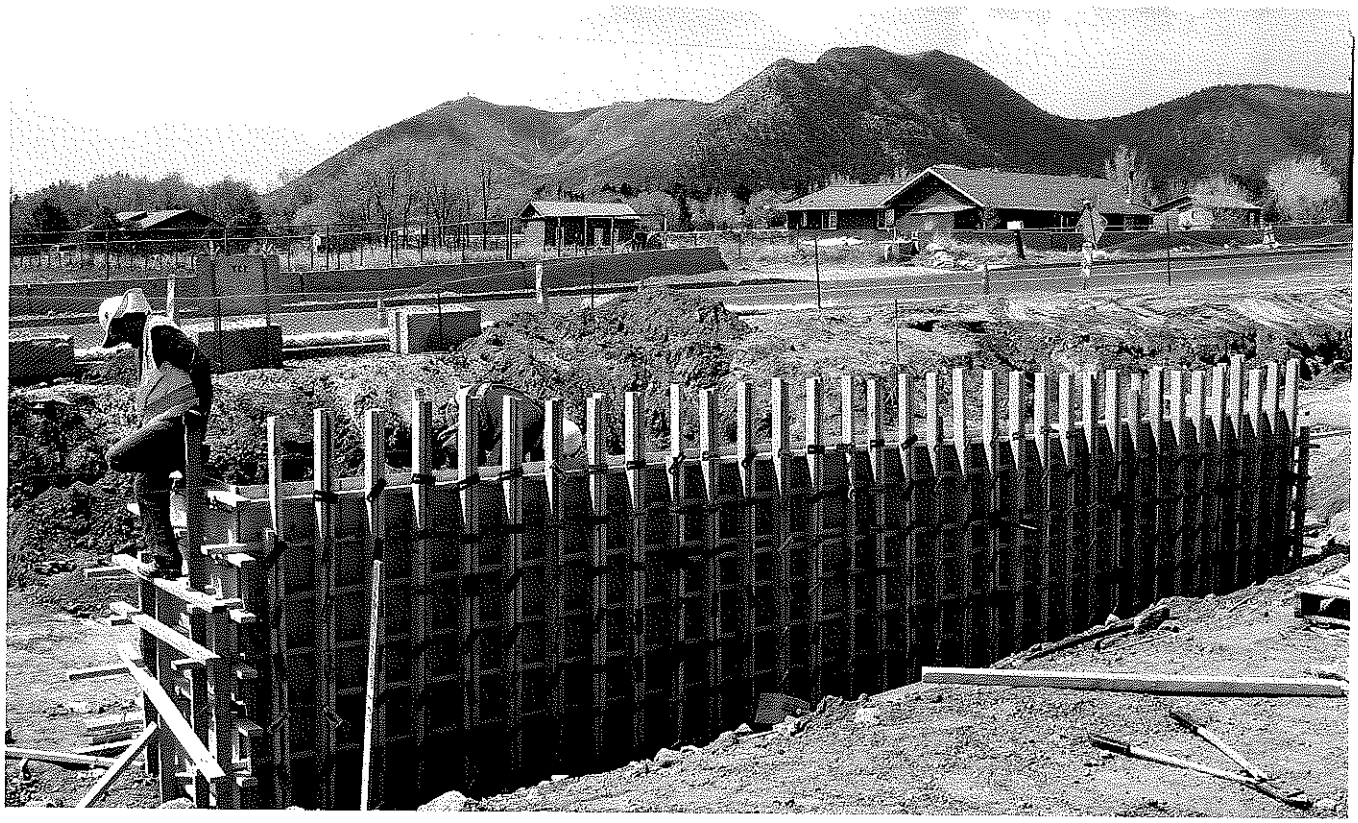
Reported Government and Utility Costs from 2010 to 2019



Government agencies and utilities adhere to strict reporting standards for capturing wildfire costs. For the 2010 Schultz Fire, suppression costs, which are captured in the first column of Table 3, accounted for approximately 6–7% of the total costs of the Schultz Fire and associated post-fire flooding as of 2019. In the original Schultz Fire full-cost accounting study (Combrink et al. 2013), $39,912,394 in expenses were documented from 2010 to 2012, including fire response, flood response, and flood mitigation.

This study updates those expenses slightly by assigning values to the years in which tasks were completed and removing projected expenses, as well as adjusting the reported numbers in each year to account for inflation to 2021 dollars. These changes resulted in a total of $44,521,954 spent between 2010–2012 on fire response, flood response, and flood mitigation, as well as added $27,871,037 in expenses from 2013 to 2019 in 2021 dollars (Table 3). In total, $72,392,991 was incurred in government and utility expenses from 2010 to 2019 in 2021 dollars.

The original study (Combrink et al. 2013) projected flood mitigation expenses for 2012–2014. These projections were validated using reported expenses as of 2019. Overall, the accuracy of those projections varied between entities but were slightly high for the 2012–2014 time period. For example, Coconino County reported spending $3 million more than projected in that time period, while other entities like FEMA spent slightly less than projected. Similarly, the expenses projected for 2012–2014 for the FWHA were later incurred in 2015 and were slightly less than projected. Projecting exactly when post-wildfire costs may be incurred is difficult due to factors such as funding availability and grant spending periods.



Box culvert construction underway on Crisp Hill Road in 2013. *Photo courtesy of Coconino County*

Table 3. Reported government and utility expenses from the Schultz Fire, 2010–2019, accounting for inflation to 2021 dollars from the year in which each expense was incurred; does not account for potential reimbursements received by these entities.

Funding Agency	Fire Response 2010	Flood Response 2010	Flood Mitigation 2011–2012	Flood Mitigation* 2013–2019	Total
City of Flagstaff	$39,494	$900,632	$5,365,628		$6,305,755
Coconino County		$6,360,584	$2,136,033	$11,580,316	$20,076,933
Coconino County Resource Advisory Council			$170,985		$170,985
Arizona Department of Emergency and Military Affairs		$1,006,892	$184,599	$246,416	$1,437,908
United States Geological Survey		$60,006	$57,943		$117,949
Arizona Department of Transportation (ADOT)			$3,520,727		$3,520,727
Summit Fire Department	$33,603	$61,326		$49,388	$144,316
Unisource Energy Systems		$219,140			$219,140
Arizona Public Service		$138,013		$152,300	$290,312
Doney Park Water		$107,331			$107,331
Federal Emergency Management Agency (FEMA)		$4,792,040	$1,082,795	$807,476	$6,682,310
US Forest Service	$11,281,035	$4,980,457	$376,632	$603,626	$17,241,750
Natural Resources Conservation Service (NRCS)			$255,419	$9,225,920	$9,481,339
Federal Highway Administration (FWHA)			$1,390,642	$5,205,596	$6,596,237
Total	**$11,354,133**	**$18,626,419**	**$14,541,402**	**$27,871,037**	**$72,392,991**

**The 2013 report estimated flood mitigation expenses totaling $19,192,000 as projected costs between 2012–2014*

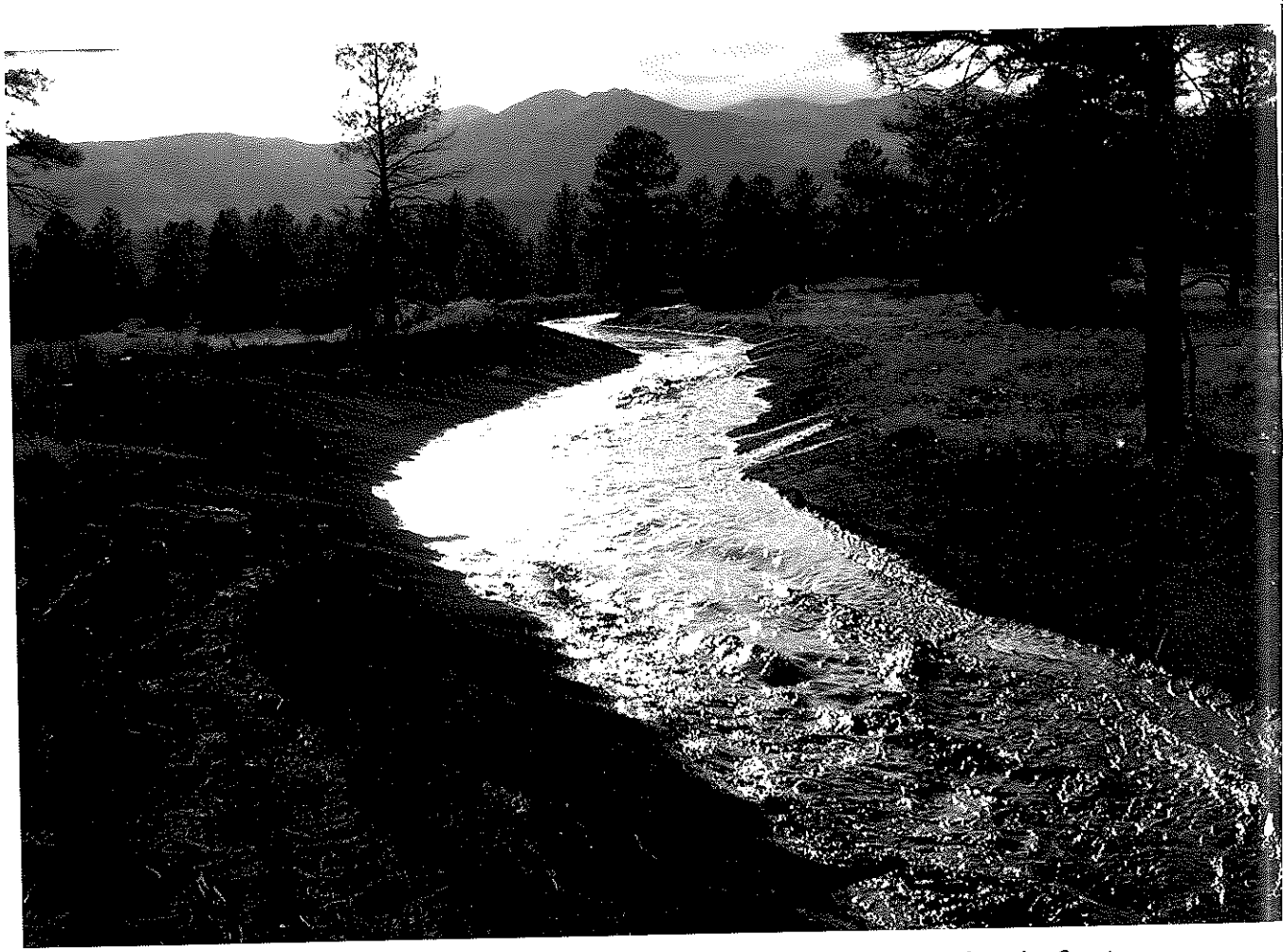
Flood Mitigation Projects

A series of floodwater mitigation projects were completed as a result of the Schultz Fire and post-fire flooding. The projects were funded jointly by the Coconino County Flood Control District and partner agencies, which included the Forest Service, FEMA, USGS, AZ DEM, NRCS, and FHWA. In total, the Schultz flood mitigatio projects cost a reported $31.462 million (Table 4) between 2010 and 2019, with partner agency funding covering $18.93 million (60%) of the costs, not accounting for inflation.

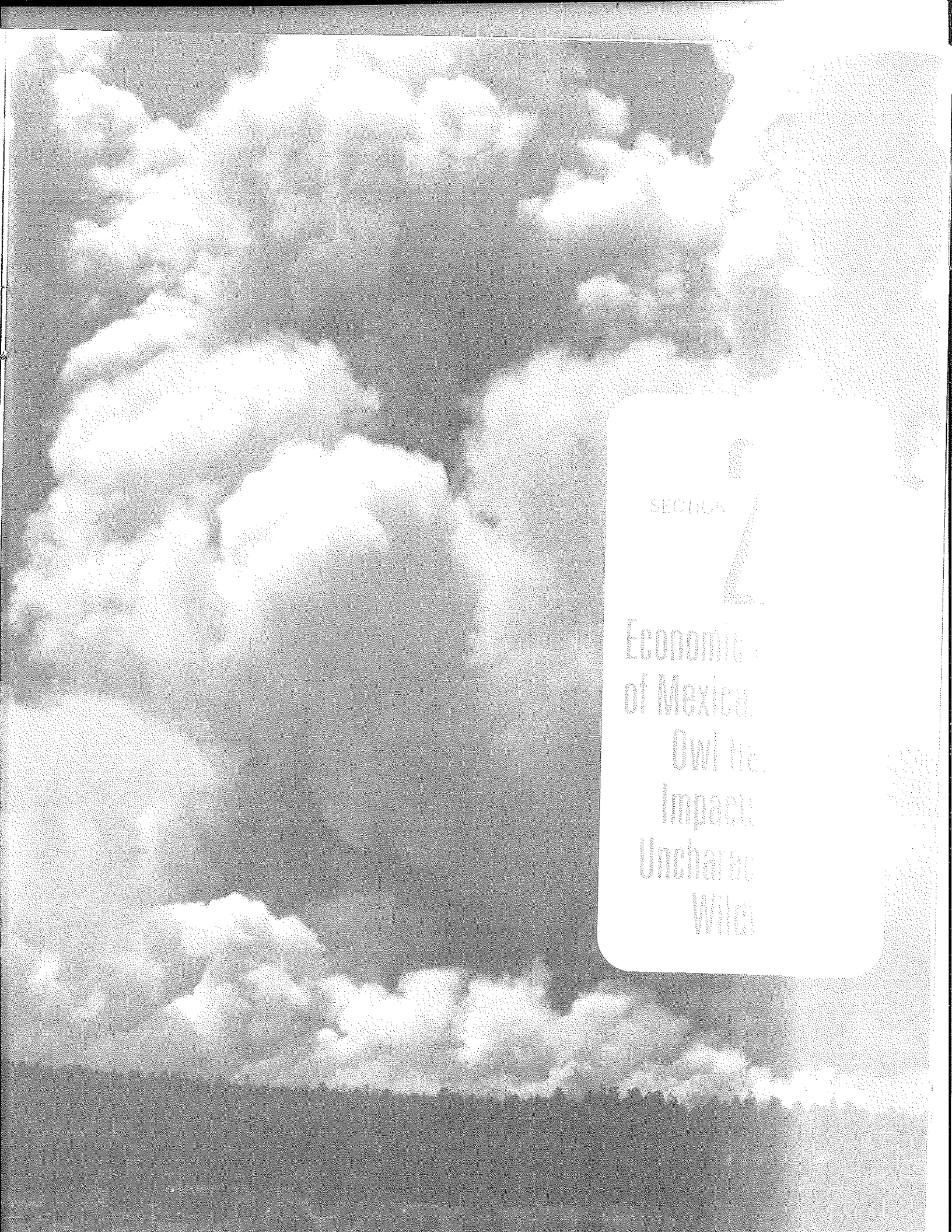
Some of the projects took place on National Forest System (NFS) lands and involved check dams, sediment retention basins and other emergency watershed protection (EWP) projects. Other projects included box culverts and retention basins in neighborhoods, as well as roadway realignments (Table 4). Engineering studies were the first tasks following the fire and were completed in 2013. The first on-the-ground projects began in 2011; three projects occurred in 2012; four projects in 2013; five projects in 2014; and four projects in occurred in 2015, two of which were EWP projects that resulted in the highest yearly costs (Figure 1). In 2019, there were additional repairs to infrastructure that were a result of damages from a 2018 monsoon event that was not associated with post-fire flooding but damaged infrastructure built following the Schultz Fire.

Table 4. Schultz Flood Mitigation Projects (2010–2019), total reported costs in nominal dollars including partner agency funding and Coconino County/Flood Control District funding, not accounting for inflation to 2021 dollars; Source: Reproduced from Coconino County, "2010–2019 Schultz Flood Mitigation Projects: By the Numbers."

Schultz Flood Mitigation Projects	Year	Cost
Engineering Studies	2010/2011	$500,000
Mitigation Projects Engineering	2011–2013	$2,000,000
Copeland Ditch	2011	$1,200,000
Twin Berms	2011	$325,000
Lower Campbell Ditch	2012	$2,000,000
Girls Ranch Road Berm	2012	$300,000
Rodeo Drive Reprofile	2012	$300,000
Brandis Way Emergency Watershed Protection (EWP) Project (located on Forest Service and Coconino County land)	2013	$3,800,000
Wupatki Trails EWP Project (located on Forest Service and Coconino County land)	2013	$1,000,000
Upper Campbell Ditch (construction and repair)	2013	$1,200,000
Crisp Hill Box Culvert	2013	$1,000,000
Upper Campbell EWP Project (located on Forest Service and Coconino County land)	2014	$2,200,000
Paintbrush North EWP Project (located on Forest Service and Coconino County land)	2014	$2,915,000
Paintbrush North Individual Lot Mitigation Measures (EWP)	2014	$308,000
South Paintbrush Individual Lot Mitigation Measures (EWP)	2014	$316,000
Alice Drive Crossing	2014	$450,000
Lower Campbell Box Culverts Project	2015	$900,000
South Paintbrush EWP Project (utilities plus located on Forest Service and Coconino County land)	2015	$4,067,000
South Paintbrush Individual Lot Mitigation Measures (EWP)	2015	$80,000
Copeland Detention Basin	2015	$5,301,000
North Schultz Flood Mitigation Repair Project	2019	$1,300,000



A berm constructed on Girls Ranch Road in 2012 redirects water from a monsoon storm event. *Photo courtesy of Coconino County*



SECTION

2

Economic
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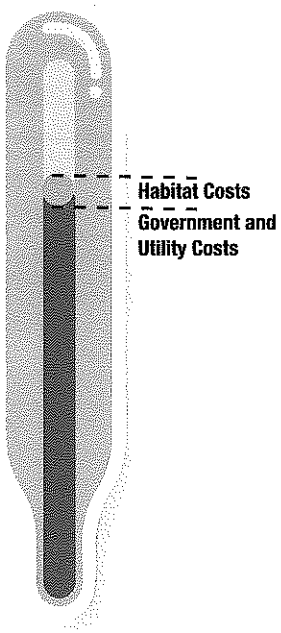
A stand of ponderosa pine trees smolders in the aftermath of the 2010 Schultz Fire. This area experienced high-severity fire, which resulted in high tree mortality and a displacement of existing Mexican spotted owls in the fire footprint. *Photo by Brady Smith, Coconino National Forest, USDA Fores Service*

Economic Valuation of Mexican Spotted Owl Habitat Impacts from Uncharacteristic Wildfire



Uncharacteristic wildfire can degrade ecosystem services, or nature's benefits to humans, which results in economic losses to society. Typically, losses from wildfire have been assessed based on goods that have markets associated with them such as timber. Economic values of market goods, as compared to those of nonmarket goods, are easily calculated. However, the majority of ecosystem services on public lands are not easily tracked, measured, or understood, nor are they traded in the marketplace. Without associated dollar values, nonmarket ecosystem services are much more difficult to measure.

In this section, we value nonmarket ecosystem services for the Mexican spotted owl (MSO) (*Strix occidentalis lucida*). We estimate the costs associated with MSO displacement and habitat loss of 1,050 Protected Activity Center (PAC) acres resulting from the Schultz Fire. Benefit transfer methods are used to apply previous spotted owl valuations from the literature to the valuation of the Schultz Fire's effects on MSO habitat. A net present valuation is conducted to address longitudinal dynamics of lost economic value immediately after the Schultz Fire and ten years later.

Estimates of economic costs associated with degraded MSO habitat represent the lost value from just one exemplary ecosystem service adversely affected by uncharacteristic wildfire. Numerous other flora and fauna and ecosystem functions and processes can be adversely affected by wildfires that burn more intensely than historically normal. Likewise, a number of ecosystem services can be enhanced by moderate wildfire in fire-dependent forests, or portions of a wildfire that fall within the historical range of variability (HRV). Additionally, some wildfire can generate more benefits than costs for spotted owls, particularly the California spotted owl (e.g., Lee 2018). Because of this, our estimates of costs associated with lost MSO habitat acres within the fire footprint should be considered only a portion of the total costs to ecosystem service from the Schultz Fire.

To estimate the benefits of species preservation, economic methods were developed to conduct nonmarket valuation where conservation and preservation values are determined by society's willingness to pay (WTP) for ecosystem services ranging from the production of clean water, to recreation, to just knowing that animals will have available and healthy habitat.

Background

With the spotted owl controversy in the early 1990s, there was a flurry of nonmarket valuations of spotted owls. Rubin et al. (1991) conducted one of the first contingent valuation studies of the northern spotted owl, finding mean annual WTP values ranging from $15–$37 per household for conservation policies that would ensure survival of the species by foregoing logging. Rubin et al. (1991) extrapolated sample estimates from the Pacific Northwest to the rest of the nation to estimate almost $1.5 billion of economic benefit (or societal WTP) associated with protecting spotted owl habitat. Hagen et al. (1992) published another contingent valuation of a conservation policy to protect the northern spotted owl, finding mean annual WTP of $86 per household. For the MSO, we are only aware of one study that estimated the conservation value of protecting the species. Loomis and Ekstrand (1997) found a mean WTP of $40 per household, resulting in a national economic benefit of $2 billion for conservation management on 4.6 million acres of Southwest forests.

With the listing of the northern spotted owl as "threatened" under the Endangered Species Act in 1990, and the subsequent listing of the MSO in 1993, timber harvest in forest habitat associated with spotted owls was nearly

eliminated. But new, emerging threats were affecting the survival of the species, such as uncharacteristic wildfire (Jones et al. 2021) and invasions of other owl species (barred owls). Interest grew in accounting for nonmarket values in the economic analysis of wildfire management (e.g., González-Cabán and Chase 1992, González-Cabá 1993), leading to a series of studies valuing the WTP for wildfire reduction programs in spotted owl forests that found strong WTP from the public (Table 5).

