

# Documenting Twenty Years of the Contracted Labor-Intensive Forestry Workforce on National Forest System Lands in the United States

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## Abstract

This paper presents the first nationwide analysis detailing the scope and scale of labor-intensive forestry contracts performed on National Forest System lands and examines the businesses contracted, location and types of work performed, and distance traveled by businesses between 2001 and 2020. During the study period, 61,698 contracts were awarded to 7,896 businesses, totaling \$12.9 million, to perform labor-intensive forestry work, with most work being contracted for wildfire-related activities. Businesses were typically located in western states and non-minority owned businesses received the majority of contracts. Of minority-owned businesses, Hispanic American-owned businesses received the most contracts. The median distance that businesses traveled to accomplish work increased significantly through time but differed by business type. Understanding the scope and work of businesses awarded contracts provides insight into the workforce and its relationship to marginalized populations. Strategic investment in this workforce may have widespread impacts on federal, state, and local economies and the livelihoods of forest workers.

**Study Implications:** Between 2001–2020, the USDA Forest Service spent billions of dollars on contracts with thousands of businesses to conduct labor-intensive forestry projects; however, project locations and awarded businesses were not evenly distributed through space and time. Emerging and minority businesses represented a small proportion of contracts awarded. Advancing understanding of the businesses conducting labor-intensive forestry work lays the foundation for inquiry into the working conditions forest workers experience as well as disparities in contract capture. Some regions may have benefitted more from contract capture than others. Understanding factors enabling places and businesses to capture these contract dollars may help identify others that may benefit from investment.

**Keywords:** USDA Forest Service, labor-intensive forestry, national forest system, federal contracting, federal procurement data system, product service codes, restoration business

Public land management agencies are increasingly investing in landscape-scale restoration and wildfire mitigation treatments for protecting and improving water and environmental quality, restoring wildlife habitat, and reducing wildfire hazard to communities and ecosystems (Charnley et al. 2020; Schultz et al. 2012). Public and agency recognition of the need for these types of work has intensified as wildfire seasons have lengthened and wildfires have grown larger and more severe due to climate change, human behavior, and past forest management (Dunn et al. 2020; McWethy et al. 2019; Schoennagel et al. 2017). Through programs like the Collaborative Forest Landscape Restoration

Program (Schultz et al. 2012) and the Joint Chiefs' Landscape Restoration Partnership (Cyphers and Schultz 2019), recent legislation such as the Infrastructure Investment and Jobs Act (H.R. 3684, 117<sup>th</sup> Congress 2021), and grants and agreements through tools like the Good Neighbor Authority and the 2018 Shared Stewardship Strategy (Kooistra et al. 2022), the USDA Forest Service (USFS) has sought to increase the "pace and scale" of forest restoration and management in National Forests (McIver and Becker 2021). However, within the agency, USFS budgets have declined and shifted towards wildfire management, and resources and workforce capacity are diminished (Santo et al. 2021; USDA Forest Service 2015;

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Westphal et al. 2022). More broadly, private contractors are often preferred for providing a lower cost for necessary work, which can shift economic returns from workers to businesses and often means the reduced costs come from lower wages and reduced benefits (Weil 2011). Most national forests increasingly rely on contracts with private sector businesses to implement these treatments.

Labor-intensive forestry work is a key component of implementing forest and watershed restoration and hazardous fuels reduction projects on national forests, yet it often receives less attention from researchers than other types of forestry and wildland fire suppression work. Continuity of work opportunities may help maintain the skills and capacity of workers in rural, historically forest-dependent communities (Spies et al. 2019). Labor-intensive forestry work uses crews of people performing physically demanding, manual, and often seasonal forest management tasks. This work includes tree planting for reforestation, hand thinning of trees and brush for objectives other than commercial timber harvest, manual herbicide application, and slash piling and burning without the use of heavy machinery (Charnley et al. 2018; Moseley 2006). This work is different from other related forestry work that is equipment intensive, such as road maintenance and decommissioning, or technically intensive, such as timber cruising or surveying. The sociodemographic characteristics of the labor-intensive forestry workforce is also notably different than other types of forestry work. Since the 1970s, labor-intensive forestry contracts have increasingly been awarded to businesses relying on a workforce predominantly made up of lower-income Latino immigrants, guest workers, and undocumented workers (Sarathy 2006, 2012). These positions can entail low wages (which can go unpaid) and lack health benefits. In addition, workers are often faced with dangerous working conditions (Moseley et al. 2014; Wilmsen et al. 2015, 2019).

