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Estimating ecosystem damages from wildfire: Comparison of two valuation methods

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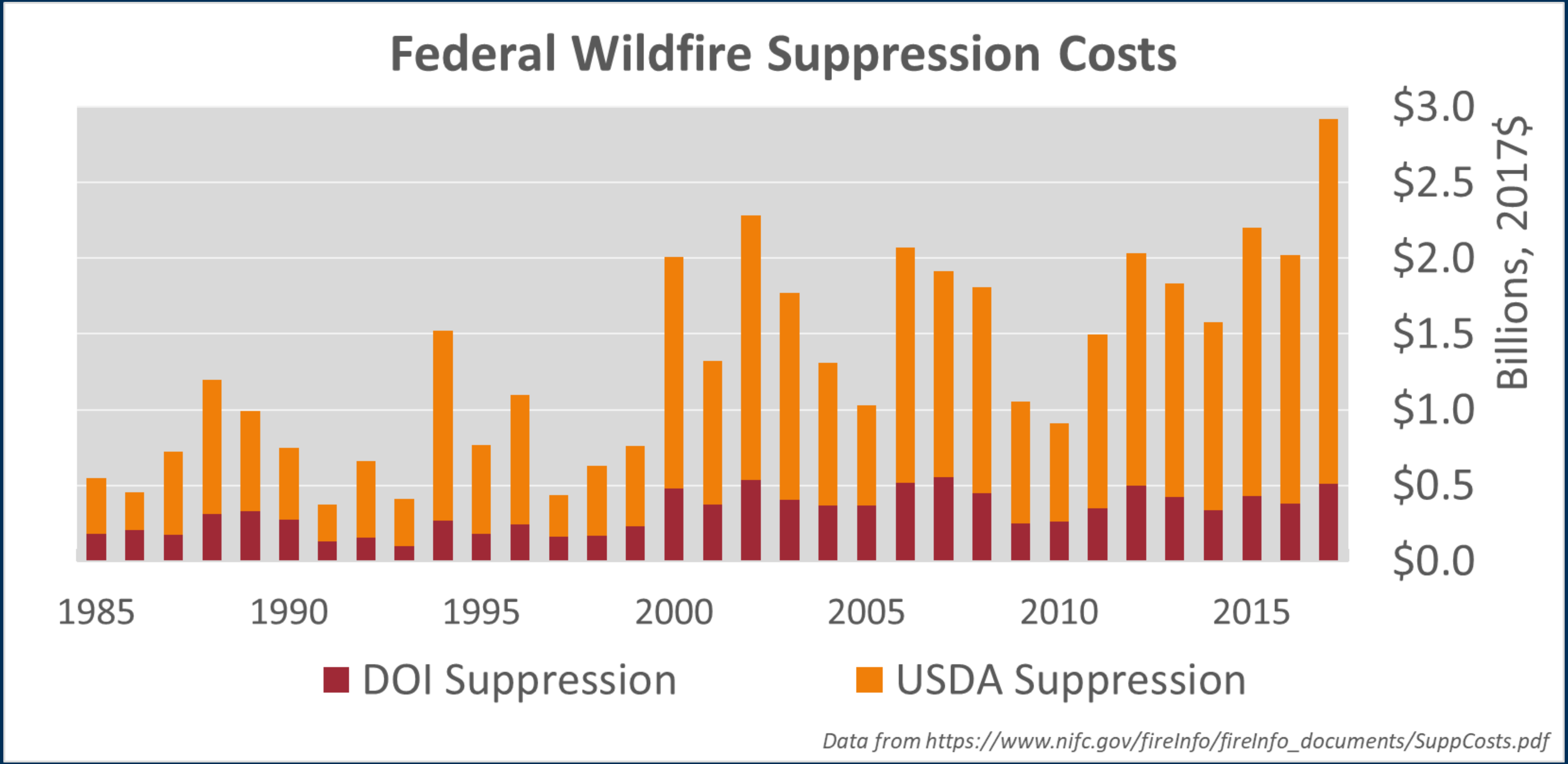
ACES 2018 | Washington, DC | December 4, 2018

U.S. Department of the Interior
U.S. Geological Survey

Wildland fire suppression costs



(2018 YTD as of 11/29/2018: $3.2 billion)