Table 5. Economic valuations of protecting spotted owls. *

Authors	Year	Ecosystem Service Valued	Mean WTP (US$)	Extrapolation (millions$)**
Rubin, Helfand, and Loomis	1991	Conservation policy protecting NSOs and old growth habitat	$15–$37	US = $1,48
Hagen, Vincent, and Welle	1992	Conservation policy protecting NSOs and old growth habitat	$86	N.
Loomis and González-Cabán	1994	Fire reduction policy for protecting NSOs and old growth habitat	$59–$90	Oregon = $84.
Loomis, González-Cabán, and Gregory	1994	Fire reduction policy for protecting NSOs and old growth habitat	$90	Oregon = $84.
Loomis and González-Cabán	1996	Two fire reduction policies for protecting NSOs (Oregon) and CSOs (California)	$44–$57 $45–$79	US = $4,73
Loomis and González-Cabán	1997	Combined fire reduction policy for protection NSOs (Oregon) and CSOs (California)	$61–$95	California + New En gland = $621–$1,24
Loomis and Ekstrand	1997	Critical Habitat Designations protecting MSOs and habitat	$40	US = $2,00

**All WTP estimates are annual per household. NSO = Northern Spotted Owl; CSO = California Spotted Owl; MSO = Mexican Spotted Owl.*
***Extrapolations for applicable households in region listed for the year of the study in nominal dollars.*

The literature on economic valuations of protecting spotted owls represents a fairly small sample size, dominated by a couple of researchers. As the primary studies were all conducted in the 1990s following the Northwest Fores Plan implementation, uncertainty exists about whether the public would still value spotted owls in a similar manner and if the spotted owl would have a less prominent role amongst the ever-growing environmental and conservation concerns encircling western forests (e.g., climate change). Regardless of temporal trends, all estimat of the conservation value of the spotted owl and its habitat have demonstrated that benefits greatly outweigh the costs of protection programs and have illustrated the economic efficiency of spotted owl habitat conservation pla (see Appendix B for more detailed background, literature review, and methods).

Comparison of Three Economic Approaches and Findings

In this section, we discuss the methods for applying spotted owl valuations to the Schultz Fire. The Schultz Fire in 2010 was an uncharacteristically intense wildfire, resulting in crown fires that burned through portions of three MSO PACs. Ecological monitoring by wildlife biologists documented that the Schultz Fire resulted in high severity burns on approximately 1,050 MSO PAC acres but did not result in any MSO loss, but rather a reduction in total habitat and a displacement of the existing owls within the fire footprint to nearby suitable habitat (personal communication with Shaula Hedwall, US Fish and Wildlife Service, on May 3, 2021). The synthesized owl values from Table 5 provide averages for WTP to protect and ensure the survival of the entire MSO species. For our application, we needed to understand the marginal cost of losing 1,050 MSO PAC acres t uncharacteristic, high severity wildfire, as opposed to losing the entire MSO species and all its habitat. Applying the overall average WTP in the literature is not appropriate when estimating marginal changes (e.g., Montgomer and Adams 1994).

Willingness-to-pay values for protection are known as "benefits" in cost-benefit analysis. When that protection is lost, these values become "costs." To estimate the "costs" of losing MSO habitat to the Schultz Fire, we must assess how much protection, or public benefit, was reduced. That is, the lost ecosystem services and their correlating societal benefits can be approximated by a portion of the total WTP that is represented by the Schultz Fire burn area. To do this, we applied three types of benefit transfer—value unit, measure of central tendency, and function transfer—using derived per-acre WTP estimates. Benefit transfer is conducted by transferring primary estimates from a source study to a new policy site. In this case, we transferred values from multiple spotted owl studies to our policy site of MSO habitat in and around Flagstaff, Arizona and those included within the Schultz Fire.

For all three types of transfers, we focused on the displacement of MSO habitat from three PACs within the fire footprint, or 1,050 acres of the Schultz Fire that burned with high severity. When presented with modeling alternatives, we chose the conservative options to err on the side of underestimating WTP to protect MSOs from uncharacteristic wildfire (see Appendix B for more information).

Unit Value Transfer

The simplest benefits transfer used mean estimates from the one source study that measured WTP for protecting MSOs and their habitat (Loomis and Ekstrand 1997). Given the time gap between the Loomis and Ekstrand study (1997), the Schultz Fire (2010), and the present (2021), our use of Loomis and Ekstrand's estimates can be considered a temporal benefit transfer. Loomis and Ekstrand (1997) estimated annual household average WTP of $40 to protect MSOs. Updated to 2021 dollars, mean annual WTP per household for protecting MSOs is $66. As MSOs are a threatened species that exists mostly on public lands, the sampling frame to determine WTP was throughout the US. These values held for MSOs can be extrapolated to all US households as done by Loomis and Ekstrand (1997). They conservatively estimated $2 billion of total annual WTP for the US.[1] Updated to 2021 dollars, provides an annual WTP of $3.3 billion to protect the MSO.

Transferring unit values from source studies of total WTP for protecting spotted owls is the first step in estimating the marginal costs associated with the displacement of two MSO PACs from the Schultz Fire. To go from total costs to marginal costs, we divide total WTP ($3.3 billion) by the number of MSO habitat acres presented in the original valuation (4.6 million acres). This provides a WTP of $717 per acre. When applying this value to the human-caused Schultz Fire burn area, we can assess the value based on a loss of 1,050 acres. Using this approach, we estimate that the adverse fire effects on MSOs and their habitat led to a reduction in societal welfare of approximately $753,000.

Assuming the loss of 1,050 MSO habitat acres within the fire footprint, the unit value transfer produces a societal welfare loss, or cost, of $753,000.

Measure of Central Tendency Value Transfer

A second method of unit value transfer can be conducted by identifying and synthesizing multiple viable source studies. This is called "measure of central tendency value transfer" and is a method used by Rosenberger and Loomis (2003). Table 6 illustrates the four studies that valued the WTP for protecting spotted owls, and their forested habitat, from intense wildfires. Because there has been no contingent valuation specifically conducted on wildfire prevention programs and MSOs, we assumed the valuations for NSOs and CSOs, as conducted in the source studies (Table 6), are transferable to MSOs and the Schultz Fire.

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1 *Loomis and Ekstrand (1997) report national WTP ranging from $2 billion to $3.7 billion based on treatment of non-respondents. The higher number assumed non-respondents have the same WTP as respondents. The more conservative, and lower, estimates incorporate the assumption that non-respondents have a zero WTP.*

Table 6 displays per-acre WTP values for three fire prevention and control programs that would reduce the number of acres burned in spotted owl habitat (ranging from a 20%–50% annual reduction of spotted owl acres burned annually). Per-acre WTP estimates were derived by dividing mean annual WTP estimated for the US by the total number of spotted owl acres spanning fire prevention programs.

Table 6. WTP for protecting spotted owls from wildfire.

Spotted Owl Protection Policy Being Valued	Documenting Research	Sampling Frame	Policy Acres	Extrapolated Total WTP (2021 US$)	Per-Acre WTP (2021 US$)
Fire reduction policy for protecting NSOs in Oregon	Loomis and González-Cabán 1994; Loomis, González-Cabán, and Gregory 1994	Oregon	3 million	$1.52 billion*	$507
Fire reduction policy for protecting CSOs in California	Loomis and González-Cabán 1996; Loomis and González-Cabán 1997	California; New England states	5 million	$8.07 billion	$1,614
Fire reduction policy for protecting NSOs in Oregon	Loomis and González-Cabán 1996; Loomis and González-Cabán 1997	California; New England states	3 million	$7.48 billion	$2,493

**The Loomis and González-Cabán (1994) extrapolation of Oregon WTP to the US is likely very conservative, as they estimated the rest of the nation's WTP at only 10% of the mean WTP for the sample frame. The follow-up studies conducted in California and New England states illustrate the conservative nature of this estimate.*

When synthesizing the three final per-acre WTP values, we could have chosen the mean ($1,538/acre) or the median ($1,614). As in previous steps, we chose the more conservative measure, which is the mean. Applying the mean WTP values to the loss of 1,050 MSO PAC acres in the Schultz Fire yields a total loss of $1.615 million ($1,538 x 1,050 acres).

Assuming the loss of 1,050 MSO habitat acres within the fire footprint, the measure of central tendency value transfe produces a societal welfare loss, or cost, of $1,615,000.

Benefit Function Transfer

For the benefit function transfer, we utilized Loomis and González-Cabán's (1998) WTP function for protecting acres of spotted owl habitat from fire. They estimate WTP using the measurement from Hanemann's (1984) formula for calculating median WTP for households. To transfer Loomis and González-Cabán's (1998) WTP function to Schultz Fire MSO habitat losses, we started by estimating variables for the state of Arizona to transfe results from California-derived WTP to Arizona-derived WTP for protecting MSOs. Loomis and González-Cabán (1998) illustrate coefficients for six explanatory variables used to determine average WTP, including loss of acres (i.e., expected reduction in spotted owl acres burned); old growth existence values; importance of general environmental quality, household income, age, and whether respondents were financial supporters of environmental organizations. Of the six explanatory variables, we were able to attain equivalent metrics for Arizona for two of the variables: mean income and age.

The Hanemann (1984) formula was used to determine median WTP with an assumption of 20 percent reductio in number of spotted owl acres burned, resulting in an estimated median Arizona household WTP of $50 compared to the Loomis and González-Cabán's (1998) median estimate of $56 for California. We inflated to 2021, resulting in $82 per household for Arizona. Conservatively, we only extrapolated our estimated median

WTP to 50% of households to account for Loomis and González-Cabán's (1998) 50% response rate. Additionally, households below the poverty line are unlikely to have discretionary income to use for environmental protection, so we subtracted these households from our WTP extrapolation as done in Hjerpe and Hussain (2016). Loomis and González-Cabán (1997) estimated WTP for households in New England states, thousands of miles away from the study site, at 65% of the regional sample WTP in Oregon and California. Given the higher income rates in New England states, we conservatively assume that the rest of the US households would have a mean WTP of approximately 50% of the Arizona estimated WTP.

We started the extrapolation with the state of Arizona and its 2.67 million households and removed 13.5% of households (US Census Bureau 2019) below the poverty level, leaving 2.31 million Arizona households. With 125 million households in the rest of the US, minus the state of Arizona, we removed 10.5% of households below the poverty level, leaving approximately 112 million households. We reduced our total applicable households by 50% to accord with the response rate found in Loomis and González-Cabán (1998), leaving 1.16 million eligible Arizona households and 56 million of the rest of the US households.

Applying the median AZ WTP of $82 and the remaining median US WTP of $41 to eligible households resulted in approximately $2.4 billion of total WTP. Dividing this total by the 4.6 million acres of MSO habitat (Loomis and Ekstrand 1997), gave us a WTP of $520 per acre. Multiplying this value by 1,050 acres of MSO PAC acres that burned with high severity, results in $546,000 in lost societal value.

Assuming the loss of 1,050 MSO habitat acres within the fire footprint, the benefit function transfer produces a societal welfare loss, or cost of $546,000.

Final Results

Based on three types of benefit transfer, the range of costs stemming from the loss of 1,050 MSO habitat acres within the fire footprint was estimated to be between $546,000 and $1,615,000.

Estimates of MSO Habitat Losses from the Schultz Fire Over Time

Because effects of uncharacteristic wildfire can persist for many years, it is important to understand the longitudinal trajectory of associated wildfire costs. Our estimated costs were annual estimates for MSO habitat losses from the Schultz Fire. Thus, as long as the MSO habitat stays in its new and unusable condition, annual WTP for MSO habitat losses can be aggregated for total loss estimates from the Schultz Fire over time. To account for wildfire cost persistence, and to appropriately account for monetary inflation, economists can conduct a net present valuation (NPV) to qualify MSO habitat loss costs over time. NPV is the process of summing the annual costs (or benefits) resulting from the Schultz Fire, where revenue sums are discounted into the future to account for society's preference for money now as opposed to money in the future. In other words, NPV is the discounted marginal value of altered forest ecosystem services over time.

We used the annual WTP estimates for the lost MSO habitat acres, as quantified in the prior results section, to project costs into the future and discount them back to present dollars. To align with cost-benefit analysis performed by the Forest Service in land management planning, we incorporated two discount rates[2] in our NPV analysis, which helped bracket future uncertainty for both monetary inflation and biological dynamics.

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2 *OMB Circular A–4 — Regulatory Analysis (Sept. 17, 2003) requires use of two discount rates (both 3% and 7%). It should be noted, however, that some economists suggest the use of a zero (or even negative) discount rate when valuing intact ecosystems for future generations, lending greater preference for future ecosystem values.*

We projected out costs for 20 years—as we expect MSO habitat degradation to last at least that long—under the three WTP cost estimates presented in the results section. Table 7 illustrates that if the MSO acres that burned with high severity persist as unsuitable habitat for MSOs for the next 20 years, the net present value of lost conservation benefits ranges from approximately $6 million to $24 million.

Table 7. Net present value of lost conservation benefits related to burned MSO habitat.

Benefit Transfer Type	Annual Lost Conservation Benefits	NPV @ 3%	NPV @ 7%
Unit Value	($753,000)	($11,202,700)	($7,977,300)
Measure of Central Tendency Value	($1,615,000)	($24,027,100)	($17,109,300)
Benefit Function	($546,000)	($8,123,100)	($5,784,300)

Based on three types of benefit transfer and a 20-year timeframe, the net present value of costs stemming from the loss of 1,050 MSO habitat acres within the fire footprint is estimated to be between $5.78 million to $24.03 million.

Discussion

In terms of summarizing the costs associated with MSO habitat losses and the Schultz Fire, we offer a few words of caution. While contingent valuation of nonmarket ecosystem services is an inexact science, uncertainty related to monitoring of biophysical attributes and processes and their influence on MSO habitat selection can cloud the ability for accurate economic valuations of MSOs. It is difficult to find funding and maintain detailed ecological monitoring across numerous forests. But ecological monitoring, before and after a wildfire, is necessary to understand changes in MSO habitat due to fire, the potential for future MSO habitat within burn perimeters, and the resulting economic values held by society for protecting MSOs from uncharacteristic wildfire.

On the other hand, we incorporated conservative methods for our estimates of WTP. Additionally, our accounting stance, which incorporated all eligible US households, may have been too limited given evidence of cross-border species and international WTP for protecting endangered species (Haefele et al. 2018). Having spotted owl source studies that were well aligned methodologically was helpful for our estimates.

Overall, we found the Schultz Fire spurred annual losses of societal conservation benefits related to protecting the MSO that ranged from $546,000 to $1,615,000. When accounting for the likely persistence of MSO habitat losses over the next 20 years, we estimated net present values ranging from $5.78 million to $24.03 million. It is difficult to compare our estimates to the estimates in the original Combrink et al. (2013) study, as more time was needed to determine the effects on MSO habitat. We can say that these annual estimated losses have been accumulating for the last eleven years since the Schultz Fire and will continue to accumulate in the near future. Finally, MSO habitat is only one of many nonmarket ecosystem services that can be degraded from uncharacteristic wildfire, meaning that our economic estimates are vastly underestimating total costs. Other important, nonmarket ecosystem services include things like clean water or air, cultural or ethical values, recreation opportunities, or natural hazard preventions.

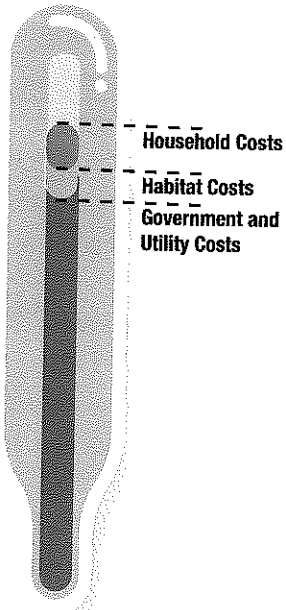
SECTION 3

Household Survey

Severe post-fire flooding impacted properties located below the Schultz Fire footprint. *Photo courtesy of Coconino County*

Household Survey

Overview



Data collection to determine household impacts associated with post-fire flooding is rare, particularly regarding undocumented expenses and the role of insurance in household recovery. The original 2011 survey of Schultz-area households conducted by Combrink et al. (2013) was one of the earliest efforts to systematically document economic losses after post-fire flooding, determining household-level out-of-pocket expenses rarely captured in traditional post-fire analyses. Our 2020 survey sought to replicate core questions from the 2011 survey and introduce new questions designed to understand how these expenses and experiences have evolved over the past decade. In this section, we discuss the findings of the 2020 household survey, with the intent to provide a temporal comparison of economic implications for residents and capture undocumented long-term consequences to Coconino County residents.

Approach

Household-level surveys are a methodological tool used to capture changes in impacts and attitudes around fire and associated secondary hazards over time. The original full-cost accounting study of the Schultz Fire included a mail survey distributed to 1,339 affected households. That study received 321 responses for a 24% response rate. We replicated this effort—with a slightly expanded focus on sampling households in the projected 100-year flood event area—in the fall of 2020. This sample's focus on long-term risk represents a slight expansion on the 2011 sample, which was concerned predominantly with flooded areas. A mixed-mode survey was administered to 1,802 households in the area, which resulted in 407 completed questionnaires for a 22.6% response rate.

Survey materials were mailed to households beginning in early October 2020. Each household received materials in three phases: 1) an introductory letter with information about the study, a questionnaire booklet and a pre-paid return envelope; 2) a postcard reminder one week later; and 3) a final reminder letter after an additional two weeks to incentivize responses from those yet to participate. Respondents also had the option to complete the survey online; a link to this format was provided in each mailout. The survey instrument is included in Appendix C.

Survey questions spanned six topics: 1) information about the respondent's property and experience with the Schultz Fire and subsequent flooding; 2) property effects associated with flooding, including insurance claims and mitigation actions; 3) efforts to address community flood risk; 4) respondent well-being since the Schultz Fire; 5) respondent concerns and priorities for landscape recovery after the Schultz Fire; and 6) basic socio-demographic information. The last page included space for participants to share additional comments. Questions were designed to solicit responses from both residents who lived in the area during the fire in 2010 and those who had moved into the area since the Schultz Fire. Unfortunately, the 2011 survey did not associate responses with household addresses, so we were unable to determine how many households responded to both the 2011 and 2020 surveys. This second survey effort also shifted away from highly detailed questions about expenses and costs requested in the 2011 survey given that participant efforts to recall 10 years of itemized expenses is unlikely to yield accurate responses.

Survey Findings

Basic Respondent Information

The average survey respondent was 63 years old. Approximately 50% of respondents identified as male, 49.5% as female, and 0.5% indicated "other." The majority of respondents (99.2%) owned their property and resided there full time (88.3%), with an average parcel size of 2.2 acres. Respondent ethnicity was predominantly white (86.7%);

7.5% identified as American Indian or Alaskan native, 1.1% as Asian, 1.1% as Black or African American, 3.9% as Hispanic or Latino, 0.3% as native Hawaiian or Pacific Islander, and 3.3% as something not listed. Respondents reported a higher-than-average household income; 79% earned $60,000 or more a year before taxes compared to Coconino County's median income of $57,616 and the census track average of $86,591 that the surveyed population lies in (US Census Bureau 2019). Respondents had generally received a high level of education, with 69.9% of respondents holding a four-year degree or a more advanced qualification. Respondents were representative based on the most recent census data for this area.

Experiences with the Schultz Fire and Subsequent Flooding

Approximately 71% of respondents (281 respondents) moved into their property prior to the Schultz Fire. A minority of respondents (13.5%) were concerned about potential flood risk when they moved into their property, while a larger number of respondents (37.7%) were concerned about potential wildfire risk. More than half of all respondents (51.3%) moderately or strongly agreed that they knew an event like the Schultz Fire and flood could happen in this area. Responses indicate that those who moved in after the Schultz Fire had a greater awareness of fire and flood risk when they moved into the area in comparison to those who lived there prior (Table 8).

When asked about current flood risk to their property, more than half (56.9%) of respondents indicated that it was low (Figure 3). Residents whose property had been flooded during the Schultz Fire (131 respondents) were far more likely to report concern about future flood (44.1% of those whose properties had flooded versus 12.6% of those whose had not flooded before). Given the long-term effects fire can have on local hydrology, respondents were asked to indicate how long they anticipated post-fire flood risk to last; only 21.8% responded that the risk was no longer present (Figure 4).

Table 8. Concern regarding flood and wildfire risk among respondents who moved into the study area before and after the Schultz Fire.

	Moved in **before** Schultz	Moved in **after** Schultz
Concerned about potential **flood risk** when they moved into Schultz area property	5%	34.8%
Concerned about potential **wildfire risk** when they moved into Schultz area property	33.6%	48.2%

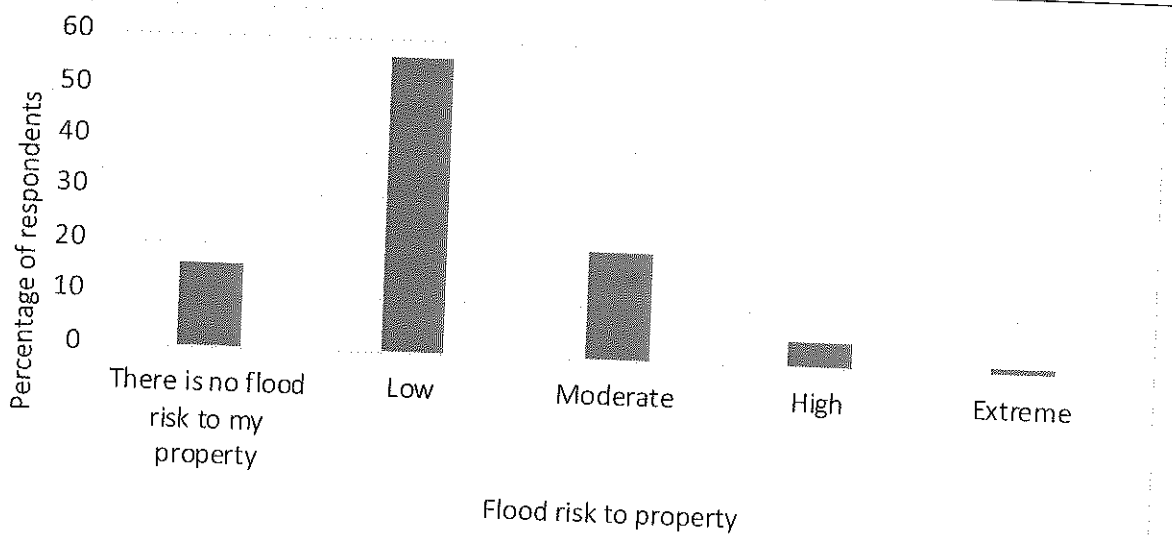


Figure 3. Respondent perceptions of current flood risk to their Schultz-area property.