Despite the important role that it plays in forest management, little is known about the labor-intensive forestry sector. Research into this topic has primarily been localized, case-study based analyses that examine limited time scales (Kooistra and Moseley 2019; McIver et al. 2018; Moseley 2006; Moseley and Reyes 2008) or examinations of occupational health and safety issues (e.g., BenDor et al. 2015; Bosworth and Brown 2007; Mohr and Metcalf 2018; Sarathy 2012; Wilmsen et al. 2015, 2019). In addition, much of the work to date has been through forest or sector-specific technical assessments (Ellison and Huber Stearns 2017; Huber-Stearns et al. 2016; Moseley and McDaniel 2006). Given the historic role and ongoing significance of labor-intensive forestry activities in achieving forest management and wildfire risk reduction goals, better understanding of long-term trends in this sector at a national scale is needed. This includes expanding knowledge on the nature and distribution of this work, types of businesses that perform this work and their location, and characteristics of the involved workforce. Documenting and understanding the extent of labor-intensive forestry contracting and the characteristics of businesses that conduct this work can lay the groundwork for further inquiry and expansion of previous research into the working conditions of forest workers themselves, as well as disparities in contract capture, and connections between business and contracting competitiveness and job quality. The extent and increase of labor-intensive contracting nationwide highlights the importance of further inquiry into working conditions for

this labor force, given both what is known from past research on this topic (Moseley et al. 2014; Wilmsen et al. 2015, 2019) and the current Biden-Harris administration emphasis on equity, which goes beyond which businesses obtain contracts to job quality for this labor force. Moreover, understanding who these businesses employ and where they are located is timely. Over the next 5 years, the USFS plans to treat up to an additional 20 million acres of National Forest System lands and up to an additional 30 million acres of other federal, state, tribal, and private lands (USDA Forest Service 2022). The USFS will rely on forest restoration businesses to perform these treatments. Strategically investing funding towards this workforce may have widespread impacts on federal, state, and local economies and the livelihoods of those performing this work.

This article expands on previous literature (Kooistra and Moseley 2019; Moseley and Shankle 2001) to offer a nationwide view of patterns in National Forest System contracts to implement labor-intensive forestry activities between 2001 and 2020. The purpose of our study is two-fold. First, we seek to understand the scope and scale of labor-intensive forestry contracts on National Forest System lands. Second, we characterize the contractor landscape, including (1) who is performing labor-intensive forestry work, (2) what work they are doing, (3) where they are performing it, and (4) how far they are traveling to perform it.

## Methods

### Data

We downloaded all contract data reports with the USFS listed as the contracting agency between federal fiscal years 2001 and 2020 from the System for Award Management (SAM.gov), the federally managed website that consolidates data from the Federal Procurement Data System (FPDS; see Table 1 for definitions). Datasets for other types of mechanisms such as for grants and agreements were not publicly available at the scale necessary to include in a complementary analysis. Federal regulations require federal agencies to record and report in FPDS all actions on contracts exceeding the micro-purchase threshold of \$10,000. The selected years were the only years for which we could obtain complete data in the SAM.gov system; however, this still provided two decades of data for understanding trends over time, particularly during more recent years of focus on wildfire risk reduction and forest health. Contract data reports were filtered for contracts with product service codes (PSCs; Table S1) and North American Industry Classification System (NAICS) codes (Table S2) relevant to labor-intensive forestry work awarded to businesses located within the United States. The PSCs and NAICS codes are used by federal agencies to classify the type of goods or services provided under each contract. Only USFS contracts were analyzed to discern patterns in businesses at a national scale; however, many of these businesses may also conduct other work on other public and private lands (e.g., wildland fire suppression services, timber management), providing a potential opportunity to make inferences about the larger labor-intensive forestry contractor landscape. We caution against inferring too far, given the lack of information available about what proportion of each businesses' portfolio is composed of contracts from the USFS.