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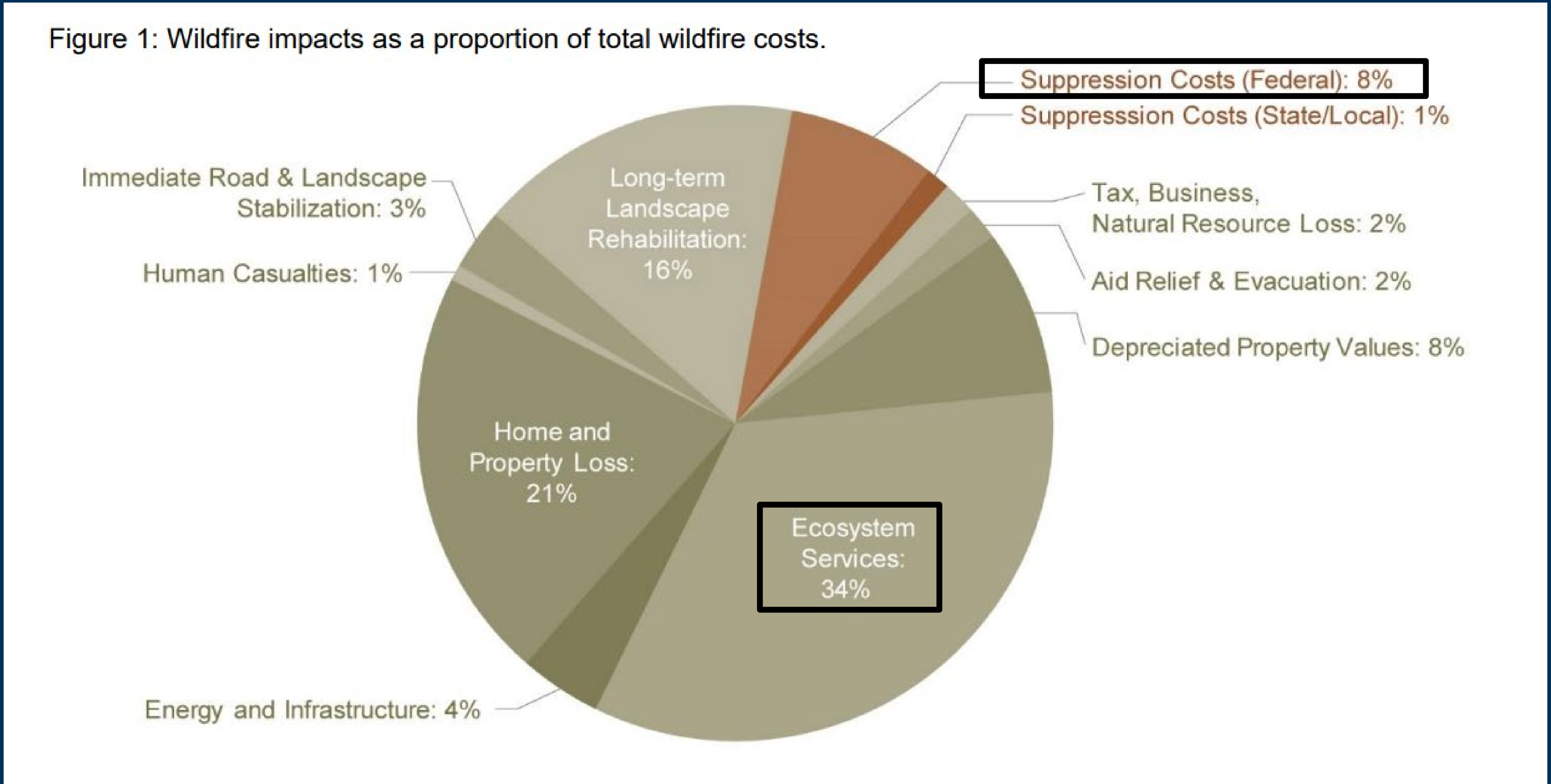
Suppression vs total costs



https://headwaterseconomics.org/wp-content/uploads/full-wildfire-costs-report.pdf (May 2018)

Cost categories (recoverable in trespass cases)

1. Fire suppression costs
2. **Resource damages**
3. Emergency stabilization & rehabilitation costs
4. Cost of repairing or replacing physical improvements
5. Cost of repairing, replacing, or rehabilitating offsite values
6. Direct (administrative) costs