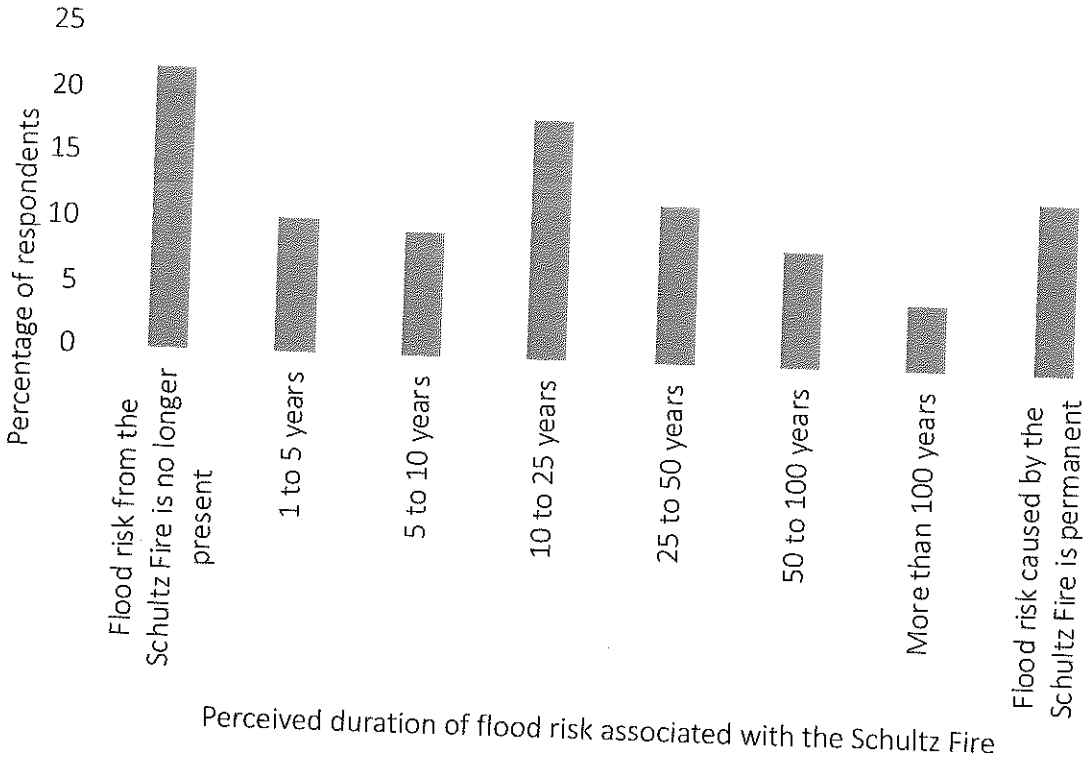


Figure 4. Respondent perceptions regarding the duration of flood risk associated with the Schultz Fire.

Long-Term Outcomes of Post-Fire Flooding at the Household Level

Several questions from the 2011 survey instrument were replicated in the 2020 survey (see Appendix C for 2020 Survey Instrument) to allow for comparisons related to flooding and its outcomes at the household level over time. The findings presented below compare data from both surveys wherever available. In the following sections we examine consequences related to insurance, finances, and well-being at the household level between 2010 to 2020. Respondents reporting that they were affected in the following sections are predominantly those who moved into the area before the Schultz Fire began, therefore we did not split the data by respondents who had tenure in the area starting before and after 2010.

Flood Insurance

Many respondents reported purchasing flood insurance annually in the years following the Schultz Fire: a total of 126 respondents (39%) self-reported holding flood insurance in the 2011 survey, while 69 (17%) reported that they still renewed flood insurance annually in 2020. A subset (55 respondents, or the total 69 respondents) shared the annual cost to renew their insurance, which had increased significantly since 2011 (Table 9).

Table 9. Overview of flood insurance costs among respondents who still renew their coverage annually.

Survey	Mean	Median	Std. dev	Minimum	Maximum	Respondents (#)
2011	$357	$350	$357	$140	$900	113
2020	$613	$500	$353	$185	$2,000	55

Given this decline in annual flood insurance renewal between both surveys, respondents who no longer purchase flood insurance were asked to provide the final year they renewed. Figure 5 displays a peak in non-renewals in 2012, and most non-renewals ended by the end of 2015.

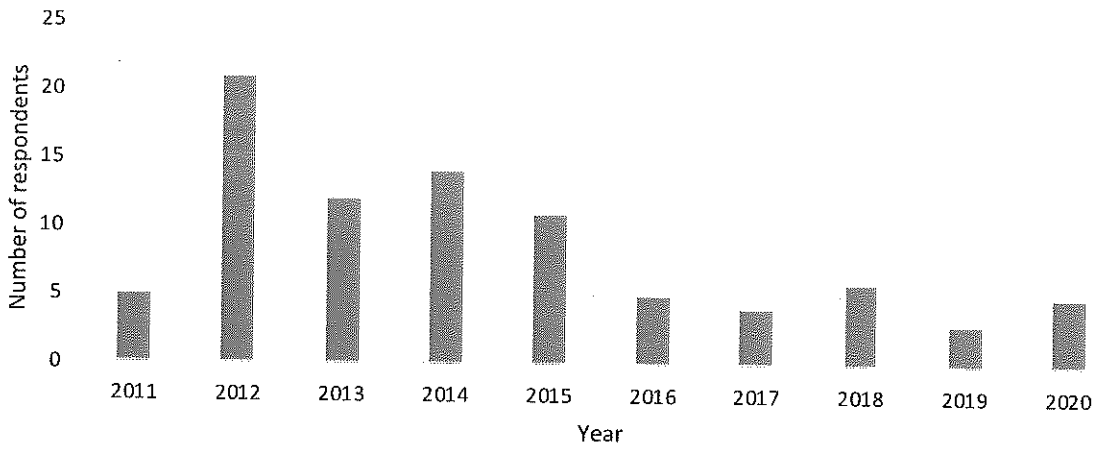


Figure 5. Year in which respondents who previously had flood insurance stopped renewing their coverage.

Respondents were also asked to share the type(s) of coverage their insurance provided, in a question format that was identical to the 2011 survey. Table 10 shows changes in coverage type between the two surveys. Small decreases in home content, structure, and renter's insurance coverage were identified, while coverage of outbuildings like garages increased.

Table 10. Insurance coverage type.

	2011 survey (139 respondents)		**2020 survey** (157 respondents)	
Coverage type	**%**	**Respondents (#)**	**%**	**Respondents (#)**
Home contents	61.9%	86	53.5%	84
Home/living structure	97.1%	135	95.5%	150
Other residential structures	15.1%	21	22.9%	36
Other residential contents	6.5%	9	5.7%	9
Renter contents	1.4%	2	0.6%	1

Approximately a third of respondents (131 respondents) from the 2020 survey reported damage from flooding at some point since the Schultz Fire, compared to the higher value of 45% (146 respondents) who reported damage in the 2011 survey. The type of damage incurred also varied between the 2011 and 2020 surveys as shown in Table 11. All types of reported damage decreased from 2011 to 2020, while those who reported no flood damage increased from 46.2% in 2011 to 74.4% in 2020.

Table 11. Type of damage incurred by post-fire flooding; the number of respondents refers to the total number of people who reported yes AND no to damage to remain consistent with Combrink et al. (2013).

	2011 survey (299 respondents)		2020 survey (398 respondents)	
Type of damage	**%**	**Respondents (#)**	**%**	**Respondents (#)**
Non-structural (driveways, landscaping, fences, etc.)	53.5%	160	23.1%	92
Home foundations – area under home	2.7%	8	2.3%	9
Exterior home/structures (including attached garages, secondary structures)	13.5%	40	8.1%	33
Interior of home (living space)	5.0%	15	2.3%	9
No flood damage	46.2%	138	74.4%	297

Insurance Claims

A minority of respondents (14) made an insurance claim associated with flood damages between 2019 and 2020. Estimated cost of damaged versus received compensation is presented in Table 12.

Table 12. Differences in estimated costs versus pay-out for insurance claims.

	Mean	Median	Minimum	Maximum
Estimated cost of damage*	$23,285	$18,000	$2,200	$75,000
Compensation received	$13,025	$11,000	$1,200	$39,000

** Damage claims included: fencing, driveway damage, sheds and other outbuildings (and in some cases, contents of these buildings), mud removal, landscaping, and septic tanks.*

Approximately one-fifth (22.5%, 90 respondents) of those who completed surveys reported flooding damage to their property for which they did not file an insurance claim. Losses for which no insurance claim was made typically included: debris/mud removal, landscaping, lost rental income, loss of pasture for livestock, flooding in living areas of house, landscaping and fencing losses, driveway, and patio or deck loss. In 14 instances, claims were not filed because the damages occurred within the 30-day period before flood insurance came into effect. The average cost of damages for which an insurance claim was not made are presented in Table 13.

Table 13. Average cost of damages that insurance did not cover.

Mean	Median	Minimum	Maximum	Respondents (#)
$12,111	$5,000	$100	$75,000	76

Damage resulting from post-fire flooding had enduring consequences for respondent properties. The length of time to complete repairs is shown in Table 14. Additionally, 10.5% (34 respondents) reported that they are still working on repairs and 4.6% (15 respondents) stated that the damaged area or building would not be repaired.

Table 14. How long it took to fully repair damage (in months).

Mean	Median	Minimum	Maximum	Respondents (#)
26.9	12	1	124	64

Surveyed households in 2020, a decade after the fire, indicated they were still experiencing long-term well-being and mental health effects. Namely, 25% of respondents shared that the Schultz Fire and subsequent flooding has caused significant stress, while just under 20% agreed that their mental health has suffered because of fire or flooding. *Photo courtesy of Coconino County*

Effects of the Schultz Fire on Well-Being Between 2011–2020

One frequently overlooked consequence of wildfires and post-fire flooding is well-being, which can be assessed through survey methods. The survey asked participants to self-report responses to a number of questions related to mental health, physical health, and well-being since the Schultz Fire. Negative well-being outcomes were predominantly documented among those who lived in the area during the Schultz Fire; those who moved into the area since 2010 rarely reported negative consequences to their well-being associated with the fire and flooding. The following statistics summarize key impacts to well-being documented at any point in the last ten years following the Schultz Fire:

- 18.9% of respondents moderately or strongly agreed that their mental health suffered as a result of the fire
- 12% of respondents moderately or strongly agreed that their physical health suffered as a result of the fire
- 25.3% experienced significant stress as a result of the Schultz Fire
- 8.3% of respondents reported that pre-existing health conditions were worsened by the Schultz Fire
- 4.4% of respondents reported that they are still experiencing health issues related to the Schultz Fire at the time of our 2020 survey
- 14.5% of respondents do not like living in the area as much since the Schultz Fire and flooding events.

These statistics indicate a spectrum of current well-being across the population in this study.

Response to Flood Risk, Management, and Remediation Efforts

Mitigation and remediation efforts to address heightened flood risk after the Schultz Fire occurred on both publi and private lands. This section explores the type and cost of work conducted on private property, and resident perceptions of remediation on public land.

Flood Risk Mitigation and Costs on Private Property

Respondents were asked to report the flood mitigation efforts they had undertaken on their property, and the approximate time frame in which they implemented each activity. Table 15 provides an overview of this data. Sand bag placement was the most commonly reported action, completed by 47.6% of respondents—the majorit of whom began this activity immediately after the fire. Less common mitigation efforts typically involved more financial and time investment, and often required some form of permanent construction or home modification. Respondents were also able to report actions not listed in the survey; the most common addition was creation o

Table 15. Most common types of flood mitigation on private property.

	Immediately after the fire	Within a month of the fire	Within a year of the fire	More than a year after the fire	Did not implement
Placed sandbags around structures on my property	30.6%	12.0%	3.2%	1.9%	52.4%
Ensured the lower levels of my home were waterproofed	6.4%	4.1%	2.0%	2.3%	85.1%
Constructed barriers around my home	12.0%	7.5%	5.3%	5.3%	71.9%
Installed flood openings in fountain and/or enclosure walls	1.8%	1.2%	0.0%	0.9%	96.1%
Elevated my home's electricity, gas, and/or water sources	0.6%	0.0%	0.9%	0.9%	97.6%
Other*	9.3%	4.1%	7.2%	5.7%	73.7%

** "Other" category included: raising or creating berms, creating or cleaning culverts, clearing and deepening roadside drainage, planting trees and other vegetation, and regrading property.*

Respondents also were able to report influences on their decisions not to undertake some mitigation efforts. Those responses are shown in Table 16. Many indicated they believed flood risk to their property was too low to warrant extensive mitigation work. Several options received neutral responses—including the cost of mitigation activities, time required, cost of upkeep, and aesthetic changes caused by mitigation—indicating that these outcomes or requirements had little influence on respondents' decisions not to mitigate.

Table 16. Most common reasons for not implementing flood risk mitigation efforts listed in Table 15, with the most frequent responses highlighted in bold.

	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
My property's flood risk is too low to warrant these mitigation efforts	7.8%	12.1%	11.5%	31.2%	**37.4%**
Those actions would not reduce flood risk to my home	9.7%	11.9%	**30.9%**	23.4%	24.1%
My property is insured, so mitigation actions seem less necessary	**32.7%**	12.6%	35.6%	8.2%	4.9%
The cost to carry out those actions is too high	16.1%	13.9%	**41.6%**	19.4%	9.0%
Those actions take too much time	21.0%	16.5%	**46.5%**	11.6%	4.5%
Those actions require too much upkeep	17.9%	13.6%	**53.2%**	12.0%	3.2%
Those actions would detract from the appearance of my property	13.9%	13.2%	**47.1%**	15.2%	10.6%
No one in this household is able to perform those actions	26.6%	13.1%	**42.0%**	9.3%	9.0%

Many of these mitigation efforts were not covered by insurance. While some materials such as sandbags were provided by Coconino County, other efforts incurred out-of-pocket costs to the homeowner. Table 17 reviews household costs for preventative measures across both the 2011 and 2020 surveys. The average cost of preventative measures on private property has doubled since 2011.

Table 17. Total estimated cost of preventative measures on respondent's property. Dollar amounts are reported for the year the data was collected and have not been adjusted.

	Mean	Median	Minimum	Maximum	Respondents (#)
2011	$3,089	$600	$30	$50,000	88
2020	$7,227	$2,500	$20	$100,000	118

Table 18 overviews the cost of upkeep for these preventative measures over the past 10 years. Responses indicate that this accounts for approximately half of costs incurred since the Schultz Fire.

Table 18. Total estimated cost of upkeep for private property mitigations.

	Mean	Median	Minimum	Maximum	Respondents (#)
2020	$3,620	$1,000	$10	$50,000	37

Perceptions of Flood Risk Reduction Efforts at Different Scales

Existing research indicates that perceptions of responsibility can be highly influential in household decisions to conduct risk mitigation efforts. Perceptions of unmet responsibility can also lead to local conflict if left unaddressed. The survey assessed respondent perceptions across different land ownerships, with a focus on determining whether enough has been done to reduce risks associated with those lands. The majority of respondents moderately or strongly agree that work on the Coconino National Forest and Coconino County right-of-way is enough to safely reduce flood risk.

Determining who the public feels should be responsible for flood risk mitigation is helpful for tailoring local messaging and communication around land management and flooding. Survey participants were provided with a list of different groups and asked to indicate the extent to which they agreed or disagreed that responsibility for flood risk mitigation should be borne by them (Table 19). Respondents widely agreed that all parties listed carried responsibility for mitigation, including themselves as property owners. This aligns with responses from a recent survey of Flagstaff residents affected by the 2019 Museum Fire, where there was near unanimous agreement that efforts to address wildfire risk reduction would be most successful when addressed collaboratively (Edgeley and Colavito 2020).

Additional analysis indicates that respondents whose properties were damaged by post-fire flooding following the Schultz Fire were more likely to agree that responsibility for risk mitigation lies with the property owner. Those who purchased and renewed flood insurance for their Schultz-area property were also more likely to agree that responsibility for mitigation lies with FEMA.

Table 19. Overview of which organizations or agencies residents felt should carry responsibility for flood risk mitigation, with the most frequent responses highlighted in bold.

Responsibility for post-fire flood risk mitigation lies with …	Strongly disagree	Moderately disagree	Neither agree nor disagree	Moderately agree	Strongly agree
The property owner	10.2%	13.2%	13.5%	**42.6%**	20.5%
Coconino County	4.0%	3.2%	11.3%	**44.0%**	37.5%
USDA Forest Service	4.8%	3.5%	12.6%	36.5%	**42.6%**
The State of Arizona	5.4%	5.2%	21.2%	**36.7%**	31.5%
The Federal Emergency Management Agency (FEMA)	6.8%	6.2%	20.5%	32.2%	**34.3%**

Survey participants were also asked which mediation measures caused the most notable decreases in risk to their private property. Table 20 reviews responses, indicating that ditches, new channel construction, and emergency stabilization efforts in the burned area were perceived as most successful. The latter indicates high public support for Burned Area Emergency Response teams, and a public recondition of the value of federal and county risk mitigation in cross-boundary risk reduction.

Table 20. Mitigation efforts that survey respondents felt most significantly decreased risk to their private property, with the most frequent responses highlighted in bold.

	Significantly increased risk	Moderately increased risk	No change in risk	Moderately decreased risk	Significantly decreased risk
Berms	1.7%	4.6%	**36.0%**	32.3%	25.4%
Ditches	3.4%	2.8%	29.3%	31.0%	**33.5%**
Culverts	3.4%	3.7%	**33.6%**	26.7%	32.5%
Reprofiling channels	3.6%	3.3%	**34.8%**	27.6%	30.6%
New channel construction	3.8%	3.8%	30.9%	25.1%	**36.4%**
Detention basins	2.6%	2.6%	**35.5%**	26.3%	33.2%
Mitigation on private lands	2.3%	5.0%	**54.5%**	24.6%	13.5%
Emergency stabilization efforts in the burned area	2.9%	4.6%	29.2%	**36.7%**	26.6%

Discussion and Conclusions

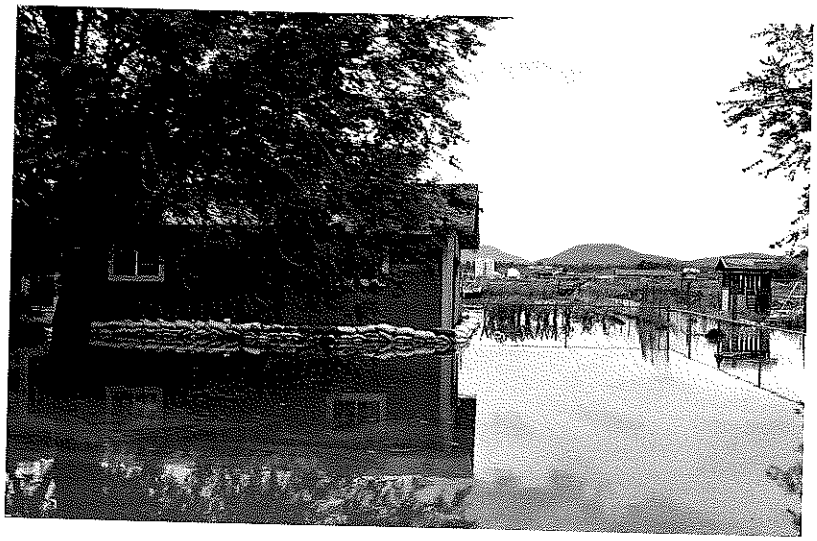
Household impacts from the Schultz Fire and subsequent flooding remain prevalent more than a decade later. Most notably, expenses associated with flood damages, mitigation, and maintenance have continued to increase since the 2011 survey.

Efforts to repair property damage caused by flooding typically take over two years, but some respondents were still working on repairs at the time of the survey. Many of these repairs were out of pocket as respondents either did not have insurance coverage or considered it unworthy of an insurance claim. The average affected household has spent $12,111 on uninsured damages; for damages that were covered, claims typically only covered a little over half the estimated cost of damage. Out-of-pocket costs have shifted from implementation of flood risk mitigation such as ditches and berms to their long-term maintenance and upkeep. Purchase and renewal of flood insurance

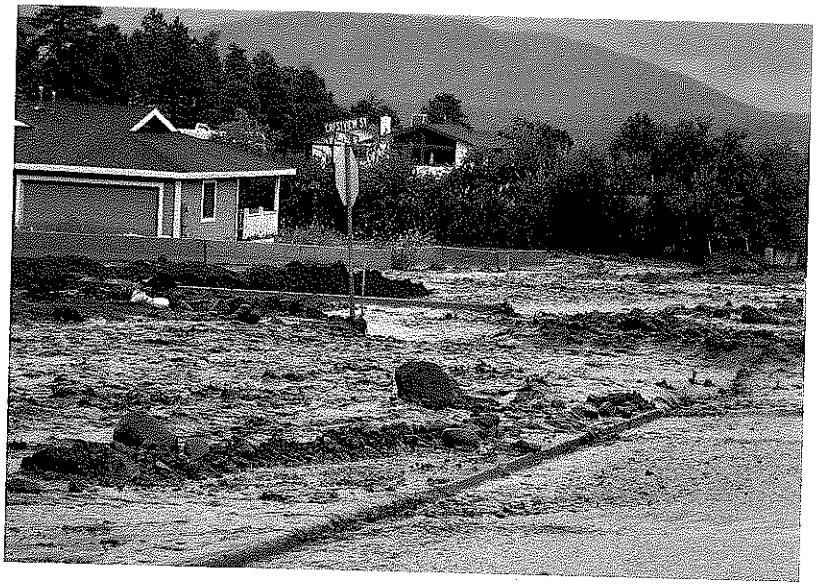
began to decrease in 2012, just two years after the Schultz Fire. This indicates that for populations near areas with long-term post-fire flood risk, communication and outreach efforts should be reengaged around this time.