In federal databases, labor-intensive forestry contracts are not explicitly differentiated from other types of

**Table 1.** Definitions of national contracting terms.

Term	Definition
Business	Businesses registered with a Unique Entity ID that have entered into a contractual agreement with any department or agency within the Federal government.
Contract	A contractual agreement between the Federal government and a business to provide supplies or perform services. These were identified based on unique PIID and UEIs within the Federal Procurement Data System.
Federal Procurement Data System (FPDS)	The central repository of information on Federal contracting.
North American Industry Classification System (NAICS) code	The identifier that represents the NAICS classification assigned to the solicitation and resulting award identifying the industry in which the contract requirements are normally performed.
Place of performance	The location where the work is taking place.
Procurement Instrument Identifier (PIID)	The unique identifier of the specific award being reported. PIIDs are required for all actions.
Product and Service Code (PSC)	The code that best identifies the product or service procured.
Solicitation	Any request by the federal government to obtain offers for a single contract or a multiple award contract.
System for Award Management (SAM)	The primary Government repository for contractor information required for the conduct of business with the Government.
Unique Entity Identifier (UEI)	A 12-character alphanumeric identifier assigned to all organizations to bid on and receive a contract directly from the federal government. Businesses were identified as each unique UEI.
<b>Types of businesses</b>	
Small business set-asides (SBSA)	Contracts reserved by the federal government to limit competition for qualifying small businesses. Some set-asides are specifically limited to businesses that participants in the 8(a) Business Development or HUBZone programs or are small businesses owned and operated by service-disabled veterans or women.
8(a) Business Development Program	A program developed by the US Small Business Administration to aid socially and economically disadvantaged firms by offering participants in the program training, technical assistance, and federal contracting preference.
Historically Underutilized Business (HUB) Zones Program	A program that provides contracting preference to small businesses located within and with 35% of employees living in demographically specified regions considered Historically Underutilized Business Zones, and with 51% of the business owned and controlled by a company part of a Community Development corporation, agricultural cooperative, Alaska Native corporation, Native Hawaiian organization, or Indian tribe.
Minority-owned (MO) business	A business in which more than 51% of the interest, stock and otherwise, is owned by minority group members. Businesses that select this category also need to select a subcategory that best represents the persons who hold primary ownership. Subcategories include Asian-Pacific American Owned, Subcontinent Asian (Asian-Indian) Owned, Black American Owned, Hispanic American Owned, Native American Owned, or Other.
Service-disable veteran-owned business	Businesses at least 51% owned and controlled by service-disabled veterans and have one or more service-disabled veterans managing day-to-day operations.
Women-owned small business	Small businesses at least 51% owned and controlled by women who are US citizens and have women managing day-to-day operations and making long-term decisions.

forestry-related contracts involving heavy machinery, support services (for example, catering, towing, and medical assistance), and wildfire response activities. In fact, much of this work shares the same NAICS codes and PSCs. To identify labor-intensive activities, we first selected PSCs related to labor for land treatment and wildland fire response to capture both restoration and wildfire mitigation work. However, as PSCs are broad categories, we identified labor-intensive forestry contracts by filtering these data to retain contracts related to forest restoration work (Supplement 1). Data were filtered using keywords to remove contracts with business, funding office, and contracting office names signifying the business was contracted to conduct non-labor-intensive forestry or wildland fire suppression work. For example, all contracts funded through the National Interagency Fire Center (indicating work was contracted for wildland fire suppression services) were removed, as well as business names containing words like “sanitary,” “helicopter,” and “petroleum” (Table S3). This was particularly important given the size of these contracts, many for millions of dollars each, that could have obfuscated our labor-intensive forestry contract focus. In addition, these selected PSCs do not contain all fire

suppression contracts, so including some of them would have resulted in an incomplete accounting of fire suppression contracts. Finally, we used an intensive and iterative inspection process to extract the remaining identifiable wildfire suppression and aviation-related contracts that did not fit our definition of labor-intensive forestry work (Table S1).