Source: Bureau of Land Management Handbook H-9238-1

Fires in sagebrush biome

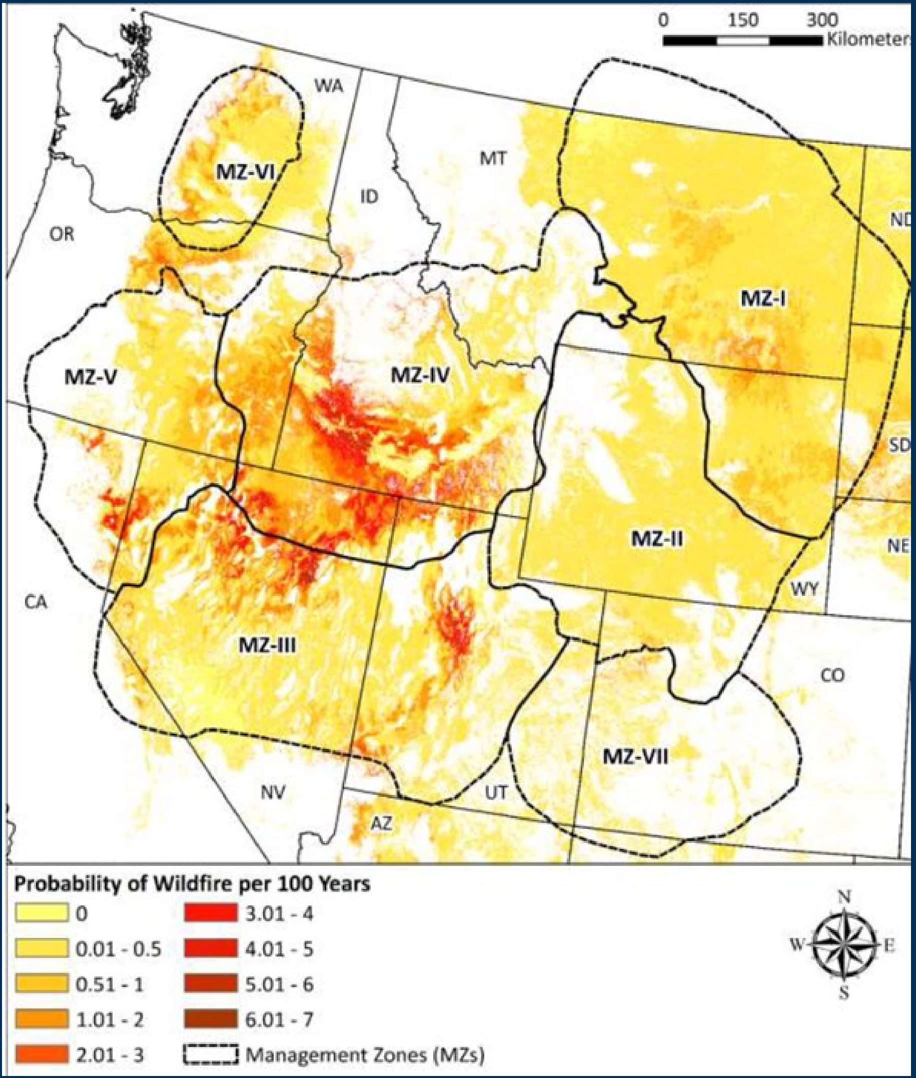
~40%

of federally-managed land is shrub/scrub ecosystem

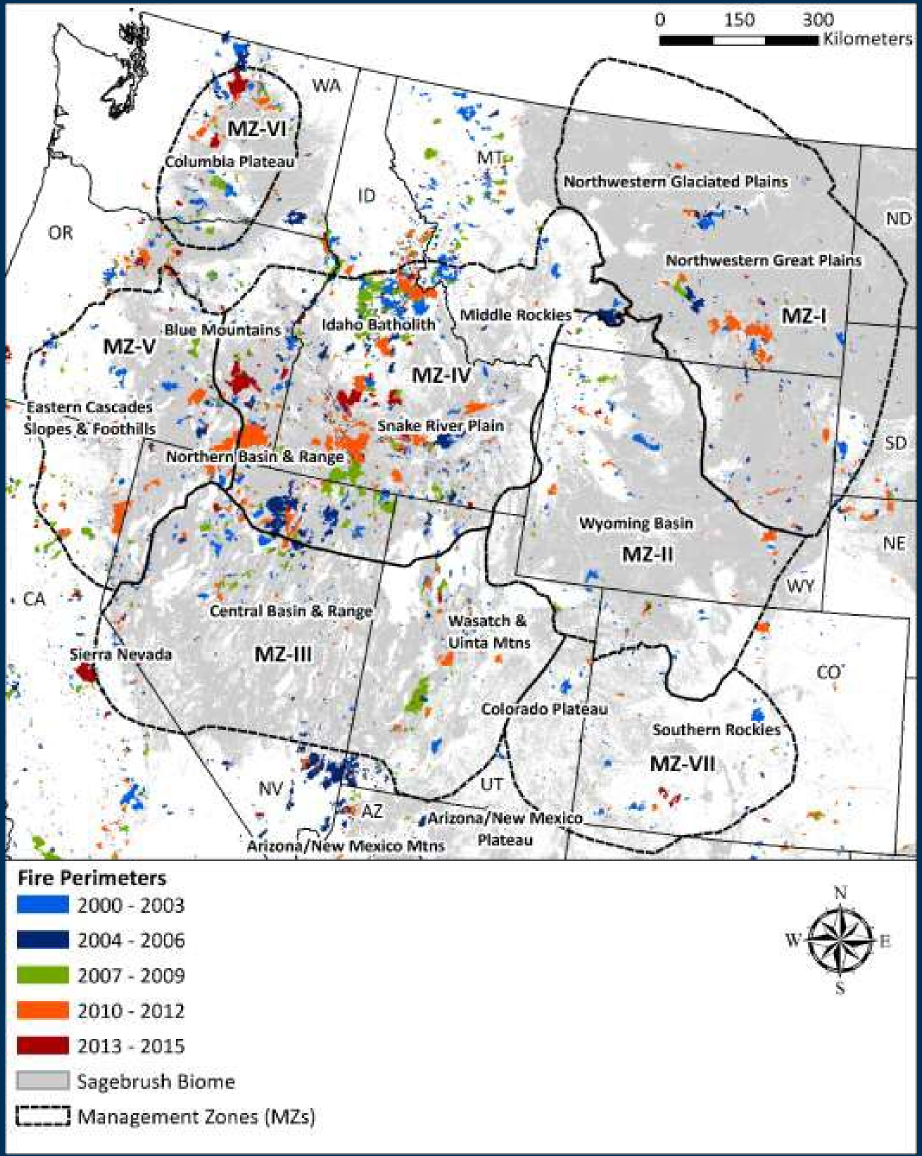
including

~70%

of BLM-managed lands



FSim system results (Finney et al. 2011; Short et al. 2016)



Perimeters of fires since 2000 (Chambers et al. 2016)

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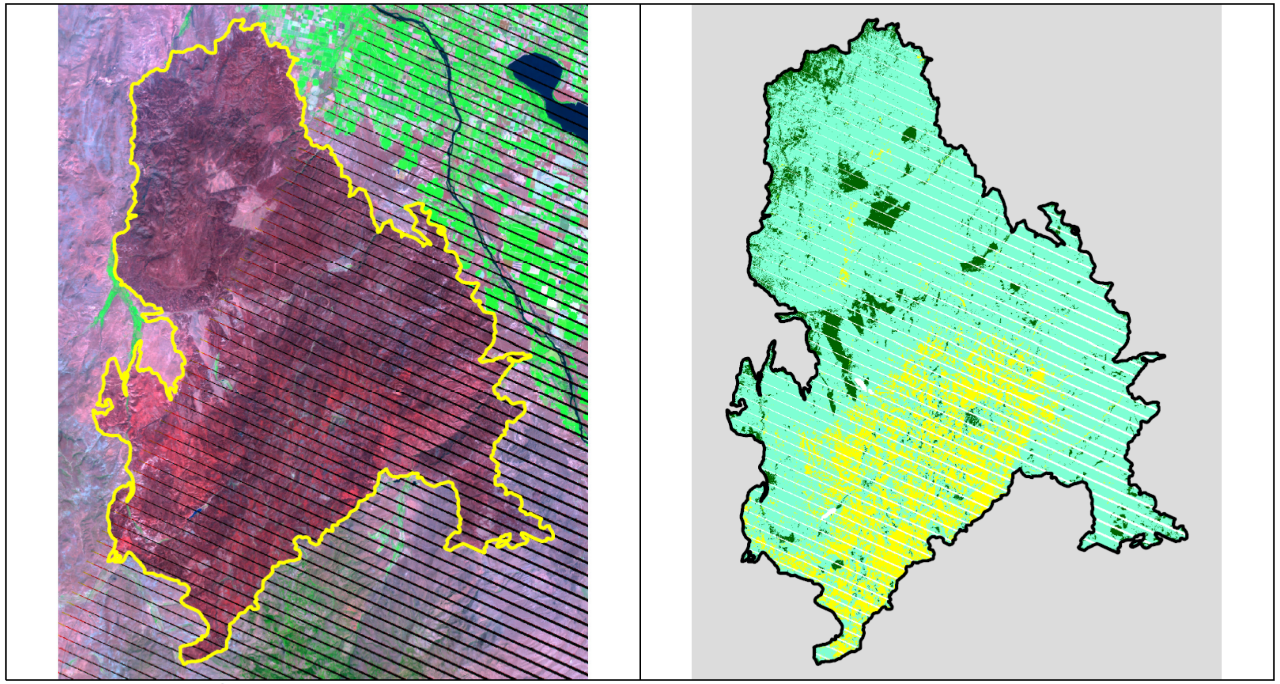
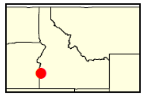
Two case study fires