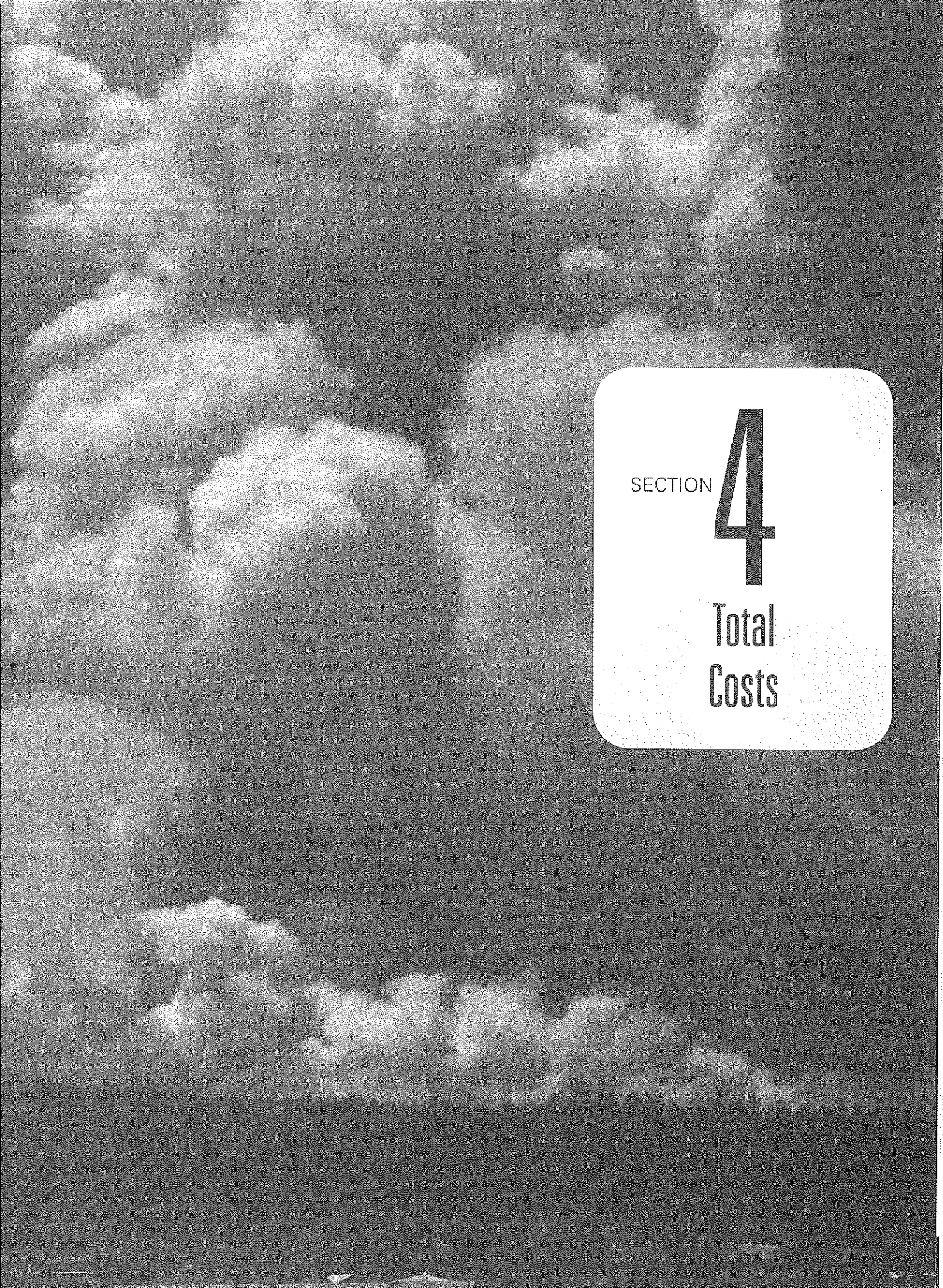
Our survey also indicates that some long-term consequences are associated with well-being and mental health. A quarter of respondents shared that the Schultz Fire and subsequent flooding caused significant stress, while 18.9% agreed that their mental health suffered because of fire or flood events and outcomes.

There are significant differences in how those who lived in the area before and after June 2010 responded to survey prompts, particularly those associated with risk. Newer residents reported greater awareness and consideration of both flood and fire risk upon moving to the area. This indicates an opportunity to capitalize on this interest and engage newcomers on arrival to conduct property mitigation, participate in collective efforts to address risk, and purchase flood and fire insurance coverage among other proactive activities. Furthermore, respondents indicated high support and satisfaction related to flood mitigation conducted by both the Coconino County and Coconino National Forest, among other agencies. This finding aligns with previous research that highlights a strong understanding of shared responsibility across members of the public (Edgeley and Colavito 2020). Together, these data suggest that residents in the areas affected by Schultz Fire flooding continue to be amenable to discussions about long-term flood risk mitigation on both private and public lands at a range of scales.



Household-level costs extrapolated from the survey were estimated to range between $4.6 million to $6.6 million for insurance-related costs and between $3.4 million to $5.3 million for prevention and mitigation measures, which represent a range of approximately 8% to 12% of the post-fire flooding-related costs. *Photo courtesy of Coconino County*





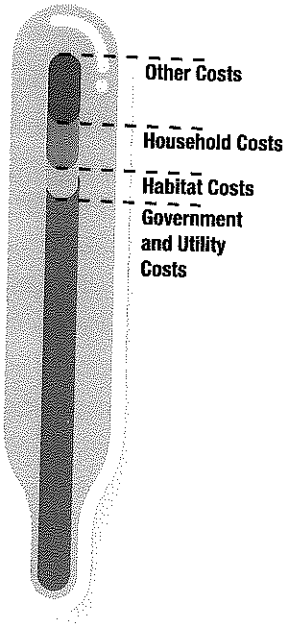
SECTION 4

Total Costs

Smoke from the Schultz Fire on June 20, 2010. The long-term costs of the Schultz Fire, as estimated in 2021, not including assessed property values, together yield a conservative full-cost estimate of approximately $98.3 million. *Photo by Mike Elson*

Total Costs

The long-term costs of the 2010 Schultz Fire, as estimated in 2021 and not including assessed property values as was done in the original study (Combrink et al. 2013), together yield a conservative full-cost estimate of approximately $98.3 million (Table 21). These costs represent some of the more complex and difficult to measure costs of wildfire and post-fire flooding.



The estimates for government and utility expenses, MSO habitat displacement, insurance, and prevention and mitigation measures were updated using new data and methods. The government and utility expenses were reported values incurred in specific calendar years. We gathered additional reported expenses from 2013 to 2019 for this study, adjusted these expenses to account for inflation to 2021 dollars, and calculated a total of $72.4 million in government and utility expenses.

The habitat valuation was updated to account for recent biological information regarding the effects of the 2010 Schultz Fire on MSO PACs in the fire footprint. The original Combrink et al. (2013) study estimated that four MSO PACs were affected by the fire. As of 2021, we know that while the MSO habitat was affected by the 2010 Schultz Fire, there was no MSO loss, rather a reduction in total habitat and a displacement of the existing owls to nearby suitable habitat. The adjusted habitat valuation estimates were derived using three different economic approaches that produced a range of $546,000 to $1.6 million. We used the mean of this range (which is also reported) to calculate our total costs on MSO habitat (Table 21).

Table 21. Total estimated costs of the 2010 Schultz Fire as of 2021; the costs for 1) loss of life; 2) structural damage; 3) cleanup; 4) unpaid labor; 5) home contents; and 6) fire evacuation were not updated from the Combrink et al. (2013) study but were adjusted to account for inflation to 2021 dollars. Where available, range of costs are presented.

	Total Costs
Government and utility expenses 2010-2019	$72,392,991
Mexican spotted owl habitat displacement	$1,080,500 (range $546,000–$1,615,000)
Insurance	$5,611,193 (range $4,613,866–$6,608,520)
Prevention and mitigation measures	$4,368,748 (range $3,437,271–$5,300,225)
Loss of life	$6,721,478
Structural damage	$3,470,499
Cleanup	$2,044,592
Unpaid labor	$1,698,409
Home contents	$614,158
Fire evacuation costs	$250,456
Total	**$98,253,024** (range $95,789,720–$100,716,328)

The original Combrink et al. (2013) study was able to capture more detailed information from households affected by the fire. The estimates for: 1) loss of life; 2) structural damage; 3) cleanup; 4) unpaid labor; 5) home contents; and 6) fire evacuation costs were not remeasured in this study but the costs captured in Combrink et al. (2013) were updated to account for inflation to 2021 dollars. Our remeasurements from the household survey focused on flood insurance costs and claims, as well as the costs of preventative measures and upkeep of those measures. Because the survey respondents were deemed to be representative of the broader study area with a non-response bias survey, we were able to extrapolate out the reported survey responses for: 1) flood insurance costs

(Table 9); 2) insurance claims (Table 12); 3) damages not covered by insurance (Table 13); 4) preventative measure costs (Table 17); and 5) upkeep of preventative measure costs to the entire study area (Table 18). We calculated a range of $4.6 million to $6.6 million for insurance-related costs (i.e., insurance, claims, damages) and a range of $3.4 million to $5.3 million for prevention and mitigation measures (i.e., initial costs and upkeep). We used the means of these ranges to calculate the total costs (Table 21).

We also estimated the potential cost savings that could have been incurred by treating a significant portion of the Schultz Fire footprint. Using information from the Jack Smith/Schultz Project, which was planned but not implemented prior to the 2010 Schultz Fire, we estimated that treatments could have cost between $471 and $2,100 per acre and $12 to $600 per acre for prescribed fire (Taylor et al. 2015). This would have represented a $12 to $2,100 per acre cost to treat the area affected by the Schultz Fire, potentially totaling between $4.8 and $20.3 million in total treatment costs for the Jack Smith/Schultz Project. Using the updated estimates of the total long-term costs of the Schultz Fire of $98.3 million, we estimated a $6,517 per-acre full cost, assuming 15,075 acres burned. Thus, there could have been a potential cost savings of between $78 million and $93.5 million had the area been treated, which would represent an approximate return of six times the amount invested. This is a rough estimate that includes numerous assumptions about how treatments might have affected the outcomes of the human-caused Schultz Fire, but they provide insight into the potential cost savings of proactive treatments for this particular example.

Conclusions

- In 2013, the total cost of the Schultz Fire was conservatively estimated to be between $133 million and $147 million. This estimate included a loss in personal wealth due to reduced assessed property values in the amount of $59.4 million. We reassessed property values in the fire and flood footprint over time and found that average assessed property values in the study area had rebounded 51.5% from 2010 (Appendix A). Thus, we did not include property value changes in our updated full-cost accounting because the decrease documented in 2013 was likely driven by macro-level economic trends in the housing market rather than an effect of the fire and flooding (Table 21).
- By removing property values from the amount estimated in the original study (Combrink et al. 2013), the full costs in 2013 dollars would have been between $73.6 million and $87.6 million.
- In the current study, the total cost of the Schultz Fire for the period 2010–2021 was conservatively estimated to be between $95.8 million and $100.7 million in 2021 dollars, including the fire response and post-fire flooding response and mitigation, but excluding all losses and gains related to assessed property values. This represents a 30%–15% increase in the respective range of costs from 2013, excluding the 2013 property values.
- The largest costs were incurred by government and utility entities in the amount of $73.4 million over ten years. Coconino County and the Forest Service bore the largest expenses (Table 3). At the same time, survey respondents indicated high support and satisfaction related to flood mitigation conducted by both Coconino County and Coconino National Forest, among other agencies.
- The government and utility expenses were largely incurred between 2010 and 2015, which demonstrates that the pace of expenses decreases over time. Nonetheless, the most expensive mitigation projects for the post-fire flooding from the 2010 Schultz Fire were incurred in 2015.
- With additional ecological monitoring of MSO PACs since the original study (Combrink et al. 2013), we were able to determine that there was no MSO loss, but rather, displacement and a reduction in total MSO habitat—mixed-conifer forests within the fire footprint. As such, the economic valuation for MSO habitat loss was adjusted to reflect the costs associated with an overall reduction in MSO habitat due to the fire.
- Surveyed households in 2020, a decade after the fire, indicated that they were still experiencing long-term well-being and mental health effects. Namely, 25% of respondents shared that the Schultz Fire and subsequent flooding has caused significant stress, while just under 20% agreed that their mental health has suffered because of fire or flooding events.
- Individual costs from the updated household survey were estimated to range between $4.6 million to $6.6 million for insurance-related costs (i.e., insurance, claims, damages) and between $3.4 million to $5.3 million for prevention and mitigation measures (i.e., initial costs and upkeep), which represents a range of approximately 8% to 12% of the post-fire flooding-related costs. There was also a decline in respondents who said they were purchasing flood insurance over time.
- The household survey responses aligned well with previous research in nearby communities affected by fire (i.e., the 2019 Museum Fire near Flagstaff) and highlighted a strong understanding of shared responsibility across members of the public (Edgeley and Colavito 2020).

Lessons Learned and Considerations for Wildfire Full-Cost Accounting

- Undertaking a wildfire full-cost accounting is complicated by the effects of macro-level events that compound local micro-economic events. For example, we determined that macro-economic effects from the Great Recession and housing crisis drove the estimates of personal wealth loss due to reduced assessed property values in the original study (Combrink et al. 2013) and were not driven by the fire and post-fire flooding. Nonetheless, macro-level events can put additional pressure on micro-level economic events, such as the 2010 Schultz Fire and flooding in 2010 to 2012. Macro-level events compound local trends and are difficult to tease apart from assessed housing values in the study area.
- Full-cost accounting studies that include economic costs of non-market values like habitat will benefit from longer-term ecological data to inform overall trends and costs to ecosystem services like changes in suitability of habitat, and thus value, over time.
- Events like the 2010 Schultz Fire and post-fire flooding can have long-lasting effects that often go undocumented. These include long-term financial costs, but also effects that are more difficult to quantify such as decreases in local ecosystem services and societal costs like community well-being. Long-term studies such as this one that provide a unique look at the ongoing costs of a major wildfire are important to understand the true scope and scale of the effects of uncharacteristic wildfire and post-fire flooding. Studies such as this can provide further justification for the importance of proactive forest restoration and fuel reduction treatments to reduce the risk of uncharacteristic wildfire to ecosystems and communities.

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Appendix A. Property Value Changes in the Schultz Fire and Flood Footprint

Available at *https://tinyurl.com/Schultz-property-value-changes*

Appendix B. Economic Valuation of Mexican Spotted Owl Habitat Impacts from Uncharacteristic Wildfire: Additional Background, Literature Review, and Methods

Available at *https://tinyurl.com/Schultz-MSO*

Appendix C. Survey Instrument

Available at *https://tinyurl.com/Schultz-survey-instrument*

About the ERI White Paper Series: Issues in Forest Restoration

Ecological restoration is a practice that seeks to heal degraded ecosystems by reestablishing native species, structural characteristics, and ecological processes. The Society for Ecological Restoration International defines ecological restoration as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability ... Restoration attempts to return an ecosystem to its historic trajectory" (Society for Ecological Restoration International 2004).

Throughout the dry forests of the western United States, most ponderosa pine forests have been degraded during the last 150 years. Many ponderosa pine areas are now dominated by dense thickets of small trees, and lack their once-diverse understory of grasses, sedges, and forbs. Forests in this condition are highly susceptible to damaging, stand-replacing fires and increased insect and disease epidemics. Restoration of these forests centers on reintroducing frequent, low-intensity surface fires—often after thinning dense stands—and reestablishing productive understory plant communities.

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of dry, frequent-fire forests in the Intermountain West. By allowing natural processes, such as fire, to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

The ERI Issues in Forest Restoration series provides overviews and policy recommendations derived from research and observations by the ERI and its partner organizations. While the ERI staff recognizes that every forest restoration is site specific, we feel that the information provided in the series may help decision-makers elsewhere.

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ERI—Issues in Forest Restoration

1. Forestlands Health and Carbon Sequestration: Strengthening the Case for Western Forest Restoration
2. Smoke from Prescribed Burning: Issues on Public Forestlands of the Western United States
3. Public Perceptions of Forest Restoration in the Southwest: A Synthesis of Selected Literature and Surveys
4. Integrating Ecological Restoration and Conservation Biology: A Case Study from Southwestern Ponderosa Pine Forests
5. Communications between Forest Managers and Property Owners in Pine Flat, Arizona: A Case Study of Community Interactions in a High Fire Hazard Area
6. Wilderness Management and the Restoration of Fire: An Analysis of Laws and Regulations in Northern Arizona
7. Navigating the Motives and Mandates of Multiparty Monitoring
8. Forest Service Contracting: A Basic Guide for Restoration Practitioners
9. Case Study of Community Stewardship Success: The White Mountain Stewardship Contract
10. What to Expect from Collaboration in Natural Resource Management: A Research Synthesis for Practitioners
11. Southwest Ecological Restoration Institutes (SWERI) Biophysical Monitoring Workshop Report
12. Carbon Credits for Restored Western Forests?
13. Ecological Restoration as Economic Stimulus: A Regional Analysis
14. Exploring the Potential of Obtaining Carbon Credits for Restoration Activities on Navajo Tribal Forest Lands
15. Integrating Domestic and Wild Ungulate Grazing into Forest Restoration Plans at the Landscape Level
16. Workforce Needs of the Four Forest Restoration Initiative Project: An Analysis
17. A Full Cost Accounting of the 2010 Schultz Fire
18. Forest Restoration Treatments: Their Effect on Wildland Fire Suppression Costs
19. The History of the Four Forest Restoration Initiative: 1980s–2010
20. Administrative and Legal Review Opportunities for Collaborative Groups
21. Flagstaff Watershed Protection Project: Creating Solutions through Community Partnerships
22. The Four Forest Restoration Initiative (4FRI): The Role of Collaboration in Achieving Outcomes
23. Planning for and Implementing Prescribed Fire in Fire-Dependent Forests of the Intermountain West
24. Assessing Metrics of Landscape Restoration Success in Collaborative Forest Landscape Restoration Projects
25. Assessment of Community Wildfire Protection Plans (CWPP) in Arizona and Throughout the West
26. Wildfire Trends Across the Western US: Forest Fires Have Increased in Size, Severity, and Frequency Across Western Forests
27. Local Experiences with the 2019 Museum Fire and Associated Flood Risk: A Survey of Flagstaff-Area Residents

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NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute

FACT SHEET

August 2021

Calculating the Full Costs of the 2010 Schultz Fire: A Ten-Year Review

Understanding the Long-Term Socio-Economic Implications of High-Severity Wildfire and Post-Wildfire Flooding

By Melanie Colavito, Andrew Sánchez Meador, Catrin Edgeley, Jack Burnett, Evan Hjerpe, Thomas Combrink

Introduction

The 2010 Schultz Fire was ignited by an abandoned campfire on June 20 and burned 15,075 acres northeast of Flagstaff, Arizona. Following the fire, intense monsoon rains over the burned area produced flooding that resulted in extensive damage. In 2013, a full-cost accounting was conducted that estimated costs for the first three years of between $133 million and $147 million (Combrink et al. 2013). This study re-evaluates those costs after ten years and provides unique insights into the long-term economic, ecological, and social effects of a major wildfire and post-fire flooding.

Methods

The original study included an assessment of costs for: property values, official government agency and utility costs, destruction of Mexican spotted owl (MSO) habitat, loss of life, structural damage, cleanup, unpaid labor, armoring against flooding, fire evacuation, and insurance. This study re-evaluated costs for property values, government agencies and utilities, MSO habitat, insurance, and prevention and mitigation measures using multiple methods, including a second survey sent to households in the affected area in 2020. Cost remeasurements from the 2020 household survey focused on flood insurance costs and claims and the costs of preventative measures and upkeep of those measures.

The original study estimated a loss in personal wealth due to reduced assessed property values in the amount of $59.4 million. This study found that average assessed property values in the study area had rebounded 51.5% from 2010. We concluded that the changes in value were similar to those in the greater Flagstaff area not impacted by the fire and flooding. Thus, we did not include assessed property value changes in our updated full-costs. Removing property values from the original study would have resulted in a full-cost estimate in 2013 dollars between $73.6 million and $87.6 million.

Key Research Findings

Costs associated with the Schultz Fire and flooding continued to accrue over ten years, although at a slower rate than during the first analysis. In the current study, the total cost of the Schultz Fire for the ten-year assessment period was conservatively estimated to be between $95.8 million and $100.7 million in 2021 dollars, including the fire response and post-fire flooding response and mitigation, but excluding all losses and gains related to assessed property values (Table 1). This represents a 30%–15% increase in the respective range of costs from 2013, excluding property values. These costs represent some of the more complex and difficult-to-measure costs of wildfire and post-fire flooding.

Table 1. *Total estimated costs of the 2010 Schultz Fire as of 2021; the costs for 1) loss of life; 2) structural damage; 3) cleanup; 4) unpaid labor; 5) home contents; and 6) fire evacuation were not updated from the Combrink et al. (2013) study but were adjusted to account for inflation to 2021 dollars. Where available, range of costs are presented.*

	Total Costs
Government and utility expenses 2010-2019	$72,392,991
Mexican spotted owl habitat displacement	$1,080,500 (range $546,000–$1,615,000)
Insurance	$5,611,193 (range $4,613,866–$6,608,520)
Prevention and mitigation measures	$4,368,748 (range $3,437,271–$5,300,225)
Loss of life	$6,721,478
Structural damage	$3,470,499
Cleanup	$2,044,592
Unpaid labor	$1,698,409
Home contents	$614,158
Fire evacuation costs	$250,456
Total	**$98,253,024** (range $95,789,720–$100,716,328)

The largest costs were incurred by government and utility entities in the amount of $73.4 million over ten years. Coconino County and the US Department of Agriculture Forest Service bore the largest expenses. At the same time, survey respondents indicated high support and satisfaction related to flood mitigation conducted by Coconino County and the Coconino National Forest, among other agencies. The government and utility expenses were largely incurred between 2010 and 2015, showing that the pace of expenses decreased over time, though the most expensive mitigation project was in 2015.