### Procedure and Analysis

Businesses were identified by their Unique Entity IDs, distinctive twelve-character alphanumeric identifiers assigned by SAM.gov to all entities registered to do business with the federal government and eligible to apply for solicitations. Solicitations refer to any request by the federal government to submit a quote or offer and are identifiable within the data by a unique Procurement Instrument Identifier (PIID). One solicitation can result in separate contracts being awarded to multiple businesses and each contract can result in multiple entries at SAM.gov due to modifications. To identify each unique contract, we grouped all data entries sharing a PIID and Unique Entity ID, then summed the contract values of each associated entry to find the total contract value. Once

the total value of each contract in the dataset was calculated, we adjusted for inflation by finding the average producer price index for each year throughout the study period and converting each contract value to 2020 dollars based on the producer price index of the final award year of each contract.

To identify geographic areas where businesses performing labor-intensive forestry work are concentrated, we calculated the state-level location quotient (LQ) for both dollar value and number of contracts. The LQ is a widely used geographic index and an analytical statistic that is “a ratio of ratios” (Wheeler 2005). We use it to compare the ratio of labor-intensive forestry contracts in a smaller reference area (i.e., a state) with the ratio of that industry in a larger reference area (i.e., the nation) to show how concentrated or specialized the industry is in the smaller area compared with the larger reference area (US Bureau of Economic Analysis 2018; Uslu 2016). An LQ of 1 indicates that the state and nation are equally specialized or concentrated; values greater than 1 indicate a higher concentration of labor-intensive contracts in the state relative to the nation; and values less than 1.0 indicate the state is less specialized in labor-intensive forestry contracts or contract dollars than the nation. For our purpose, we calculated the LQ of state,  $s$ , relative to nation,  $n$ , using both the dollar value,  $V$ , and number,  $N$ , of labor-intensive forestry contracts,  $i$ , relative to all forestry contracts,  $c$ , reported in SAM.gov (Isserman 1977):

$$LQ, \text{ value of labor - intensive forestry contracts} = \frac{V_{is}/V_{cs}}{V_{in}/V_{cn}}$$

$$LQ, \text{ number of labor - intensive forestry contracts} = \frac{N_{is}/N_{cs}}{N_{in}/N_{cn}}$$

The approximate distance traveled by businesses to perform work based on street network analysis was calculated using the Generate Origin Destination Cost Matrix Tool in ESRI ArcGIS Pro v.2.9.3. Origins were based on the city of the business address and destinations were based on the city name listed as the principal place of performance for each contract. The geographic coordinates of origins and destinations were found by joining each city to coordinates from the US Cities Database (<https://simplemaps.com/data/us-cities>) and manually identifying coordinates for cities not included within that dataset. The distance traveled by businesses to place of performance were analyzed by contract year and business type (defined in Table 1). On analysis, data were found to have non-normal distributions, so we compared them using the Kruskal-Wallis one-way analysis of variance test followed by the Dunn test for multiple comparisons (Dinno 2015).

In the results, we report findings using terminology and categories as defined by the FPDS. We analyzed contract data for businesses that identified as minority-owned or were qualified to compete for small business set-asides contracts to identify impacts contracting activities may have on these business types. The US Small Business Administration sets aside contracts for small business set-asides if at least two qualified small businesses are likely to submit offers and could do the work for a fair price. Preference is given to participants in the 8(a) Business Development or Historically Underutilized Business (HUB) Zone programs, along with small businesses owned and operated by women or businesses owned by service-disabled veterans. We included all service-disabled veteran-owned businesses in our analysis because the dataset did not explicitly identify whether service-disabled veteran-owned

businesses were small businesses. Businesses may select multiple socioeconomic categories when registering in the FPDS; therefore, we collectively refer to minority-owned businesses and businesses qualifying for small business set-asides (SBSA) using the acronym SBSAMO and those not belonging to one or more of these categories as non-SBSAMO. For some analyses, we further separate SBSAMO businesses into those that are minority owned and those that qualify for small business set-asides.