2015 Idaho: SODA

id4311811696020150810





Latitude: 43° 19' 08.4"
Longitude: -116° 51' 39.6"
Fire Ignition Date: August 10, 2015
Assessment Type: Initial
Pre-Fire Image Date: July 29, 2015 (Landsat 8)
Post-Fire Image Date: August 22, 2015 (Landsat 7)

This map portrays fire severity for the fire specified in the map title and summarizes proportions of fire severity classes. These data are produced under the Monitoring Trends in Burn Severity (MTBS) project jointly implemented by the USGS EROS and the USFS RSAC. The MTBS project ascertains the locations of fires based on available fire occurrence information provided by federal and state agencies, and other reliable sources. The MTBS project reserves the right to correct, update or modify geospatial inputs to this map without notification.

* Areas in either the pre-fire or post-fire reflectance imagery containing clouds, snow, shadows, smoke, significantly sized water bodies, missing lines of image data, etc.

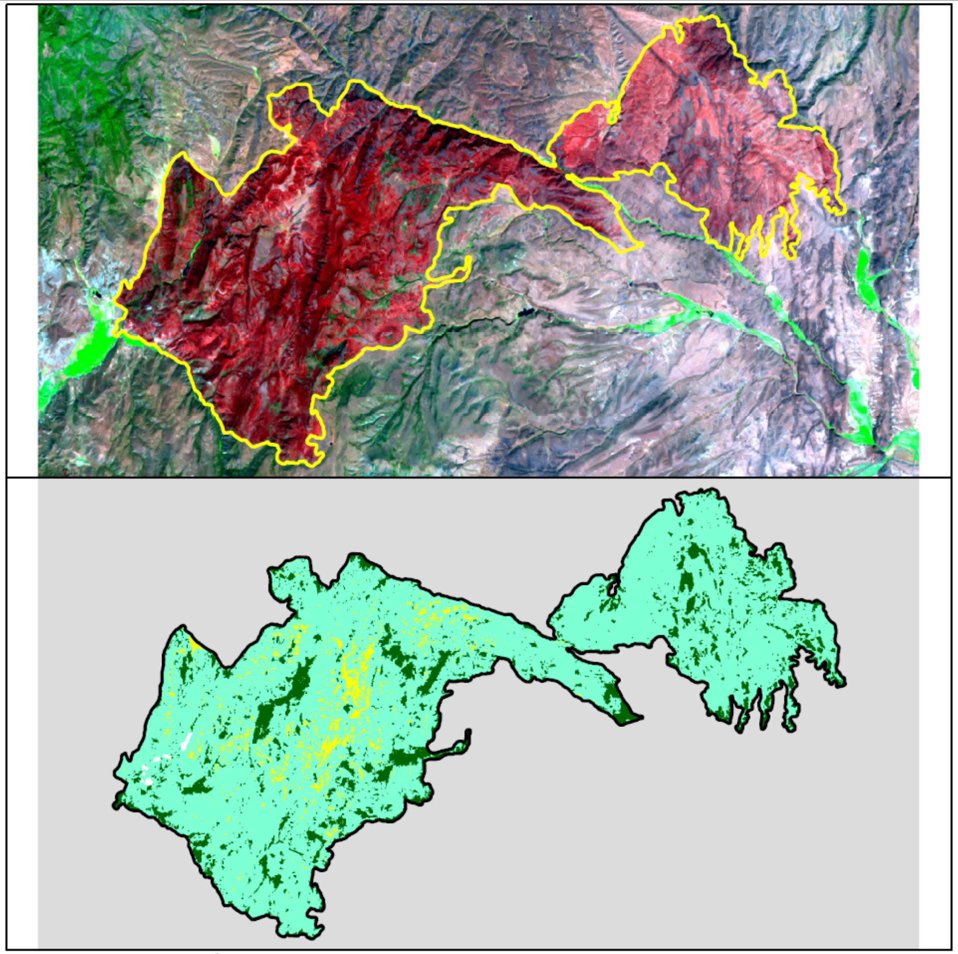
0 8.5 17 Miles

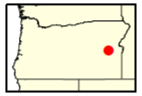
Acreage of Burn Severity

Burn Severity	Acres
Unburned to Low	23,140
Low	192,109
Moderate	38,446
High	0
Increased Greenness	176
Non-Processing Area Mask*	29,021
Total	**282,891**

2015 Oregon: BENDIRE COMPLEX

or4398911806120150811





Latitude: 44° 01' 33.6"
Longitude: -117° 56' 49.2"
Fire Ignition Date: August 11, 2015
Assessment Type: Initial
Pre-Fire Image Date: September 03, 2014 (Landsat 8)
Post-Fire Image Date: September 06, 2015 (Landsat 8)

This map portrays fire severity for the fire specified in the map title and summarizes proportions of fire severity classes. These data are produced under the Monitoring Trends in Burn Severity (MTBS) project jointly implemented by the USGS EROS and the USFS RSAC. The MTBS project ascertains the locations of fires based on available fire occurrence information provided by federal and state agencies, and other reliable sources. The MTBS project reserves the right to correct, update or modify geospatial inputs to this map without notification.