The reanalysis of costs associated with habitat loss of MSO benefited from 10 years of data collection. Although MSO habitat was severely burned, we learned that no MSO were lost, but rather there was a reduction in total habitat and a displacement of the existing owls to nearby suitable habitat. Three separate valuation approaches were used to estimate a range of $546,000 to $1,615,000 in habitat loss for the 10-year period.

Surveyed households in 2020, a decade after the fire, indicated that they were still experiencing long-term well-being and mental health effects. Namely, 25% of respondents shared that the Schultz Fire and subsequent flooding has caused significant stress, while just under 20% agreed that their mental health has suffered because of fire or flooding. Individual costs from the 2020 household survey represented a range of approximately 8% to 12% of the post-fire flooding-related costs. There was also a decline in respondents who said they were purchasing flood insurance over time.

We also estimated the potential cost savings that could have been incurred by treating a significant portion of the Schultz Fire footprint. Using information from the Jack Smith/Schultz Project, which was planned but not implemented prior to the fire, we estimated that treatments could have potentially totaled between $4.8 and $20.3 million. Using the updated estimates of the total long-term costs of the Schultz Fire of $98.3 million, we estimated a full cost of $6,517 per acre. Thus, there could have been a potential cost savings of between $78 million and $93.5 million had the area been treated. This is a rough estimate that includes numerous assumptions, but it provides insight into the potential cost savings of proactive treatments for this particular example.

Conclusions and Considerations for Wildfire Full-Cost Accounting

*We conservatively estimated that the total costs of the 2010 Schultz Fire for the period 2010–2021 was between **$95.8 million and $100.7 million in 2021 dollars**, including fire response and post-fire flooding response and mitigation, but excluding all losses and gains from assessed property values. This is a 30%–15% increase in the respective range of costs from 2013 — excluding 2013 property values.*

Post-fire flooding on Campbell Avenue, summer 2010. Photo courtesy of Coconino County

Undertaking a wildfire full-cost accounting is complicated by the effects of macro-economic events that compound local micro-economic events. We determined that macro-economic effects from the Great Recession and housing crisis drove the estimates of reduced assessed property values in the original study and were not driven by the fire and post-fire flooding. Nonetheless, macro-level events can put additional pressure on micro-level economic events and are difficult to tease apart from local effects.

Full-cost accounting studies that include economic costs of non-market values like habitat will benefit from longer-term ecological data to inform overall trends and costs to ecosystem services like changes in suitability of habitat, and thus value, over time.

Events like the 2010 Schultz Fire and post-fire flooding can have long-lasting effects that often go undocumented. These include long-term financial costs, but also effects that are more difficult to quantify such as decreases in local ecosystem services and societal costs like community well-being. Long-term studies that examine the ongoing costs of a major wildfire are important to understand the true scope and scale of the effects of uncharacteristic wildfire and post-fire flooding. Studies such as this can provide further justification for the importance of proactive forest restoration and fuel reduction treatments to reduce the risk of uncharacteristic wildfire to ecosystems and communities.

This fact sheet summaries information from the following publication:

Colavito, M.M., T. Combrink, E. Hjerpe, C. Edgeley, J. Burnett, and A.J. Sánchez Meador. 2021. Full-Cost Accounting Remeasurement of the 2010 Schultz Fire: Understanding the Long-Term Socio-Economic Implications of High-Severity Wildfire and Post-Wildfire Flooding. ERI White Paper—Issues in Forest Restoration. Ecological Restoration Institute, Northern Arizona University. 44 p.

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NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute

FACT SHEET

November 2020

Local Experiences with the 2019 Museum Fire and Associated Flood Risk

By Melanie Colavito and Catrin Edgeley

Introduction

Communities across the western United States are increasingly affected by uncharacteristic wildfires and post-wildfire flooding. Over the past 10 years, the community of Flagstaff, Arizona, has experienced impactful wildfires and post-fire flooding. In 2019, the Museum Fire burned 1,961 acres in the Dry Lake Hills north of Flagstaff where forest thinning had been underway as part of the Flagstaff Watershed Protection Project (FWPP). The FWPP was funded through a $10 million voter-approved bond in 2012 to support fuels reduction work on key watersheds that support the community of Flagstaff. The FWPP effort was catalyzed by the 2010 Schultz Fire, which caused between $133–147 million dollars in damage from fire and severe post-fire flooding. Although the Museum Fire has not yet resulted in the predicted post-fire flooding, it still galvanized significant community response to prevent flood damage.

Resident Survey

We conducted a survey of Flagstaff residents to understand their experiences with the fire and post-fire flood risk. The survey addressed five broad topics: 1) the respondent's experience with the Museum Fire; 2) communication of emergency information during the Museum Fire; 3) evacuation experiences and the Ready, Set, Go! (RSG) evacuation system; 4) opinions regarding forest management in the Flagstaff area, including the FWPP; and 5) basic demographic information. We received a total of 786 completed questionnaires using mail and online survey administration techniques—from those living within the evacuation zone for the fire and from those within the flood risk zone for the fire.

Findings and Recommendations

Based on our findings, we developed a set of evidence-based recommendations for decision-makers to facilitate and support community adaptation and safety during wildfire and post-fire flooding events.

Communication During the Museum Fire

- Virtual public meetings to communicate with residents during the fire were well attended. We recommend officials continue to stream in-person meetings on multiple platforms to reach a wider audience.
- Respondents were most trusting of local organizations and entities, such as local Forest Service units and local fire departments. We recommend using these entities to communicate with the public during fires.
- Many respondents found communication of information about flooding unclear, predominantly because they were uncertain about whether it was relevant to them. Local entities responsible for communicating about flood risk may need to provide more detailed information for residents to make decisions about the safety of their homes regarding flood risk.
- Many respondents had signed up for the Coconino County alert system and received alerts during the Museum Fire. We recommend the county continue to use the system to communicate to residents during an emergency and maintain efforts to encourage residents to sign up for alerts.

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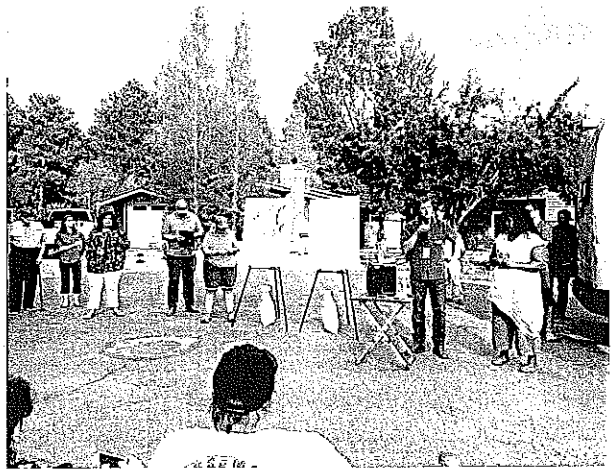
Ready, Set, Go Evacuation Notification System

The results indicate that while RSG is clear to residents in theory, there is confusion about the implementation of this system. Clarification around RSG to improve evacuation can take several forms:

- High dependence on official evacuation notices among survey respondents indicates a clear need to provide residents with knowledge that can help them make evacuation decisions autonomously. Creating and sharing resources and information with residents about fire behavior, possible thresholds for evacuation, and evacuation decision-making can encourage a reduced reliance on in-person communication and increase public safety.
- Many respondents expressed confusion regarding whether all three RSG levels will occur, and whether they will be announced incrementally from "ready," to "set," to "go." Wider communication about the RSG system, with more detail about how it may be implemented under different scenarios, can help clarify this uncertainty.
- Advanced public listing of outlets where RSG evacuation warnings will be communicated and updated can streamline public information receipt during fires. Survey findings indicate that many Flagstaff residents are signed up for the Coconino County emergency alert system, but are not aware that they will receive evacuation notices through that platform. Providing resources that help residents connect communication systems with their uses could alleviate stress and encourage the use of trustworthy information sources during wildfires.
- Many respondents were confused by incorrect place names in evacuation notices during the Museum Fire. Confirmation that neighborhood or subdivision names are accurate in emergency messaging before they are publicly shared can reduce confusion and improve public response time to notifications. Use of maps to present evacuation information can eliminate further uncertainty associated with diverse names used by different populations for the same location.
- Many evacuated residents expected to be notified that RSG for their neighborhoods had been lifted or relaxed through the Coconino County emergency alert system so they could return home, but did not receive any information through this channel. Clear communication about 1) when and where RSG evacuation notices have been lifted or reduced, and 2) where residents will be able to access the most up-to-date information about their neighborhood will be beneficial for evacuees during future fires.



A variety of organizations and agencies shared information with the public about fire risk, evacuation, suppression progress, and resource availability during the Museum Fire. *Photo by Catrin Edgeley*

Many challenges associated with the implementation of RSG are not unique to Flagstaff. Lessons learned from respondent experiences with RSG offer opportunities to further improve the safety of its residents.

Post-Fire Flood Risk

Local experiences with the 2010 Schultz Fire influenced public perceptions and expectations for flooding and flood risk management following the Museum Fire. As flood risk is likely to remain in areas downslope of the burned area long after a fire event, addressing resident concerns and misconceptions remains important. Findings from this survey support the following management implications:

- Survey respondents demonstrated a strong understanding of the connectivity between wildfires and post-fire flooding; however, those evacuated in fire risk areas often have different experiences and perceptions to those in flood risk areas that should be considered during communication and outreach.
- Maintaining communication about post-fire flood risk between local agencies and residents is critical to encourage continued awareness downslope of the Museum Fire burn scar. Support for long-term mitigation to address post-fire flooding by respondents in the flood risk area suggests these efforts should span multiple years, and can benefit from communication across the greater Flagstaff area to maintain support.

- Rapid public communication, such as in-person and virtual public meetings, about flood risk while the Museum Fire was still burning was well received and attended by respondents. We recommend that officials continue to introduce flood risk information early and through a range of communication channels, taking care to highlight which neighborhoods or areas that information is pertinent to.
- Respondents indicated willingness to see flood mitigation efforts, such as sand bags and Jersey barriers, maintained in order to reduce future flood risk. Residents in the flood risk zone were less likely to state that flood mitigation measures should be maintained, suggesting they may be experiencing some fatigue in living with the mitigation measures. This might warrant additional communication with these areas about the reasons for keeping the measures in place.

The results illustrate that addressing post-fire flood risk should largely focus on providing residents with information about why flood mitigation measures should remain in place, where they can access resources to supplement their flood mitigation measures, and how flood risk reduction efforts might be funded in the future. Providing residents with information about flood risk and mitigation will continue to be important, as the potential for flooding is still present despite recent dry monsoon seasons.

Forest and Fire Management

Survey findings indicate that although the conditions surrounding the Museum Fire concerned many residents, they did not substantially reduce public support for future forest management efforts.

- High public support for active forest management through proactive and collaborative approaches seems likely to continue following the Museum Fire.
- Survey respondents indicated a preference for collaborative forest management across agencies, governments, and organizations to address wildfire risk and forest management. A significant portion of respondents stated an interest in the continuation of FWPP or the introduction of a similar bond format to reduce fire and flood risk in the future.
- Efforts to implement additional taxation for Flagstaff residents to support forest management may benefit from a prorated approach that accounts for annual household income.
- Respondents largely recognize they are responsible for reducing fire risk on their properties. High awareness that FWPP does not reduce this need indicates that many Flagstaff residents may be receptive to resident-focused outreach efforts and resources that they can use to manage vegetation and structure risk on their property. Practices that are shared and promoted among residents should highlight the benefits of shared responsibility for wildfire risk reduction.

View of a slope burned by the Museum Fire. *Photo by Catrin Edgeley*

Under these collaborative conditions, local government and land management agencies have a relative amount of flexibility given widespread public support for and recognition of the need for forest restoration and wildfire and post-fire flood risk reduction.

Conclusion

Looking forward, Flagstaff officials can explore several paths to enhance communication and public understanding of evacuation during fires and decisions regarding flood risk mitigation measures. Public support for forest management in the Flagstaff area remains high, but there are opportunities for increased public participation in forest management in the future.

This fact sheet summarizes information from the following white paper.

Edgeley, C.M., and M.M. Colavito. 2020. Local Experiences with the 2019 Museum Fire and Associated Flood Risk: A Survey of Flagstaff-Area Residents. ERI White Paper—Issues in Forest Restoration. Ecological Restoration Institute, Northern Arizona University. 40 p.

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NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute

ERI *in* BRIEF

March 2022

The Ecological Restoration Institute: Facts at a Glance

The Ecological Restoration Institute (ERI), under the direction of Dr. Andrew Sánchez Meador, blends rigorous scientific research with service to communities and land managers in order to solve the significant environmental problems created by unhealthy forests. The ERI's mission is to serve diverse audiences with objective science and implementation strategies that support ecological restoration and climate adaptation on western forest landscapes. The ERI embraces the principle that a public university should and can directly contribute to the quality of life in the community and state.

The Ecological Restoration Institute:

- Currently employs 21 staff members, six year-round students, and six seasonal field crew students. The annual operating budget varies from **$2.6 to $3.3 million annually** (depending on individual projects and competitive grants).
- Employs undergraduate and graduate students in our ecology lab and to assist with field work. Between 2005 and 2021, more than **200 undergraduate and graduate students** have worked for the ERI. Many of these students have transitioned to professional employment or advanced degree programs.
- Has raised more than $45 million from federal appropriations, federal subcontracts, competitive grants, and other sources such as the Economic Development Administration and Salt River Project. The ERI is federally authorized (PL108-317) to receive federal appropriations administered by the US Forest Service.
- Maintains an extensive, online library with more than **450 peer-reviewed publications** and a variety of succinct communication tools such as fact sheets and working papers that translate research for application by practitioners, as well as white papers that are designed for policy audiences.

Many students who have conducted field work with the ERI have transitioned to professional employment or advanced degree programs.

- In partnership with the School of Forestry, offers a program of study and constellation of services that are **unique among the three Arizona universities**.
- Collaborates with and provides funding **to faculty and programs from other units on campus** in order to fill knowledge gaps. A few examples include: Catrin Edgeley, School of Forestry, an analysis of local experiences with the 2019 Museum Fire near Flagstaff; Thomas Combrink, W.A. Franke College of Business Economic Policy Institute, a remeasurement of the full cost accounting of the 2010 Schultz Fire near Flagstaff; David Auty, School of Forestry, investigating wood properties of ponderosa pine to inform utilization of forest restoration byproducts.
- Works in partnership or collaborates with more than **200 organizations** that represent business, environmental organizations, government, and concerned citizens.

Attachment 6

The ERI's five-year Strategic Plan (2020–2024) includes the four primary focus areas:

- *Develop and transfer restoration and climate adaptation knowledge:* work with affected entities to identify knowledge needs and provide timely and actionable science-based information related to ecological restoration and climate adaptation in forests and woodlands.
- *Overcome barriers and identify opportunities to restoration implementation at appropriate pace and scale:* apply ERI expertise to address barriers and challenges to restoration implementation at scales appropriate for enhancing resilience of forested landscapes and human communities.
- *Integrate tribal programs and practices into restoration:* engage tribal practitioners and communities who manage western forests and rangelands in multi-jurisdiction restoration and climate-related issues.
- *Foster and support partnerships:* Convene and facilitate dialogs and exchanges that advance cross-boundary restoration knowledge development and application.

A Brief History of the Ecological Restoration Institute

- The Arizona Board of Regents established the Environmental Restoration Program in 1997 with base funding provided by a $324,000 bump in NAU's budget with an understanding to increase over a three-year period to $1 million.
- The regents changed the status of the program to an institute in 1999, becoming the Ecological Restoration Institute. At that time, institutes had to be approved by the regents.
- In 2000, the first major federal appropriation to NAU for ERI was secured at $1.5 million. This was followed in 2001 by $8.8 million over 3.5 years.
- In 2004, Congress passed the **Southwest Forest Health and Wildfire Prevention Act** (PL 108-317) establishing the Ecological Restoration Institute and two other Southwest Ecological Restoration Institutes in Colorado and New Mexico and authorized the ERI as part of the federal budget, subject to matching funds from the university/state. Annual work plans are developed based on extensive input from regional, state, county, and local elected officials and other stakeholders and approved by a federal executive team each year.

Southwestern ponderosa pine stand featuring large, old trees on the Powell Plateau, North Rim, Grand Canyon. Photo by ERI

- In a January 3, 2005 letter to then Governor Janet Napolitano, NAU President John Haeger committed to providing $1 million in FY2006, $1.5 million in FY2007, and, working with the governor's office, $1.75 million in FY2007 (and thereafter) in matching funding for the federal funding.
- In June 2005, the Western Governors' Association chartered the Ecological Restoration Institute along with sister institutes in New Mexico and Colorado. President Haeger signed on behalf of NAU. Governor Napolitano signed on behalf of the state of Arizona.
- Match funding for ERI comes from three sources: 1) state appropriation to NAU for ERI, 2) the state portion of Dr. Sánchez Meador and Dr. Han-Sup Han's salaries, and 3) TRIF funding. Base annual ERI TRIF funding is currently $500,000.
- Federal appropriations in federal fiscal year 2022 to ERI is anticipated to be $2 million.

The Ecological Restoration Institute is dedicated to the restoration of fire-adapted forests and woodlands. ERI provides services that support the social and economic vitality of communities that depend on forests and the natural resources and ecosystem services they provide. Our efforts focus on science-based research of ecological and socio-economic issues related to restoration as well as support for on-the-ground treatments, outreach and education.

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NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute
TOPICS IN RESTORATION & RESILIENCY

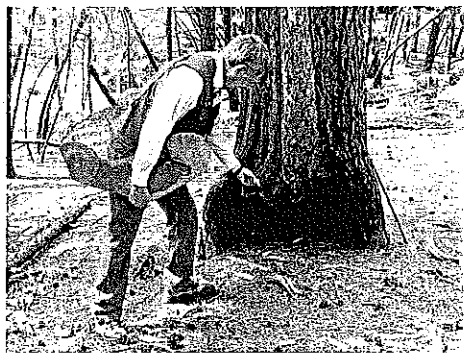
What Are Restoration Treatments?

Introduction

Land management agencies often implement fuels reduction treatments with the primary objective of reducing wildfire risk by removing hazardous fuels from the forest, such as small trees. Like fuels reduction treatments, restoration-based thinning treatments also remove smaller, younger trees and leave larger, older trees. However, they differ in that restoration treatments focus on long-term rather than short-term ecosystem health. They also seek to go beyond just one objective like fuels reduction to multiple objectives, such as enhancing ecosystem attributes like wildlife habitat, hydrology and carbon sequestration. Restoration treatments vary with location, funding, and management goals, but they generally share the qualities described below.

Restoration treatments are informed by reference conditions

Reference conditions are the forest conditions that existed before Euro-American settlers altered forest structure and function through overgrazing, fire suppression, and commercial logging. Historically, southwestern ponderosa pine ecosystems were subject to frequent surface fires, some ignited by indigenous peoples and some by lightning. Both types of fires had the same effect: they sustained forest structure by removing tree seedlings and cycling nutrients to understory plants. These conditions were stable for a long time. Soil analyses have shown that some grassy openings have existed in the same places for centuries, and perhaps much longer, while areas with clumps of pines were wooded for equally long periods.



Ecologists use reference conditions, like fire scars and old trees (pictured above), to document past fire history and forest structure. *Photo by ERI*

After Euro-American settlement, grazing removed the fine grasses that carry fire, while timber harvesting removed larger trees and made way for dense stands of younger trees. Fire suppression led to fuel accumulation and increases in fire intensity. Since settlement, forests have grown much denser, and understory productivity has declined. Today ecosystem conditions in many places are degraded and unsustainable.

Knowing reference conditions is useful because they show what a site's potential can be under self-sustaining conditions. They can be determined by locating trees or tree remains—which generally include living pines or snags with yellowed bark as well as large downed logs, stumps, and stump holes—that were present before Euro-American settlement. Tree-ring records can help document past forest structure and fire history, as can historic photographs, Forest Service records, and other written records. Relatively undisturbed sites nearby can also aid in understanding what reference conditions may have existed on a site to be treated, though the great differences in stand density and structure that can exist on even adjacent sites must be taken into account.

Reference conditions are not necessarily the same as restoration goals. Social, economic, or other management considerations may make it impossible or undesirable to attempt to recreate reference conditions. But, knowing what a site once looked like is important for guiding management goals and strategies.

Ecological Restoration Institute, P.O. Box 15017, Flagstaff, AZ 86011, 928.523.7182, FAX 928.523.0296, www.nau.edu/eri

Restoration treatments retain old trees

Decades of logging in southwestern forests that emphasized cutting large trees resulted in a scarcity of old, yellow-barked ponderosa pines. These trees tend to be resistant to fire and often provide valuable wildlife habitat, as well as aesthetic benefits, but many of those that remain are in declining health due to increased competition with younger trees. Restoration treatments preserve old, yellow-barked pines by cutting only younger pines. This lowers competitive pressures around old trees and protects these trees from fire.

Restoration treatments emphasize understory restoration

The grasses, forbs, shrubs, and other plants of the herbaceous understory comprise most of the diversity in ponderosa pine forests and are important for wildlife food and cover, as well as for aesthetics. In addition, the understory provides fuel for the needed frequent low-intensity fires that maintain forest structure. For these reasons, restoration treatments emphasize restoring the diversity and productivity of these plants. In some cases, this may require reseeding with native species or removal of invasive species.

Restoration treatments often emphasize clumps and openings

Soils analysis has shown that some grassy openings in southwestern ponderosa pine forests were apparently in place for very long periods before young pines encroached on them in the 20th century. Re-creating such openings provides habitat for many wildlife species, and can also reduce the risk of crown fires.

Ponderosa pines frequently grow in small clumps, often with interlocking crowns, that provide habitat for species that use tree trunks and crowns. The size, density, number, and location of such clumps influences both wildlife habitat and the future risk of crown fire.

As part of a full restoration treatment, crews removed an abundance of small trees from this site and have regularly burned the area (every four years) since 1994. Note the abundant understory of flowers and grasses, large old trees, and grassy openings. *Photo by ERI*

Restoration treatments incorporate fire in the long term

Fire is crucial for cycling nutrients and maintaining forest structure. Without fire, thinned forests will quickly become dense again. Future fires, whether prescribed or lightning-ignited, should be part of the restoration planning process. Though initial fires after thinning are often hot and/or smoky, due to the large quantities of needles and woody fuel on the ground, future fires should burn mainly herbaceous vegetation and tree seedlings, producing less heat and less smoke.