* Areas in either the pre-fire or post-fire reflectance imagery containing clouds, snow, shadows, smoke, significantly sized water bodies, missing lines of image data, etc.

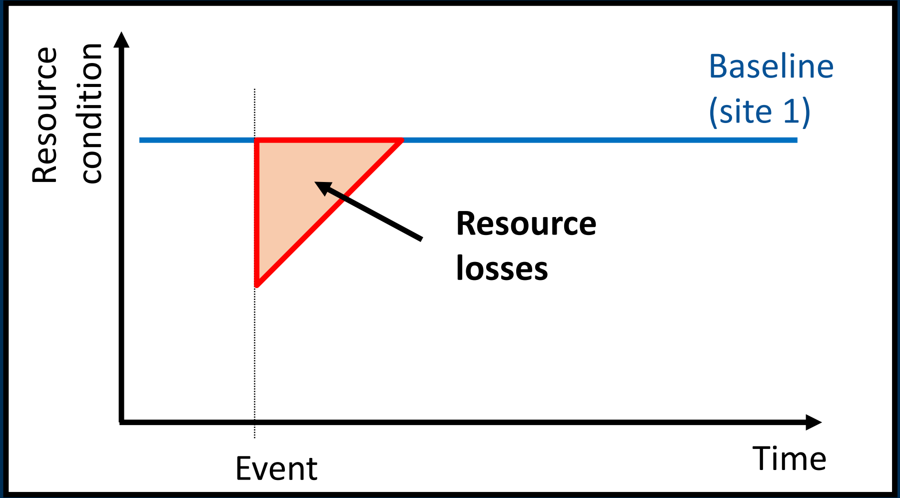
0 3.5 7 Miles

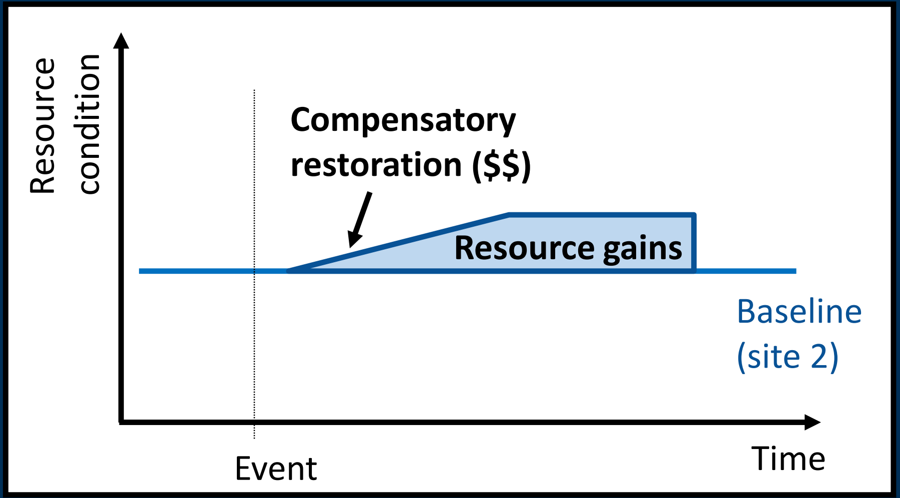
Acreage of Burn Severity

Burn Severity	Acres
Unburned to Low	7,641
Low	39,824
Moderate	1,693
High	0
Increased Greenness	7
Non-Processing Area Mask*	93
Total	**49,258**