Restoration treatments include monitoring programs and adaptive management practices

Restoration is a relatively new science, and we have much to learn about it. For that reason, monitoring of treatments and of their effects is urgently needed to improve treatment planning and implementation, modify future treatments, and communicate progress to practitioners and stakeholders. The results of monitoring programs should inform the planning of future treatments. With careful monitoring, the lessons we learn from current treatments will improve both our restoration practice and our overall management of ponderosa pine forests.

Contact: Tayloe Dubay, tayloe.dubay@nau.edu

This research was funded by a grant from the USDA Forest Service.

NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute

TOPICS IN RESTORATION & RESILIENCY

Clearing Obstacles to Restoration

Introduction

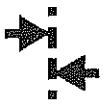
There is agreement among forestry professionals and ecologists that restoration treatments are effective at restoring forest structure and function, preventing severe wildfire, and potentially mitigating the effects of climate change. However, significant hurdles remain to treating landscapes at large scales, and they range from policy to economic and planning barriers. The Ecological Restoration Institute (ERI) works with scientists, policy makers, land managers, and the forest products industry to identify clear solutions to overcome these barriers and increase the pace and scale of restoration treatments. Some of the primary barriers, along with recommended solutions, are listed below.

Funding. Public land management agencies do not have the capacity or funds to solve the landscape-scale restoration and fire problem alone. The current degraded conditions of our forests and woodlands present a massive public health and safety problem in the form of catastrophic wildfires. They also present a risk to the delivery of important ecosystem services, like clean water and air, improved wildlife habitat and biodiversity, increased recreational opportunities and economies, cultural enrichment, climate change mitigation through carbon sequestration, and avoidance of catastrophic fire and flooding. Restoring forest health across large landscapes requires investment in solutions equal to the task. However, funding for federal, state, and local jurisdictions is often limited to address the scale of the problem.

Solution: Public land management budgets must be augmented by billions of dollars a year for the next decade to invest in science-based restoration, wildfire, and climate resilience solutions. New funding sources must be identified, with an eye toward innovative federal and state funding, partnerships with private utility companies and municipalities, and leverage investor and other financing approaches to support the delivery of ecosystem services.

Describing forest conditions and prioritizing treatments. Forest managers and decision makers lack sufficient data on existing forest conditions, fuel treatments, and fire histories within their jurisdictions and across multi-jurisdictional landscapes. Furthermore, there is often insufficient analytical capacity within agencies to use existing data sources, to plan and prioritize using commonly accepted science-based approaches, and to implement and adaptively manage restoration treatments at a pace and scale aligned with current and anticipated disturbances, such as wildfire, drought, or insect outbreaks.

Solution: Science support and use of the best available science information is critical to ramping up the pace and scale of restoration treatments. Entities that span the boundaries of science, management, and policy, like the ERI, can provide science support for land managers by collecting, analyzing, and delivering information on existing forest conditions as well as adding technical capacity to accurately describe forest conditions and support treatment planning and decision-making on the ground. This best available science helps strengthen environmental planning documents and helps land managers make informed decisions when planning for and prioritizing treatments.



Working across boundaries. In some cases, governance over forested lands is not aligned, leading to cultural and ownership differences, policy paralysis, and even conflict. Forest governance is often influenced by multiple agencies and affected entities that operate at different levels, leading to fragmentation of interests, priorities, and actions along horizontal (e.g., industrial vs. environmental values) and vertical (e.g., national vs. local government) lines.

Solution: Since severe wildfires do not stop at jurisdictional boundaries, and preventing them depends on inclusive collaboration with communities on the front lines of these threats, there is a need to work across levels of government, to develop diverse partnerships, and to work with sovereign tribes. In order to increase restoration, it is imperative that disparate groups work together to find solutions and that the necessary support for these collaborative efforts is ensured.

Better valuing resources. Most wood from restoration treatments in the Southwest (and much of the Interior West) is not merchantable (suitable for purchase or sale) and removing this material creates a biomass waste disposal problem. Furthermore, assessing the success of restoration based on traditional, forest-market valuation ignores the important (and often non- market) value of ecosystem services.

Solution: There is a need to improve the overall economics of restoration treatments through the development of a restoration economy. This necessitates a better articulation of the potential economic value of a restored acre, rather than the current focus on valuing the materials (e.g., small diameter wood and biomass) generated through thinning and restoration treatments. We must also begin to better understand the true costs of wildfire, including suppression, prevention, i.e., the cost of restoration treatments, and mitigation efforts post-fire. This type of research will help to better quantify the value of a restored acre, the potential costs of inaction, and the potential return on investment of restoration.

Inadequate business sector capacity. A major barrier to accelerating restoration and fire risk reduction throughout the West is the need for additional forest products industry capacity and markets to utilize small-diameter wood and biomass generated from restoration treatments. Many areas in the Southwest (and the interior West) lack forest products industry capacity, infrastructure, and workforce, as well as markets for the materials produced from restoration treatments. Hauling costs are often prohibitive, which prevents materials from getting to existing markets, and within the forest products industry, there is a need to increase operational efficiency and the use of small-diameter wood and biomass.

Solution: The ERI is working with partners in industry to develop a forest operations business cluster in northern Arizona. A business cluster would provide local and regional solutions to hauling, processing, and marketing low-value wood products. It would house a Forest Operations Training Center, which will build workforce capacity and create local jobs. Similar types of business clusters are needed throughout the West. In addition to adding capacity to the wood products industry, there is a need for area wood supply analyses and other cutting-edge wood utilization research to assist in attracting and sustaining the forest products industry in Arizona.

Conclusion

Many of the barriers to ramping up the pace and scale of forest restoration treatments can be addressed through federal and state policies that strengthen and increase the rationale and funding for implementation, treatment prioritization, scientific research, business sector capacity, and improving our ability to value ecosystem services. New policy solutions must seek to get to the core of the issues that present obstacles to forest restoration, i.e., the difficulty of valuing the restored acre rather than the materials it provides, and the other barriers presented here.

Contact: Tayloe Dubay, tayloe.dubay@nau.edu

This research was funded by a grant from the USDA Forest Service.

NORTHERN ARIZONA UNIVERSITY | Ecological Restoration Institute

ERI *in* BRIEF

Breaking the Biomass Bottleneck

Introduction

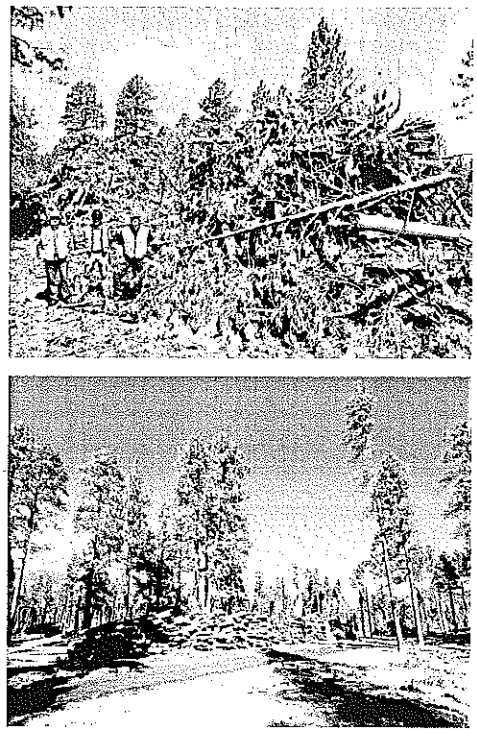
Forest restoration and hazardous fuels reduction treatments in northern Arizona are intended to improve forest health and reduce the risk of catastrophic wildfire. Forest thinning treatments focus on mechanically removing small-diameter trees in overly dense forests. These operations result in the production of a byproduct known as biomass (e.g., small logs and forest residues/slash).

The Biomass Bottleneck

Once trees are thinned, the biomass produced has almost nowhere to go due to a lack of capacity in the northern Arizona forest products industry. Few businesses in the region can utilize the materials, and high hauling costs inhibit transporting the biomass long distances to the few industry locations across the state. This results in a biomass bottleneck.

Forest restoration treatments are intended to restore forest health and reduce the risk of catastrophic wildfire. Changing climate conditions and insect and disease outbreaks increase the risk of wildfire. But, with nowhere to go, biomass is often piled on site and left in the forest to be burned when conditions permit—adding another degree of risk for wildfire.

The biomass bottleneck is a major barrier to the successful implementation of large-scale forest restoration and hazardous fuels reduction treatments.



Small-diameter trees and forest residues, referred to as biomass, are generated as a result of fire hazard reduction thinning and restoration treatments. Biomass currently has little economic use. Photos by ERI

Breaking the Bottleneck

The solution to the biomass bottleneck can be found in diversified investments in the forest products industry, like forest products business clusters. Business clusters can manufacture a variety of forest products, like engineered wood products, wood-plastic composite products, biochar, pellets, landscaping wood chips, and animal bedding materials. Additionally, business clusters can include biomass plants that produce heat and energy.

A high-capacity manufacturing facility can produce solid wood products, create and grow markets, and increase demand for wood. Lumber can be further processed into high-value wood products like windows and cabinets. The development of new forest products businesses supports rural economic development, creates jobs, and increases the pace and scale of forest restoration treatments.

The Ecological Restoration Institute is dedicated to the restoration of fire-adapted forests and woodlands. ERI provides services that support the social and economic vitality of communities that depend on forests and the natural resources and ecosystem services they provide. Our efforts focus on science-based research of ecological and socio-economic issues related to restoration as well as support for on-the-ground treatments, outreach and education.

Contact: Dr. Han-Sup Han, *Han-Sup.Han@nau.edu*; 928.523.1049

Ecological Restoration Institute, Northern Arizona University, PO Box 15017, Flagstaff, AZ 86011, *www.na*

Toward a Forest Operations Training Program at Northern Arizona University

The Need for Restoration Workforce Development

Forest restoration activities like hazardous fuels reduction, forest thinning, and other treatments can restore forest health and prevent catastrophic wildfire. A thriving private forestry operations sector is vital to implement these treatments. An increased national focus on forest and fuels management has created a growing demand for skilled professionals who can safely and efficiently operate the vehicles and equipment used in forest operations. Because of the specialized nature of operating forestry equipment and hauling logs and biomass, it can take up to six months before a new equipment operator is at maximum production levels. This amount of time, combined with safety and risk factors, is a significant investment facing the private forestry sector.

There is a growing demand for skilled professionals to safely operate the equipment needed to perform restoration operations across the West. Photo by ERI

In addition, the increasing pace and scale of forest restoration requires a large workforce of contractors capable of harvesting and transporting restoration byproducts. However, the operations workforce in the Southwest and other areas of the United States has been in decline for several decades.

To address this workforce need, the ERI received a planning grant in September 2020 from the Economic Development Administration (EDA) to develop a Forest Operations Training Program (FOTP). The FOTP will focus on three career paths: 1) forest equipment operators, 2) truck drivers, and 3) heavy equipment repair and maintenance personnel. The ERI has now a detailed plan in place to implement the training programs.

Key Actions for Program Success

Formally establish collaboration with key partners. A team effort is integral to the success of the FOTP, and it includes the following partners:

- Coconino Community College
- Yavapai Community College
- Coconino County/Workforce Development Board
- Arizona Department of Veterans' Services
- Arizona Department of Forestry and Fire Management
- Community-based organizations: Economic Collaborative of Northern Arizona (ECoNA), Northern Arizona Council of Governments (NACOG), and Greater Flagstaff Forests Partnership (GFFP)
- Equipment manufacturers: forestry machines and trucks
- Forest industry companies
- USDA Forest Service

Target audiences. A key goal of the FOTP is to develop a new workforce that will grow into mature forestry and forest products businesses. Knowledgeable and capable labor is needed to achieve forest restoration goals, which reduces the risk of catastrophic wildfires and improves local and regional forest health. The training programs offer new professional career paths in forest operations for anyone, including (but not limited to) the following groups:

- Veterans
- Native Americans
- High school graduates
- Displaced workers from the closure of coal-powered plants and mining operations
- Post-incarceration skill development initiatives

A truck hauls logs from a recently thinned area on the Coconino National Forest. Photo courtesy of USDA Forest Service

The FOTP curricula include three training programs for the following career paths:

Forest equipment operator course: Workers will operate mechanized forest equipment to cut, skid, process, and load logs onto trucks. Upon completion, students will have both the professional logger and equipment operator certifications.

Truck driver training course: There is a critical need throughout the US for trained truck drivers. The lack of certified truck drivers in forest operations is particularly acute since highway drivers are not trained to haul logs and operate chip vans and forest equipment on forest roads that pose unique situations. The FOTP will focus on operating log trucks, chip vans, and low-bed trailers hauling heavy equipment to meet this expanding need.

Heavy equipment (diesel) repair and maintenance course: Forest equipment requires extensive, regular maintenance and repair, and contractors find it difficult to get qualified, experienced professionals into the forest to effectively and efficiently repair this equipment. The FOTP will work with equipment manufacturers such as John Deere, Ponsse, Tigercat, and Caterpillar to develop thorough and effective training to meet this essential need.

The Future of the Forest Operations Training Program

The FOTP will benefit the private forestry sector by providing the needed training areas, facilities, and qualified instructors to train students in new techniques, equipment safety, and industry standards and practices. These courses and certificates will introduce forestry practices to a new generation of students while instilling knowledge, reducing risk, increasing efficiency, and creating a new cadre of workers with increased investment in the private forest industry.

Outcomes from operating the FOTP include (but are not limited to) increased capacity to achieve forest restoration goals, job creation and career development, industry and economic growth, and forest operation innovations and new technologies. The FOTP activities will support economic recovery and resilience by providing the infrastructure to support workforce development and manufacturing.

Contact Information

Dr. Han-Sup Han, Director of Forest Operations and Biomass Utilization, Han-Sup.Han@nau.edu

STATUS OF TREATMENT:

Burned Area Emergency Response (BAER) and Burned Area Rehabilitation (BAR) programs for the Telegraph Fire

November 21, 2022

Mike Martinez
Telegraph BAER Team Lead
Ecosystems Staff Officer
Tonto National Forest

BAER PROGRAM: SOME KEY CONCEPTS REVISITED

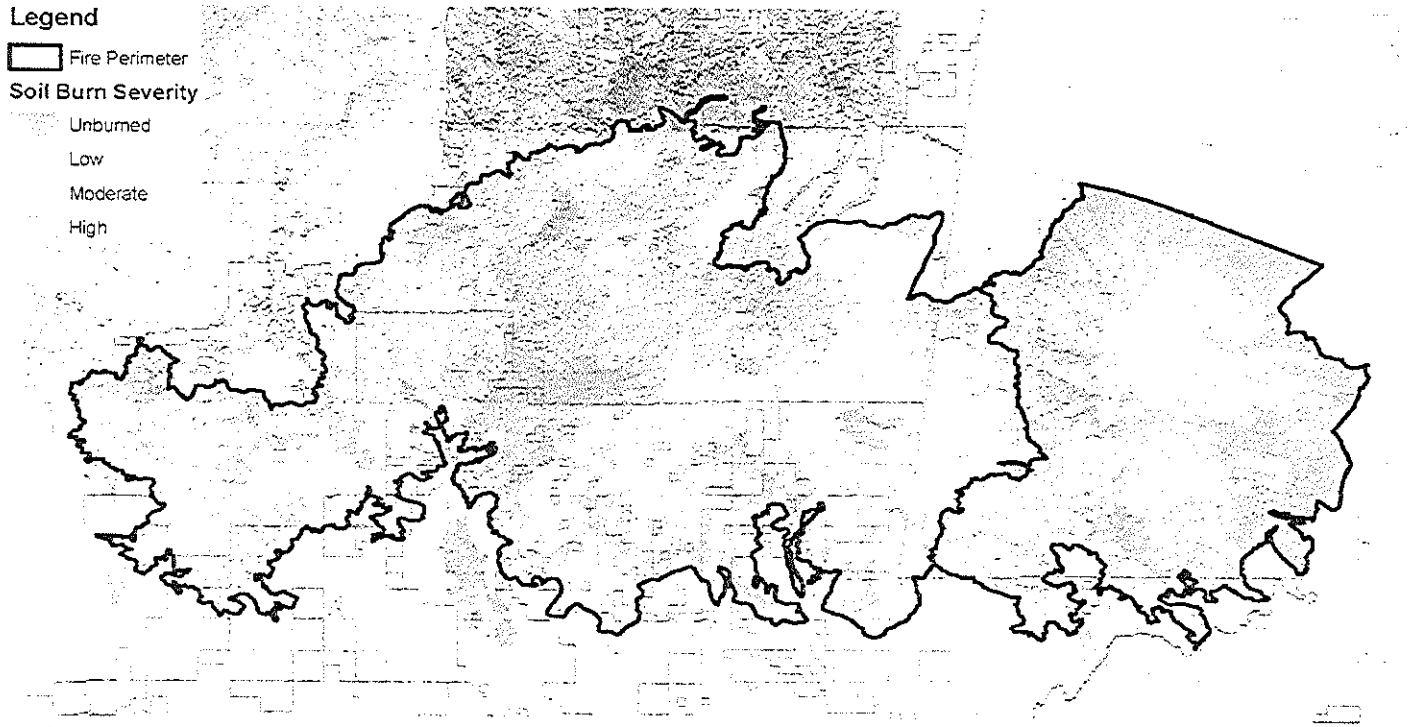
Telegraph Fire BAER Team Specialist conducting hydrophobicity test in the field.

- A program to identify imminent post-wildfire threats on National Forest System lands to human life and safety, property and critical natural or cultural resources and to take immediate actions to manage *unacceptable* risks.
- Information collected by the BAER team is shared with other Federal, State, County, and local emergency response agencies to inform their efforts to provide assistance to communities and private landowners who may also be affected by potential post-fire damage.
- The FS only has authority to complete actions on and for areas under FS jurisdiction (i.e., NFS lands and BCVs). The BAER Directives do not allow us to conduct BAER treatments on non-federal lands or to protect non-federal lands.
- NRCS, FEMA, and county emergency management have local offices and programs to assist communities and permittees.

TELEGRAPH FIRE BAER ASSESSMENT PROCESS:

Telegraph BAER Team Specialist inspecting a culvert.

- On June 15, 2021, the Telegraph Fire BAER Team deployed while the fire was still growing.
- The team conducted field verification of soil burn severity to prepare a Soil Burn Severity map.
- On Saturday, June 26, the BAER team assembled to assess risk to BAER critical values.
- By July 1, specialist reports were completed, treatment recommendations were crafted, Leadership was briefed, funding requests were initiated, and the treatment implementation phase began.

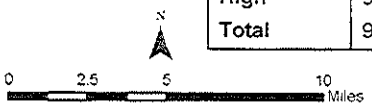


2021 TELEGRAPH - MESCAL FIRES
SOIL BURN SEVERITY
BURNED AREA EMERGENCY RESPONSE (BAER)

Date: 6/22/2021

Percent Soil Burn Severity By Fire			
Telegraph			
High	Moderate	Low	Unburned
0.6%	28.6%	53.8%	17.0%
Mescal			
High	Moderate	Low	Unburned
0.0%	7.8%	58.3%	33.9%

Acres burned by jurisdiction					
SBS Telegraph	NFS	Other Federal	State	Private	Total
Unburned	11903	6058	8887	4640	31488
Low	44179	19961	27654	7864	99658
Moderate	37488	5053	5692	4621	52854
High	958	99	14	31	1102
Total	94528	31171	42248	17156	185102



TELEGRAPH BAER TREATMENTS COMPLETED

- Removal of floatable debris from channels
- Installation of warning signage
- Storm inspection and response on FS roads
- Gate installation on FS roads
- Trail stabilization and drainage work
- Soil stabilization at mine sites

Loading wattles onto flatbed trailer for soil stabilization treatments.

TELEGRAPH BAER TREATMENTS COMPLETED

Removal of floatable debris (i.e., channel clearing) along 2.75 miles of Russel Gulch and 1.25 miles of Pinto Creek, and Forest roads protected soil productivity and hydrologic function. All work was completed by Forest Service fire crews in June 2021.

Fire crews clear a stream crossing on FR 651 heading up to the Sulphide Del Rey Campground.

TELEGRAPH BAER TREATMENTS COMPLETED

Installation of warning signage, in conjunction with short-term targeted Closures kept Forest users aware of the elevated risk. Sixteen signs were installed at strategic entry points to the Forest. Sign installation completed August 2021.

Standard BAER sign

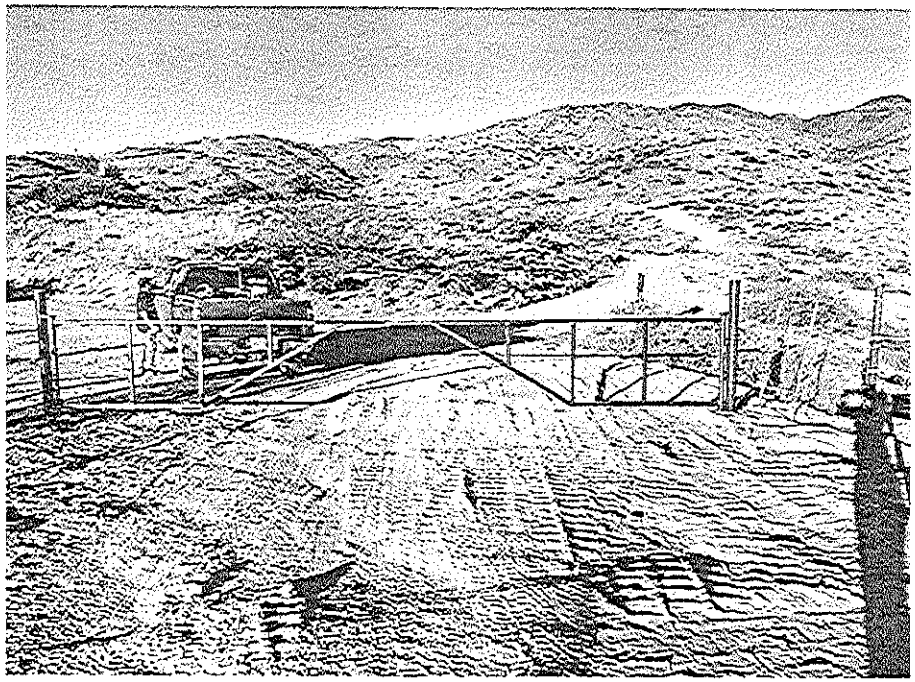
TELEGRAPH BAER TREATMENTS COMPLETED

Storm inspection and response along FR 651, 580, and 112, to address structural modification or drainage improvements necessary to protect roads. Contractors and Forest Service roads crews completed the work in March 2022.