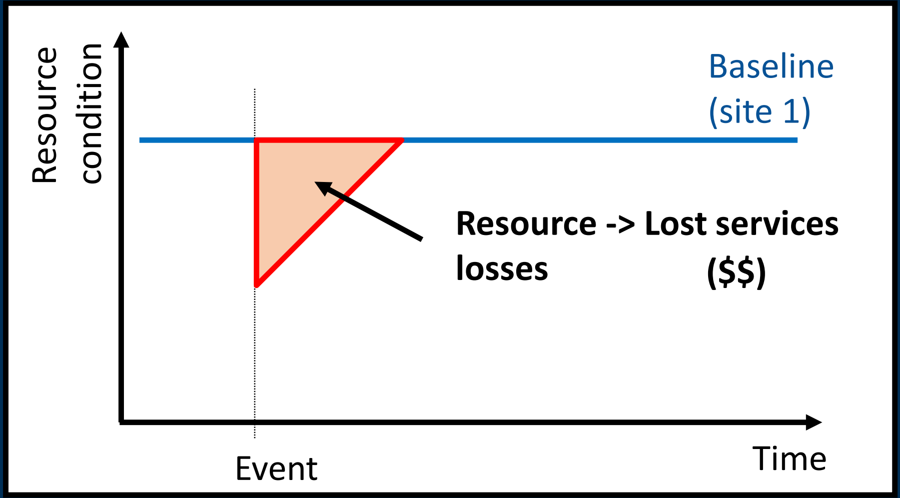
Two approaches to valuation

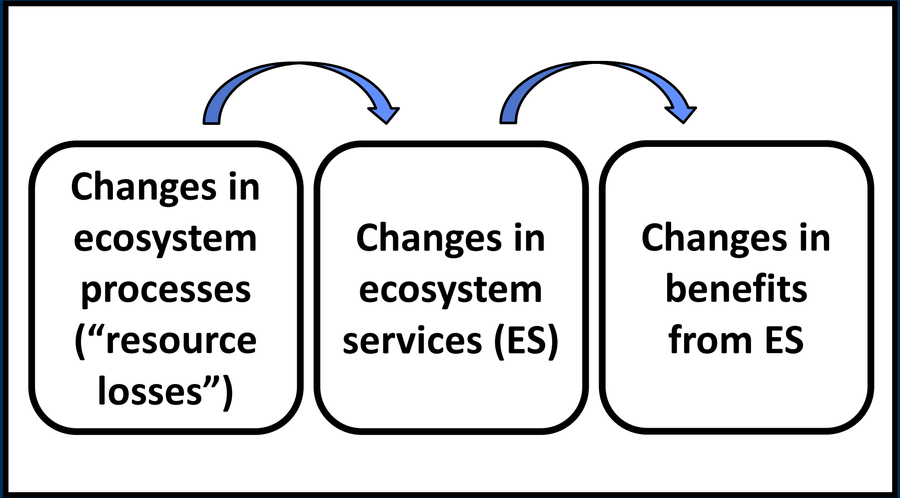
Equivalency analysis (HEA)





Ecosystem services (ES)





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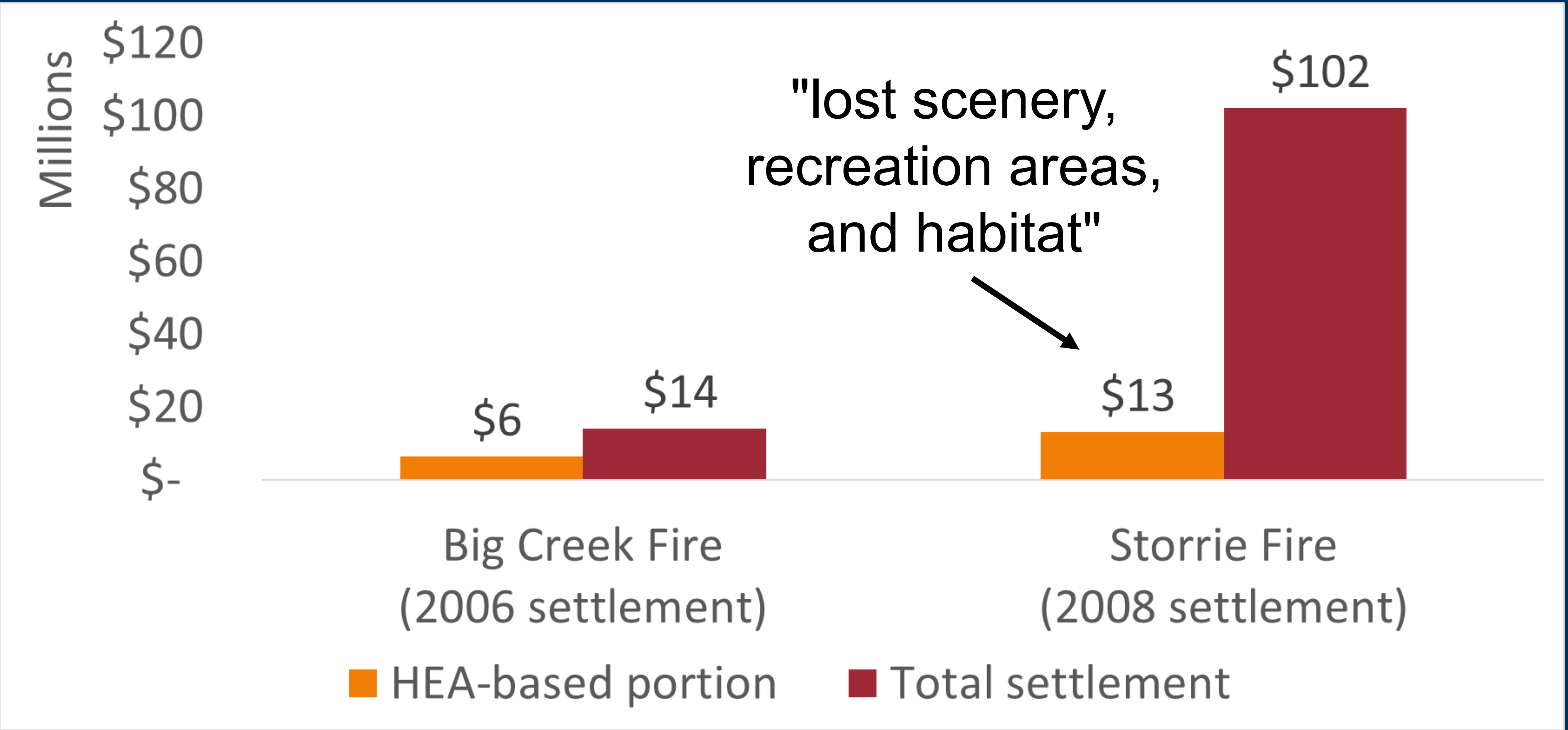
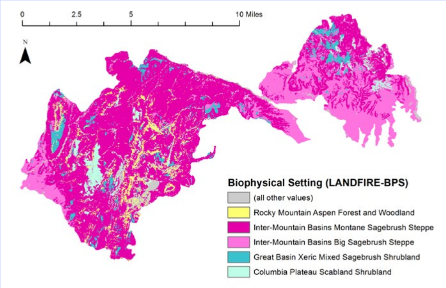
HEA: Precedent from USDA-Forest Service cases

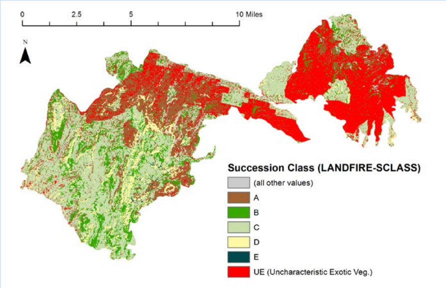


HEA: Approach

$$(n_{acres}) * \left(\frac{1}{treatment\ factor}\right) * \frac{cost}{acre} = \$\$$$