A portion of FR 651 (Pinal Peak Road) after improvement work.

TELEGRAPH BAER TREATMENTS COMPLETED

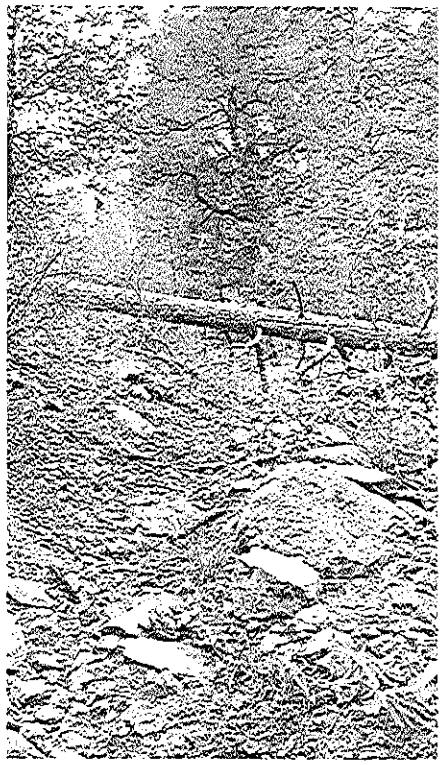
Gate installation on FR 651, FR 899 and FR 112, to better manage access and public safety. Installation of gates completed by contractors in March 2022.



FR 899

TELEGRAPH BAER TREATMENTS COMPLETED

Trail stabilization and drainage work along 2 miles of Six Shooter Canyon trail to prevent loss of trail integrity. Work accomplished by trail crews through an agreement with Conservation Legacy. Completed November 2021.

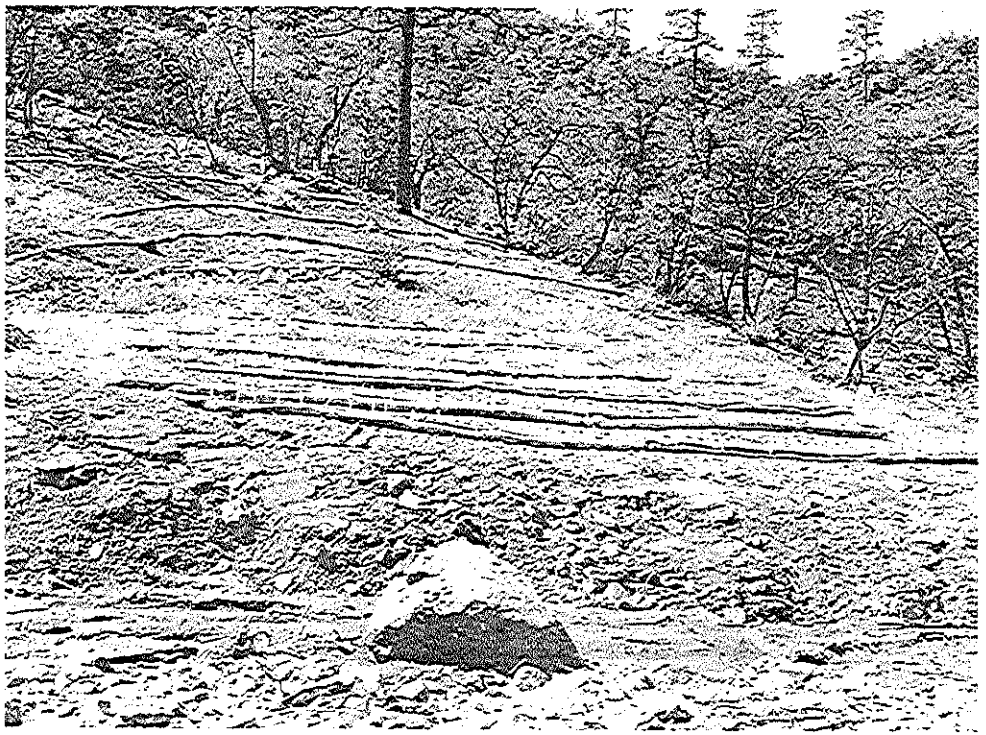


Before

After

TELEGRAPH BAER TREATMENTS COMPLETED

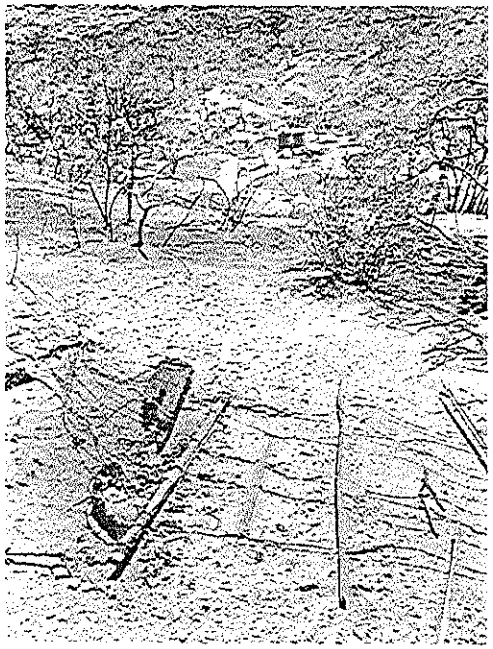
Soil stabilization and flood protection treatments at the Ellis and Blue Gate mine sites to prevent release of stored material. Much of this work was accomplished in coordination with Pinto Valley Mine (PVM). All work at both sites completed in October 2021.



Wattles installed at Blue Gate mine site in coordination with PVM for the purpose of repository stabilization. Work accomplished September 2021.

BAR PROGRAM, FORMALLY CALLED THE MINOR FACILITIES AND INFRASTRUCTURE REHABILITATION PILOT

- The fire damaged infrastructure across nine allotments, including approximately 75 miles of allotment boundary fence, 62 miles of allotment interior fence, five corrals, and 17 water developments including water pipelines, storage tanks, and troughs.
- All these assets were inventoried during the BAR assessment phase.



Fencing damaged by the Telegraph Fire

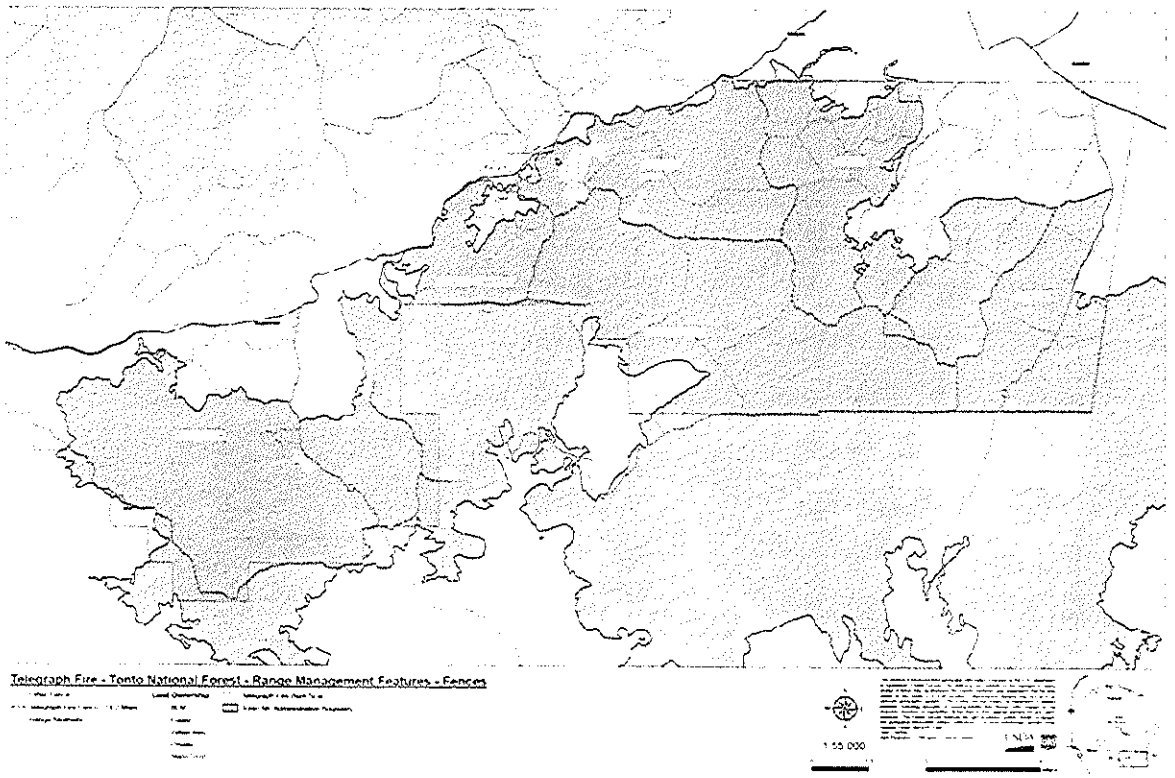
BAR PROGRAM CONTINUED...

- In coordination with NRCS, FSA, Gila County Board of Supervisors, Gila County Cattle Growers, AZ DFFM, and the local NRCD, we determined the most strategic approach to address rehab needs would be for USFS to focus efforts solely on the replacement of allotment boundary fence.
- We agreed to rely on permittees to assume the responsibility for the replacement of interior fences, water pipelines, and other infrastructure.
- Allotment boundary fence is the most critical need to allow a return to normal allotment operations and management.

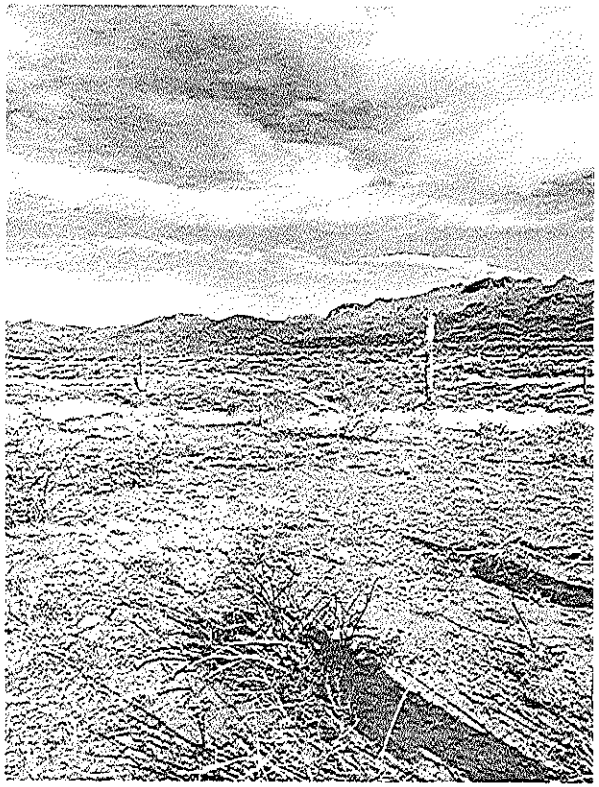
Recent work to replace range improvements damaged by the Telegraph Fire.

BAR PROGRAM CONTINUED

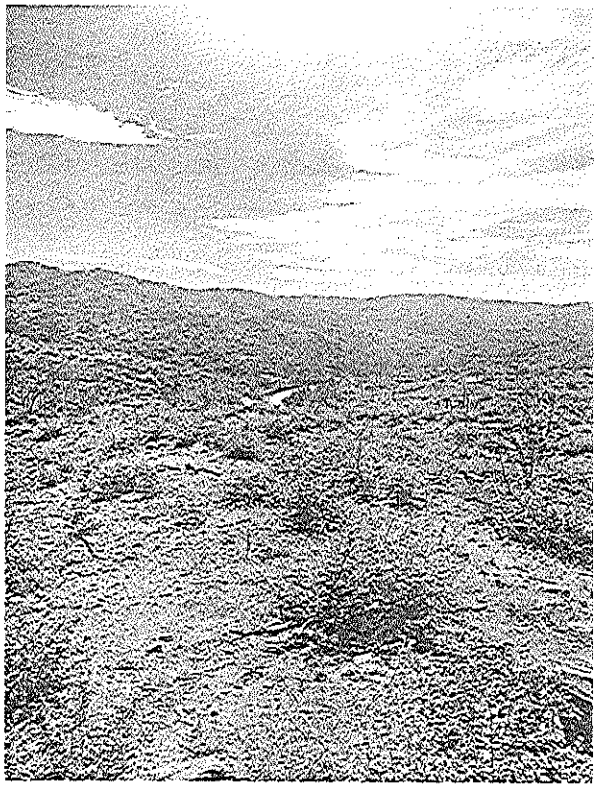
- Through our internal process, the Tonto NF received approximately $2.3 million in BAR funds to replace 75 miles of boundary fence.
- Our initial attempt to solicit bids received bids that far exceeded the available funds. As a result, we withdrew that solicitation.
- We are now talking with Gila County and the Tonto Natural Resource Conservation District to explore entering into an agreement to accomplish the replacement of boundary fencing.



Photos from early November 2022 showing some vegetative recovery in the Telegraph burn scar.



Light soil burn severity near Superior, AZ



Moderate soil burn severity near Pinto Creek, AZ

Forest and Wildfire Management
Ad Hoc Committee

Draft Final Report
November 2022

Committee Members:

Representative David Cook, Chairman
Representative Gail Griffin, Vice-Chair
Representative Tim Dunn
Representative Andres Cano
Senator Stephanie Stahl-Hamilton

Attachment 12

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REPORT 2022

Background

The Forest and Wildfire Management Ad Hoc Committee (Committee) was established by the Speaker of the House of Representatives Rusty Bowers on September 20, 2021. The purpose of the five-member Committee was to research and make recommendations for potential changes to state and federal laws and regulations related to managing wildfires in Arizona. The Committee considered protocols and accountability for reducing devastation to the public, communities and businesses (many of which are ranching operations) from fire management and post fire hazards, including appropriate services available to rehabilitate from both the state and federal levels of government.

Adopted Recommendations

The Committee did not adopt any recommendations.

Wildfire-related legislation passed by the 55th Legislature in the 2nd regular session (2022)

Laws 2022, Chapter 1 (SB1146) (fire suppression; assistance; private landowners.)—Allows the Department of Forestry and Fire Management (DFFM) to distribute up to $10 million in emergency wildfire funding to private landowners after all reimbursements have been deducted or landowners provide evidence that they do not qualify for other reimbursements.

Laws 2022, Chapter 129 (HB2580) (wildfire management; delegation of authority)—Directs the State Forester to: perform all management and administrative functions delegated to Arizona by the United States relating to wildfire prevention, mitigation and suppression activities and maintain copies of delegation of authority agreements entered into with the United States.

Laws 2022, Chapter 313 (HB2862) (general appropriations act; 2022-2023)—The FY 2023 general appropriations act appropriated state General Fund monies to the DFFM for the following wildfire-related purposes:

- $784,400 for inmate firefighting crews and $1,151,000 for post-release firefighting crews;
- $200,000 for fire suppression;
- $3,000,000 for hazardous vegetation removal;
- $2,150,900 for U.S. Forest Service land thinning;
- $65,000,000 for wildfire emergency responses which is subject to the same restrictions as in Laws 2021, 1st Special Session, Chapter 1 and Laws 2022, Chapter 1. Of this total, $3,000,000 must be used for activities related to the Woodbury Fire; and
- $38,837,300 for wildfire mitigation.

Summary of Committee Activity

The Committee met on the following dates and locations: September 29, 2021 at the Arizona House of Representatives; October 6, 2021 at the Northern Arizona Center for Entrepreneurship and Technology in Flagstaff; November 9, 2021 at Globe City Council Chambers; December 17, 2021 at the Arizona House of Representatives; and November 21, 2022 at the Arizona House of Representatives.

September 29, 2021 hearing

Chairman Cook introduced the Committee and staff reviewed the Committee's purpose. The Committee were presented with six presentations.

Department of Forestry and Fire Management (DFFM) Director David Tenney reviewed historical and current forest management practices, including the Four Forest Restoration Initiative (4FRI), the U.S. Forest Service's use of Good Neighbor Authority and master stewardship agreements, and state legislative efforts. He indicated that most forests are on U.S. Forest Service, Bureau of Land Management, and Bureau of Indian Affairs lands, and that many areas have over 1,000 trees per acre, which is significantly denser than recommended. In response to Representative Cano's questions, Tenney outlined collaborations DFFM has undertaken with the Department of Emergency Management and county emergency management teams and explained the lack of information provided on bids for 4FRI contracts. He mentioned that using Good Neighbor Authority and master stewardship agreements might be options to allow DFFM to have more say in the decision-making process for future thinning projects. In response to Dunn's question, Tenney mentioned that the Baker Butte project is managed under Good Neighbor Authority. The U.S. Forest Service wrote the treatment plan for that area and DFFM crews and contractors do the clearings. In response to Chairman Cook's question, Tenney indicated that "hundreds of thousands" of taxpayer dollars had been spent on 4FRI. Chairman Cook asked about issues DFFM has encountered working with the U.S. Forest Service on 4FRI. Tenney praised the local and regional staff but indicated that compliance with federal acquisition regulations had stalled some 4FRI efforts. Regarding reasons for denial of the 4FRI contract, Tenney pointed to two factors that made the risk too great for the federal government and bidders: the costs of building and maintaining roads and the cancellation ceiling for investors to recouple funding on timber planters that are being utilized. Separately, Chairman Cook mentioned that he had requested but not received signed delegation of authority agreements for the Telegraph, Woodbury, Bush, and Museum Fires from DFFM. He asked about risk assessments are conducted on wildfires. Tenney explained that the federal government establishes the values-at-risk. John Truett mentioned that the Wildland Fire Decision Support System helps fire managers and analysts make tactical and strategic decisions when responding to wildfires.

Jim Zornes (a former Apache-Sitgreaves National Forest Supervisor) discussed historical and current federal forest management practices, including changes in the forest products industry and thinning practices. The year 2000 marked the beginning of the megafire era, which coincided with high timber growth rates and an absence of industry. He reviewed the history of 4FRI and mentioned that the contractors had consistently under-delivered on the amount of acreage that should be mechanically thinned. Representative Cano asked how 4FRI contracting could be improved. Zornes explained that federal acquisition regulations are an obstacle. One difficulty is managing which parties will cover costs, especially cancellation ceilings. He also cited an absence of demand for biomass. Representative Stahl-Hamilton asked if there was a non-commercial way to restore forest health. Zornes indicated that it would be prohibitively expensive for the U.S. Forest Service to contract with someone else to clear. He highlighted DFFM's efforts as an example of fire suppression efforts. Chairman Cook asked why only 1,200 acres were being cleared annually under the 4FRI contracts. Zornes stated that more industry was needed to make clearing high volumes of biomass economically feasible.

DFFM Fire Management Officer John Truett gave a history of the agency's fire management practices and emphasized that every fire is a unique incident that requires a specialized strategy.

In response to questions from Representative Griffin regarding decision making authority, Truett explained that incident commanders answer to agency administrators. Local jurisdiction firefighters are sometimes released from wildland fire suppression efforts because they need to provide services to local communities due to limited staffing. In response to Representative Cano's question about the incident response pocket guide, Truett explained that the guide came from a national working group and that each wildfire firefighter carries one with them. In response to Representative Dunn's question, Truett explained that drought is factored into wildfire preparations.

Chairman Cook confirmed that Truett had signed the delegation of authority agreements he had asked Tenney about and that DFFM had copies of these agreements. Truett stated he could not distribute them without the U.S. Forest Service's permission but indicated that he could distribute unsigned copies. He mentioned that the U.S. Forest Service is conducting a Freedom of Information Act review. Chairman Cook confirmed with Truett that he worked on the Museum, Woodbury, and Telegraph Fires but not the Bush Fire. In response to Chairman Cook's question, Truett stated that he has never been at a meeting where the goal discussed was not suppressing a wildfire. Chairman Cook asked when DFFM was notified about the Woodbury Fire. Truett stated that DFFM was notified almost immediately that this fire would be a multi-jurisdictional fire. Aircraft efforts were not effective, but DFFM resources helped suppress the Woodbury Fire on state lands.

Elaine Kohrman (U.S. Forest Service Deputy Regional Forester) discussed the U.S. Forest Service's fire suppression efforts and collaboration with state governments on forest management through Good Neighbor Authority and master stewardship agreements. Two such agreements have been signed to allow the state to clear timber and there is interest in clearing landscape around For Huachuca. She also offered additional explanation for why 4FRI contracts were cancelled, including risks that were too high for future employment, areas that were no aligned with industry biomass requirements, road maintenance costs, volume of product to be processed, and restrictive clauses related to accounting for inflation. In response to Chairman Cook's question about the history of fire management in Region 3, Kohrman indicated that every fire has a suppression strategy and that the U.S. Forest Service strives for an initial attack success rate of 98%. She added that most response teams have delegation of authority agreements with multiple agencies.

Representative Cano confirmed that a cancellation cost clause comes into play when an agency cannot finance additional work. He asked about new ideas and proposals the U.S. Forest Service is considering. Kohrman mentioned an October stakeholder meeting that is focused on the biomass industry. Cano also asked if it would help if the state had a defined program with matching contributions to help forest clearing efforts and confirmed that the U.S. Forest Service follows the same pocket guide for wildland fire responses.

Representative Dunn confirmed with Kohrman that the cancellation cost clause derives from federal acquisition regulations. In response to his question on whether a fire has to be a certain size before it will elicit a response, Kohrman explained that several factors are weighed when determining the appropriate response.