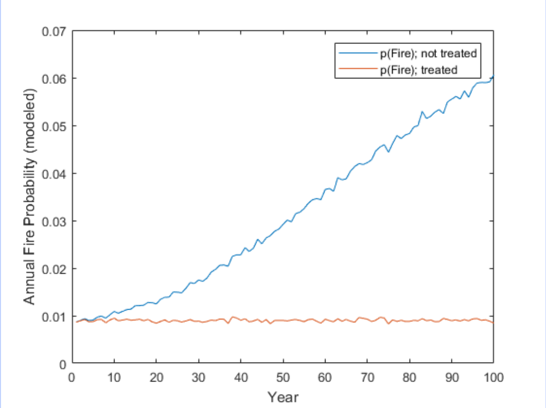
Identify ecological state with LANDFIRE data





(additional assumptions)

State and Transition Model



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Preliminary information - subject to revision. Not for citation or distribution

HEA: Results

$$(n_{acres}) * \left(\frac{1}{treatment\ factor}\right) * \frac{cost}{acre} = \$\$$$

Model Parameters					
Ecological State	MBS-1a	MBS-1b	MBS-3	WSS-1	
Large fire probability without treatment[a]	0.0330	0.0735	0.1100	0.0755	
Large fire probability with treatment[a]	0.0170	0.0170	0.0375	0.0090	
Cost of treatment[b] (2015 dollars)	$ 21.20	$ 49.46	$ 179.02	$ 21.20	
Compensatory treatment factor[c] (=V1/q2)	0.443	1.564	2.006	1.840	

[a]From Taylor et al. 2013 Tables 5 and 7 (=number of estimated fires/200 years); [b]Based on Taylor et al. (2013) Tables 1a and 1b, but assuming 100% effectiveness as a conservative assumption; [c]Calculated net present value of 60 years benefits based on Taylor et al. (2013) estimated treatment duration with 3% discount rate

Soda Fire					
Ecological State	MBS-1a	MBS-1b	MBS-3	WSS-1	**TOTAL**
V1 = q1 (i.e. acres burned)	48,946	15,205	46,258	155,403	265,812
q2 (acres to treat for compensation)	110,534	9,724	23,054	84,439	227,751
Resource damage (=q2*cost)	$ 2,342,939	$ 480,921	$ 4,127,171	$ 1,789,805	$ 8,740,835

Bendire Complex Fire					
Ecological State	MBS-1a	MBS-1b	MBS-3	WSS-1	**TOTAL**
V1 = q1 (i.e. acres burned)	9,331	5,069	12,099	21,577	48,075
q2 (acres to treat for compensation)	21,073	3,241	6,030	11,724	42,068
Resource damage (=q2*cost)	$ 446,681	$ 160,319	$ 1,079,429	$ 248,503	$ 1,934,932

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HEA: Main limitations

$$(n_{acres}) * \left(\frac{1}{treatment\ factor}\right) * \frac{cost}{acre} = \$\$$$

Ignores unique and/or irreplaceable resources

Based on change in burn probability; what about “good fire”?

ES: Related efforts

CSIRO PUBLISHING
www.publish.csiro.au/journals/ijwf *International Journal of Wildland Fire* **2011**, *20*, 327–339

Accommodating non-market values in evaluation of wildfire management in the United States: challenges and opportunities

Tyron J. Venn[A,C] *and David E. Calkin*[B]

[A]College of Forestry and Conservation, The University of Montana, Missoula, MT 59812, USA.
[B]Rocky Mountain Research Station, USDA Forest Service, Missoula, MT 59801, USA.
[C]Corresponding author. Email: tyron.venn@umontana.edu

Abstract. Forests in the United States generate many non-market benefits for society that can be enhanced and diminished by wildfire and wildfire management. The Federal Wildland Fire Management Policy (1995, updated 2001), and subsequent Guidance to the Implementation of that policy provided in 2009, require fire management priorities be set on the basis of values to be protected (including natural and cultural resources), costs of protection, and natural resource management objectives (including beneficial fire effects). Implementation of this policy is challenging because those charged with executing the policy have limited information about the value that society places on non-market goods and services at risk. This paper reviews the challenges of accommodating non-market values affected by wildfire in social cost–benefit analysis and proposes an economic research agendum to support more efficient management of wildfire in the United States.

Additional keywords: bushfire, wildfire economics, wildfire policy.

Introduction

According to Calkin *et al.* (2005), the late 1980s marked the commencement of an era of large wildfires in the western United States that have threatened lives, destroyed homes and stretched suppression resources thin. Annual suppression expenditures by the USDA Forest Service (cited henceforth as Forest Service) have increased in recent years and exceeded US$1 billion in the fire seasons of 2000, 2002, 2003, 2006, 2007, 2008 and 2009 (USDA Forest Service, Rocky Mountain Research Station, national wildfire suppression expenditure unpubl. data, 2009). Several factors have contributed to the high level of suppression expenditures, including: fuel accumulation due to past successful fire suppression activities; a more complex firefighting environment due to private development in the wildland–urban interface (WUI); climate change; limited economic accountability among fire managers; and a fire management incentive system that makes fire managers more risk-averse than may be socially optimal (National Academy of Public Administration 2002; USDA Forest Service *et al.* 2003; Calkin *et al.* 2005; Maguire and Albright 2005; Running 2006; Westerling *et al.* 2006). The United States Federal Government is concerned that fire suppression resources are not being employed in an economically efficient manner and the Forest Service is under substantial pressure to reduce fire suppression expenditures (USDA OIG 2006).

Wildfire differs from other large natural disturbances on a landscape in that managers can plan for and manage wildfire events to a greater degree than is possible with other events, such as earthquakes, floods and hurricanes. Therefore, knowledge about social values of resources at risk is helpful for setting protection priorities. Economists and other analysts have developed price-based[A] wildfire management decision-support tools that aid the allocation of wildfire suppression resources to minimise the sum of short-term direct pecuniary costs of wildfire management, as well as damage to private property, public infrastructure, timber and some non-market goods and services. However, US federal wildfire policy recognises ecosystem health benefits of fire and that 'economically viable' wildfire management must be based on the values to be protected, including natural and cultural resources, costs of protection and natural resource management objectives (USDI *et al.* 2001, p. 22). In 2009, the Fire Executive Council published guidance on the implementation of the policy emphasising that 'Wildland fire will be used to protect, maintain, and enhance resources and, as nearly as possible, be allowed to function in its natural ecological role' (FEC 2009, p. 11). To support federal land management agency implementation of contemporary federal wildfire management policy, price-based decision-support tools must better accommodate non-market benefits and costs of wildfire, including the effects of fire on air quality, wildlife habitat and recreation opportunities.

Wildfire risk assessment models based on a quantitative wildfire risk framework described by Finney (2005) are

[A]In a price-based approach, market or shadow prices are derived for all project outputs and inputs under consideration. Cost–benefit analysis is the classic example of a price-based approach.

 10.1071/WF09095 1049-8001/11/030327

ES: Related efforts

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10.1071/WF09095 1049-8001/11/030327

The Economic Impact of the 2013 Rim Fire on Natural Lands

EARTH ECONOMICS

Preliminary Assessment

TABLE 1	TOTAL ENVIRONMENTAL BENEFITS LOST TO THE RIM FIRE IN THE FIRST YEAR POST-FIRE			
Land Cover	**Area (Acres)**	**Description**	**Low ($/year)**	**High ($/year)**
Grassland and Meadow	20,201	Includes annual and perennial grasslands that dominate major regions around coniferous forests	$30,569,395	$69,202,212
Herbaceous Wetland	577	Includes wetlands dominated by herbaceous meadow vegetation; areas where total herbaceous wetland vegetation coverage is greater than 20%	$515,158	$20,284,851
Shrub	31,923	Riparian areas alongside riverine and wetland regions; exists through various altitudes	$541,959	$37,247,933
Lake	447	Contains areas dominated by shrubs less than 5 meters tall. This class includes chaparral shrubs and mixed montane shrubs	$93,926	$2,877,038
River	161	Includes areas of open water, generally with less than 25% cover of vegetation or soil	$4,073	$907,523
Riparian	190	Includes stream and creek systems and sometimes areas of open water	$47,071	$325,824
Forest (Broad Leaf and Mixed)	32,213	Includes a mixture of aspen, blue oak woodlands, and montane hardwoods that occur sporadically throughout National Parks Service and Forest Service lands	$5,098,191	$284,804,356
Forest (Coniferous)	168,941	Includes many conifer-dominated vegetation types such as Blue Oak-Foothill Pine, Closed-Cone Pine-Cypress, Douglas Fir, Jeffrey Pine, Lodgepole Pine, Ponderosa Pine, Red Fir, Sierran Mixed Conifer, and Mixed Montane Hardwoods Conifers	$63,147,300	$320,363,902
Total	*254,654*		*$100,017,074*	*$736,013,639*

p. 1

Land Cover	Ecosystem Service	Author(s) (Primary)	Minimum ($/acre/year)	Maximum ($/acre/year)
Shrub	Air Quality	Costanza, R., et al.	$6.43	$8.11
	Habitat and Biodiversity	Costanza, R., et al.	$0.64	$330.27
	Pollination	Costanza, R., et al.	$1.37	$6.89
	Recreation and Tourism	Bennett, R., et. al.	$191.88	$191.88
		Costanza, R., et al.	$15.89	$1,327.22

p. 36

ES: Available-data benefit transfer


Economic Benefits of Greater Sage-Grouse Conservation Measures

Final Report

June 30, 2016

Prepared for
Bureau of Land Management, Socioeconomics Program
Washington, DC

Prepared by
Jonathan I. Hecht, ICF International
J. David Ryder, ICF International
T. Robert Fetter, Duke University

		Soda Fire		Bendire Complex Fire	
Land cover type	Rough estimate $/acre[a] (2015$)	Acres	Rough estimate ES Damage	Acres	Rough estimate ES Damage
Grassland/Herbaceous	$34.37	84,316	$2,898,033	22,874	$786,191
Shrub/Scrub	$34.88	171,838	$5,994,017	21,445	$748,053
Mixed Forest	$190.92	24,515	$4,680,356	4,812	$918,790
Total		280,669	$13,572,406	49,131	$2,453,035

[a]Constructed from data and results for air quality regulation, waste treatment services, biological control, and pollination as reported in Hecht et al. (2016)

- **Simple benefit transfer plausible**
  - **BUT NOT RECOMMENDED**
  - **Severe limitations to underlying data**

ES: Enumerated services

Ecosystem service category	Comments / limitations / needs
Carbon sequestration and storage	Most ecosystem C stored below ground, expect little net change from wildfire
Soil erosion and debris flows	Site specific, requires detailed modeling (soils, hydrology, weather, etc.)
Air quality impacts	Site specific, requires modeling population exposure
Recreation opportunities	Site specific, requires demand estimation (e.g. substitute site availability)
Grazing opportunities	Site specific, requires demand estimation (e.g. substitute site availability)
Habitat for native flora and fauna	Requires nonmarket values of species, impact of individual fire on survival probability
Cultural heritage	Very site specific

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Overall: site specific, anywhere from negligible to immense

Takeaway messages

Sagebrush ecosystem services are not well understood, and wildland fire's impact on benefits even less so.

However, resource damages clearly add up for large fires, and either method, though imperfect, finds substantial values.

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