Representative Griffin expressed concern about the U.S. Forest Service's backburning policy. Kohrman stated that the U.S. Forest Services does not have a let-it-burn strategy.

Chairman Cook asked how the U.S. Forest Service determines compliance with agency guidelines for firefighting. Kohrman stated that there are requirements for monitoring efforts and outcomes,

particularly when the evaluating how the response is progress. The U.S. Forest Service also does after action reviews. When asked, Kohrman was uncertain on the outcome of the Telegraph Fire investigation. Chairman Cook asked why it was appropriate to have a 100,000 square acre box surrounding a 1,000-acre fire, which occurred north of Payson. Kohrman was unfamiliar with this situation but explained that the box is a planning scenario and that the fire's performance within that box prompts certain management actions that agency administrators make in consultation with the incident commander. Chairman Cook asked Kohrman to explain what "managed wildfire for resource benefit" entailed. Kohrman explained that this term focuses on the outcome of a wildfire response and not a strategy for managing that fire. When Chairman Cook asked about signed delegation of authority agreements Kohrman agreed that DFFM should have signed copies of these agreements and indicated that she would look into this matter.

DFFM Deputy Director Bill Boyd discussed the status of funds that the legislature appropriated to the agency in response to several wildfires (see Laws 2021, 1st Special Session, Chapter 1). He clarified for Chairman Cook how reimbursements are processed. In response to Representative Griffin's question on the timeline for reimbursement, Boyd explained that some larger wildfires take longer to closeout.

Arizona Department of Transportation (ADOT) Deputy Director for Transportation and State Engineer Dallas Hammit briefed the Committee on roadway damaged caused by the Woodbury Fire and federal and state funding available for repairs. The Federal Highway Administration makes funding available when an event is declared to be an emergency by the president or governor, over $700,000 in damage is caused, the road is classified at least as a rural major collector, and work must be completed within 180 days to get full reimbursement.

Representative Cano asked about a joint preliminary damage assessment form, which ADOT must submit to FEMA. Hammit was unfamiliar with that form but discussed other forms that can be submitted for federal highway relief funds. Dunn asked if the fires highlighted in the presentation were on federal lands and wondered if a statutory change was needed to allow for more reimbursements above the $700,000 threshold. Representative Stahl-Hamilton asked if the Committee should explore the impact of drought that does not allow vegetation to grow after a fire, in terms of how it impacts roads. Chairman Cook asked if ADOT received Burned Area Emergency Response (BAER) funding. Hammit was unsure but mentioned that ADOT does work with the BAER team.

During the call to the public, two public lands ranchers (Frank Dalmolin and John Fowler) who stated that backburning occurred on or near their allotments without any advanced warning. They also highlighted the lack of funding available to public lands ranchers help rebuild after wildfires and flooding. For example, Fowler recalled that the Woodbury Fire damages fences and a power pole for his well, neither of which qualified for BAER funding.

A video recording of the committee can be found at:

https://www.azleg.gov/videoplayer/?eventID=2021091007.

October 6, 2021 hearing

The Committee met in Flagstaff and heard presentations on the damage caused by the Museum Fire and subsequent recovery efforts.

Lucinda Andreani (Deputy County Manager and Public Works Director for the Coconino County Flood Control District) presented on post-fire flood mitigation work the district has undertaken

with funding from the NRCS and the City of Flagstaff. Specifically, $40 million was spent on long-term mitigation efforts. The district also used a risk analysis and model to identify about 400 homes and 35 businesses that were at risk of flooding from the Mount Elden burn scar. In response to Chairman Cook's questions about the U.S. Forest Service's flooding mitigation efforts, Andreani explained that most watershed protection funding is only available through the NRCS. Additionally, Emergency Watershed Protection Program funding cannot be used on U.S. Forest Service lands without approval.

Flagstaff Mayor Paul Deasy explained that the City of Flagstaff had suffered about $845,000 in damage to its public infrastructure from flooding and spent $1 million to address flooding impacts. The Coconino Flood Control District had also expended over $1.35 million for its operations. He added that this damage occurred even after the city voters approved a $10 million bond several years ago to pay for thinning nearby U.S. Forest Service lands. In response to questions from Chairman Cook, he indicated that Flagstaff had not received any federal relief funding for flood damage and would not qualify from any HB2001 funds (see Laws 2021, 1st Special Session, Chapter 1). Representative Dunn asked for clarification from Mayor Deasy regarding which types of disaster funding Flagstaff could not access.

Andy Bertelson (Flagstaff Water Services Director) reviewed flood mitigation efforts Flagstaff had planned and explained how these efforts will lower future clean-up costs. Specifically, the city is planning to undertake improvements to Spruce Channel and build a secondary conveyance for stormwater which in total could cost up to $48 million. The clean-up costs from the summer 2021 floods were about $1.8 million, but these costs should decrease once the improvements are installed. In response to Chairman Cook's questions, Bertelson explained that the city has not considered using eminent domain but may moving forward. He added that ideally the city would like to use local revenues in combination with state and federal funds from FEMA to finance the improvements. In response to Representative Dunn's question, Bertelson outlined revenues that are used for watershed management programs and forest thinning. Representative Stahl-Hamilton asked Chairman Cook about his thoughts on eminent domain. Andreani mentioned that one hurdle to eminent domain is to demonstrate to a court that a taking is prudent. Cook also suggested land exchanges may be beneficial tools.

Paul Oltrogge (Flagstaff Fire Specialist) briefly discussed the city's planning and wildfire mitigation efforts. In response to Chairman Cook's question, he discussed his role in mitigating the impacts of catastrophic wildfires. At Representative Dunn's request, he also provided more information about a service fee that Flagstaff established for these mitigation efforts.

Jay Smith (Forest Restoration Director for Coconino County Flood Control District) outlined the district's forest thinning and restoration projects and outlined the difficulties in recruiting industry for biomass removal. He indicated that there was a lack of funding available through the U.S. Forest Service for thinning and restoration projects. He mentioned that the lack of demand for biomass hampers removal efforts but indicated that he had been working with a couple of companies on biomass removal. Representative Griffin thanked Smith for his forest management efforts. In response to Representative Dunn's question, Smith explained that the county worked with the National Forest Foundation to treat the northern slopes of the Bill Williams Mountain. He added that the commercial entities like this approach because it reduces bureaucratic hurdles and that the U.S. Forest Service likes working with state agencies via Good Neighbor Authority. In response to Chairman Cook's question, Smith agreed that there was a lack of U.S. Forest Service

funding for treating lands and added that the Federal Emergency Management Agency cannot do any work on federal lands.

Rogers "True" Brown (Fire Management Officer, Flagstaff Ranger District, Coconino National Forest) gave a presentation on the progression and response to the Museum Fire. Chairman Cook asked if there was information in the Wildland Fire Decision Support System for all wildfires. Brown replied yes, though the level of detail varies based on the fire's severity. He also answered Chairman Cook's question on the availability of water to fight this fire. In response to Representative Stahl-Hamilton's question, Brown credited the large quantity of dry fuels for the wildfire's intensity. In response to Chairman Cook's question, Brown indicated that a strategic planning area ("the box") was drawn around the Museum Fire and explained that this approach helps evaluate what may be threatened by the fire and with long-term strategic planning. He also mentioned that some areas where the fire burned had been thinned in advance. In response to Chairman Cook's questions, Brown explained that pistol flares are used to bring fire out to control lines and that backburns are actively managed.

Sybil Smith (United Way of Northern Arizona) presented on the relief and recovery efforts following the Museum Fire and subsequent flooding. Chairman Cook asked about the availability of state, county, and municipal funding for the United Way's relief and recovery efforts. Smith indicated that she had not sufficiently researched this topic to provide an answer.

During the call to the public, the Committee heard from Flagstaff residents whose homes and property had been devastated or threatened by reoccurring floods. These residents described surrounding their homes with several feet of sandbags to keep out floodwaters.

A video recording of the committee can be found at: https://www.azleg.gov/videoplayer/?eventID=2021101004.

[After the committee's meeting, the U.S. Forest Service announced during a tour of the Museum Fire Burn Scar with Senator Kyrsten Sinema and Congressman Tom O'Halleran that Arizona would receive $6.5 million in federal funding to help with wildfire and flood mitigation efforts. Of this amount, $3.5 million was for rehabilitating lands and watersheds in the Museum Fire Burn Scar and $3 million was for flood mitigation at the Mt. Elden Estates.]

November 9, 2021 hearing

The Committee met at the Globe City Council Chambers and heard presentations on the causes, destruction, and aftermath of the Woodbury, Telegraph, and Bush Fires.

Globe Mayor Al Gameros explained that post-fire flooding had caused more damage to Globe than the actual Telegraph Fire. In response to Chairman Cook's question about what more could be done for Globe in the future, Gameros indicated that the city is re-evaluating its emergency operations plan and is considering establishing an emergency operations center. In response to Representative Cano's question, Gameros indicated that the city is planning a community townhall to prepare for flooding next year.

Superior Mayor Mila Besich explained how post-fire flooding shutdown the US-60, which limited access to healthcare, the mines, and transportation—all of which threatened her town's residents and its economy. Although she was aware of state funding for post-fire efforts, she suggested that most of it had been designated for tall pine communities. She mentioned that the town had applied for a regional grant, but it will take 5-10 years for firebreaks to be fully funded. In response to Chairman Cook's questions, Besich explained that she applied for grants to remove invasive

vegetation from Queen Creek watershed and install fire breaks. She has not received any federal funding but would like more funding for the Tonto National Forest.

Gila County Emergency Manager Carl Melford discussed the county's efforts to evacuate residents from the wildfires and plan for post-fire flooding, which included conducting hydrologic studies, pre-staging sandbags, and applying for the NRCS's Emergency Watershed Protection Program using HB2001 funds (see Laws 2021, 1st Special Session, Chapter 1). In response to Chairman Cook's questions, Melford stated that so far Gila County has not received any federal grants to assistance; all funding has come from the county or the state. Representative Dunn asked about the speed of accessing and using funds. Melford indicated that public assistance grants are limited to $250,000, while HB2001 funds do not have those limits or as much red tape. However, there is some uncertainty over what qualifies for funding. Representative Cano asked about which aspects of the relationship with the federal government are currently working. Melford praised the education and transparency but added that Gila County's size can complicate emergency payments; it never received a federal disaster declaration because it lacked over $10 million in public infrastructure that was damaged.

Neil Bosworth (Forest Supervisor for Tonto National Forest) introduced U.S. Forest Service staff and provided an overview of the Tonto National Forest.

Taiga Rohrer (Fire & Aviation Staff Officer for Tonto National Forest) reviewed the fire ecology of the Tonto National Forest, interagency federal wildland fire management policy, and strategies and tactics for fighting wildfires. Using predictive service models and weather forecasts helped the U.S. Forest Service prepare resources for deployment. He discussed the specific responses to the Woodbury, Bush, and Telegraph Fires and mentioned that these fires were human caused. Rohrer argued that there was always an effort to fully suppress these fires and that any backburns were monitored unless the crew's safety was threatened. In response to Chairman Cook's questions, Rohrer explained that the operations sections chief or incident commander would generally have the authority to order a backburn. Chairman Cook argued that backburns were started in the Pinal Mountains that threatened his property and those of his neighbors when the Telegraph Fire was miles away and conditions were ill-suited for such a fire. (He added that the U.S. Forest Service denied setting these backburns.) Rohrer indicated he received no reports of unauthorized backfires being set. He suggested that computer models showed that the fire was likely to spread to that area and that trigger points may have been set up if the fire moved towards that area. Chairman Cook asked if Rohrer took part in writing delegation of authority agreements and added that the agreements he was given were unsigned and written in the past-tense, even though these agreements should be written when the fire begins. Rohrer explained that these agreements are usually written by the agency administrator assigned to the fire and can be modified during the fire. Rohrer suggested that the end-date portion of this agreement might be written in the past tense. In response to Representative Cano's questions, Rohrer stated the Telegraph Fire was managed safely, efficiently, and mindfully and that there are scientific reasons for conducting backburns at nighttime, including that the lower temperatures minimize the risks of the backburn.

During the call to the public, residents expressed concerns about rebuilding from the fire and flooding, particularly when they may not have flood insurance. They also praised the county's emergency response efforts. Some residents expressed frustration with the U.S. Forest Service's practice of setting backburns without communicating with allotment owners. In particular, two residents related that crews seemed eager to set backburns and did not wait until these residents or their property were secure. Two Gila County Supervisors (Woody Cline and Tim Humphreys)

discussed the costs of damages from the wildfire and subsequent flooding and their concern about protecting NRCS-funded infrastructure.

A video recording of the committee can be found at: https://www.azleg.gov/videoplayer/?eventID=2021111002.

December 17, 2021 hearing

The Committee began by hearing from members of the public. Heather Heisler, a cattle rancher from El Capitan, detailed the extensive physical damage to her property from wildfire, which included her home burning down and her stock ponds filling with black sludge. She also discussed the toll this damage has taken on her family's mental health. In response to questions from Chairman Cook, she explained when she was told to evacuate her home and mentioned that helicopters dropped a record amount of retardant near her home and that six water bladders were placed about a mile from her home. She also indicated that an old ranch house that was built in the 1940s had flooded from the post-fire flooding, despite having a berm surrounding it. In response to Chairman Cook, she explained that her insurance did not cover flood damage for the house. Finally, she stated that only government assistance she received was from Gila County, which helped clean out the nearby creek and stock ponds.

Frank Dalmolin (Arizona Cattle Growers Association) recommended that the Farm Service Agency (FSA) restructure staff resources to align with community needs and allow its programs and funding to be offered for those working on public lands (similar to NRCS programs). In particular, he suggested that Gila County have a dedicated FSA office because the Holbrook office is a considerable distance from county residents and the staff have not been responsive. Members and Dalmolin discussed the similarities and differences in programs operated by the FSA and NRCS. Chairman Cook indicated that the Holbrook office operates several tribal programs because it primary serves the Navajo Nation. Dalmolin mentioned that absent the FSA, it was difficult to get loan for any improvements on a U.S. Forest Service allotment.

The Committee heard five presentations.

U.S. Forest Service Ecosystem Officer Mike Martinez gave an overview of the Burned Area Emergency Response (BAER) Program and its role in post-wildfire recovery efforts. Martinez discussed BAER efforts during the Telegraph Fire and mentioned that the U.S. Forest Service had allocated $2.3 million to a new pilot program that would replace exterior fences. In response to Chairman Cook's questions, Martinez indicated that the BAER program only applies to U.S. Forest Service lands and cannot be used to protect non-federal lands or private landowners, even when those lands are impacted by wildfires or post-fire flooding that started on U.S. Forest Service Lands. He also reviewed the timeline for compiling the specialist report and addressed Cook's questions about how feedback from livestock producers was incorporated into the report. Specifically, Martinez explained that BAER efforts do not focus on infrastructure, which is covered under long-term restoration efforts. In response to Representative Dunn's question about whether BAER teams have sufficient resources, Martinez replied that flood mitigation is difficult because monsoon rains immediately follow the fire season. Representative Cano indicated that it was unclear which responsibilities were and were not part of the BAER team. In response to Senator Stahl-Hamilton's question about changes in BAER processes, Chairman Cook suggested that reductions in staffing and resources as a likely cause.

U.S. Forest Service Deputy Forest Supervisor Tom Torres discussed fireshed management in Arizona and recent collaborations the U.S. Forest Service had undertaken with state agencies, tribal entities, and non-profit organizations. He also briefed the Committee on the status of the Four Forest Restoration Initiative (4FRI).

Representative Griffin expressed concerns about residents not being notified of nearby prescribed burns and added that these burns can destroy feeds and land. In response to Chairman Cook's question, Torres explained that the U.S. Forest Service is now using the term "fireshed" to reflect a new approach for thinking about wildfires. Cook highlighted how long forest-thinning efforts like the Save Our Forest Plan and 4FRI have existed yet failed to deliver on their goals and asked about the status of NEPA for 4FRI. Cook asked about what recourse is available to someone whose homes are destroyed by backburns. Torres replied that the system is complicated with many responsibilities for managing impacts from wildfires, including private insurance and Farm Service Agency and Natural Resource Conservation Service programs. He added that unfortunately the U.S. Forest Service's hands are tied with respect to what can be done downstream. He welcomed recommendations from the committee on improvements to any systemic issues. Torres confirmed with Cook that DFFM participates in the U.S. Forest Service's fire management decisions and does not object to these decisions.

Representative Cano followed up and asked if there were any points of disagreement between DFFM and the Forest Service on the Telegraph Fire. Torres replied no. In response to Cano's question about the status of those who do not want to evacuate their homes, Torres explained that the evacuation authority rests with the county sheriff. Lastly, when asked by Cano about the source of his optimism for the 4FRI project, Torres pointed to additional funding and more collaborative agreements with the state.

In response to Chairman Cook's question regarding the source of authority for setting backburns, Torres pointed to the collaborative fire agreement. Cook highlighted that BAER funding cannot be used on private lands, but backburns can nonetheless be set on these lands. Cano argued that there need to be separate conversations regarding backburning and resource efforts. In response to Representative Cano's question, Torres could not recall any instance when setting backburns was unnecessary.

NRCS State Conservationist Keisha Tatem reviewed her agency's efforts to protect communities and help them recover from wildfires and wildfire prevention efforts. She also discussed financing available through the Emergency Watershed Protection Program (EWPP), which can be used to address imminent hazards to life and property up to 75% of costs, and the Environmental Quality Incentives Program (EQIP), which provides agricultural producers with financial cost shares and technical assistant to implement conservation measures. According to Tatem, about $13.3 million was distributed for EWPP financial assistance in FY 2021 (an amount which does not include technical assistance dollars). By contrast, EQIP provided $127,000 for 42,000 contract acres. Tatem attributed this smaller amount of funding to a lower response rate. In response to Chairman Cook's questions, Tatem explained how the NRCS relocated an office from Chandler to Roosevelt to better serve the needs of those living in the Tonto National Forest. Tatem agreed with Chairman Cook that EQIP can be used to fund firebreaks and treatments for pastures and recommended that a producer establish a long-term conservation plan to receive this funding. In response to Cano's questions, Tatem explained that where possible, her office leverages different forms of funding and is currently recruiting someone to handle outreach efforts to educate producers on different programs. Dunn asked whether natural resources conservation districts could apply for EWPP

funding. Tatem indicated that they may lack the authority to receive this funding. Chairman Cook recalled that there had been a notable decrease in the cost share for pipelines that was caused in part by shifting from feet to pounds as the basis for the cost share. He related that the current cost share now may not even cover the cost of the pipe, which leaves the producer to handle other related costs such as installation. Tatem responded that any new pipeline should be covered in a new EQIP contract that would use the current year's payment schedule. She added that this schedule recently included a special provision for price spikes, but that she would need to look into this matter further. In response to Chairman Cook's question about setting the payment schedule, Tatem explained that the NRCS used to reimburse for actual costs but switched to a payment schedule with established rates several years ago. She mentioned that she used to manage this payment schedule, but that this schedule is now set for a multi-state region. When asked by Chairman Cook if Arizona producers would be better served by having this payment schedule set at the state-level, Tatem replied that she does not have an opinion of agency policy.

Frank Carroll (Professional Forest Management, L.L.C.) argued in his presentation that the U.S. Forest Service lacked the funding and capacity to successfully implement its fire management mission, which leads to more wildfires actively burning. He cited several instances where wildfires were allowed to spread until they became too large to easily contain and alleged that fire suppression monies were being spent to conduct ignited prescribed wildfires. He added that the post-fire impacts like flooding are also as harmful as the actual fires. He also argued that there were few ways to hold the U.S. Forest Service accountable.

Representative Cano asked Carroll about his contract and participation with first responders during the Telegraph Fire. Representative Dunn stated that the Committee should focus its discussion on the battleplan for combating fires. Representative Griffin indicated that she would like the Committee to do pursue constructive solutions like notifying and seeking the permission of landowners when setting backburns. Chairman Cook discussed the lasting mental trauma and long-term recovery that residents face after a wildfire.

Cynthia Campbell (City of Phoenix Water Resources Management Advisor) discussed how catastrophic wildfires and post-fire flooding negatively impact the quality of Phoenix's water supply. As part of her presentation, she showed a video of a flashflood filled with debris and ash from the Woodbury Fire flowing into a canal system. Campbell explained that when the water exceeds a 2,000 Nephelometric Turbidity Units (NTU) turbidity threshold it becomes untreatable. Floodwaters from post-fire flooding have sediment and debris loads that can exceed 8,000 NTU. When these floodwaters enter the canal systems, water treatment plants shut down so that the water can pass through. However, this water ends up being deposited in rural areas. Similarly, the post-fire flooding builds up sediment and increases total organic carbon levels in reservoirs, which makes it difficult to treat water over the long-term. Campbell mentioned that since 2000, Phoenix has spent over $200 million to install carbon filtration systems at its water plants. It has also set up water monitoring and advanced communication systems to better monitor the impact of post-wildfire floods on its water supply and is partnering with the Nature Conservancy, Salt River Project, and the Northern Arizona Forest Foundation on watershed management efforts. She added that the Phoenix was not the only city facing increased water treatment costs due to post-fire flooding.

Due to time constraints, DFFM Deputy Director Bill Boyd could not update the Committee on funding disbursed from HB2001 (Laws 2021, 1st Special Session, Chapter 1). At Chairman Cook's request, he emailed information to the Committee. The DFFM report indicated that it had approved

over $14.8 million for fire suppression, about $6.4 million for capital expenditures, nearly $12.2 million for mitigation projects to address post-fire flooding, and almost $336,000 for financial assistance to public and private landowners.

Members thanked the presenters and Chairman Cook discussed how the Committee will handle recommendations for its final meeting.

A video recording of the committee can be found at: https://www.azleg.gov/videoplayer/?eventID=2021121015.

November 21, 2022 hearing

[Note: Awaiting Committee action.]

Respectfully submitted by:

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Appendix A:

September 29, 2021

Minutes and Reference Materials

Appendix B:

October 6, 2021

Minutes and Reference Materials

Appendix C:

November 9, 2021

Minutes and Reference Materials

Appendix D:

December 17, 2021

Minutes and Reference Materials

Appendix E:

January 5, 2022

Minutes and Reference Materials