All data processing, analyses, and visualization were completed using R v4.1.3 (R Core Team 2022) in RStudio v2022.2.3.492 (Rstudio Team 2022) with the following packages: dplyr (Wickham et al. 2022), ggplot2 (Wickham 2016), sf (Pebesma 2018), and FSA (Ogle et al. 2022).

## Results

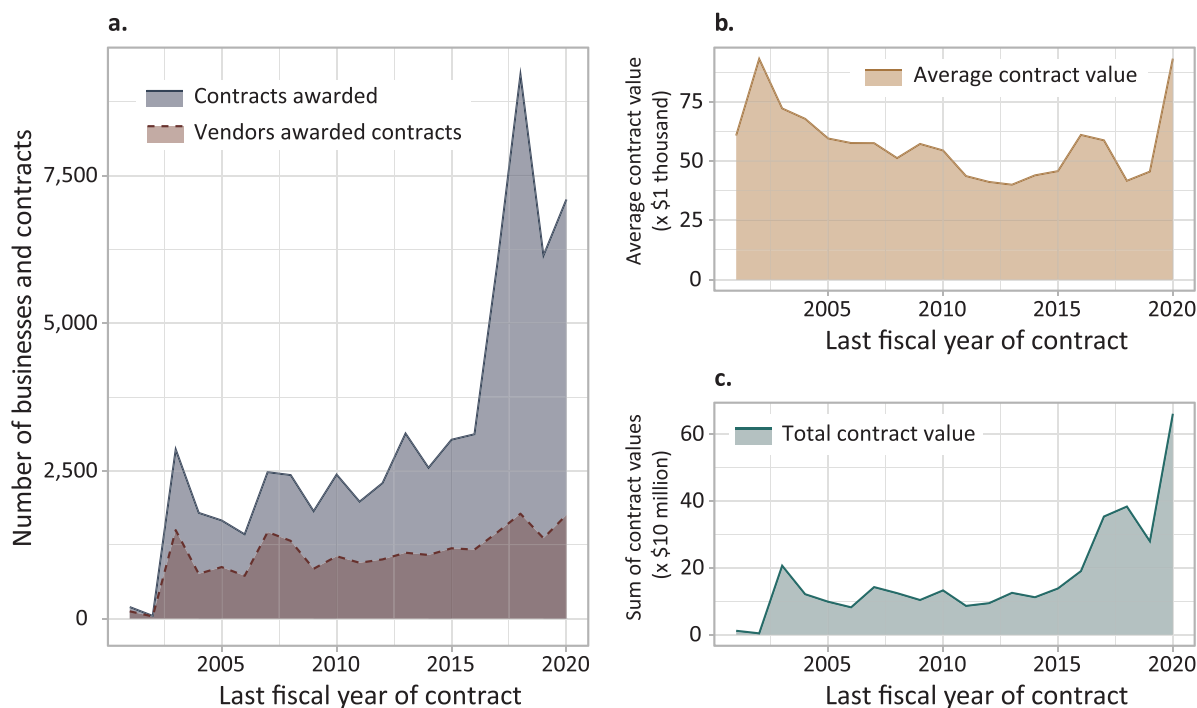
### Contracting Through Time

Between 2001 and 2020, the USFS awarded a total of 61,698 contracts to 7,896 businesses to perform labor-intensive forestry work across forty-eight states, Puerto Rico, and the District of Columbia totaling 12,917,907,763 dollars. Two states (Rhode Island and Delaware) did not have any contract data entered in FPDS. An average of 3,085 contracts (median of 2,458 contracts) were awarded annually, with the number of contracts awarded ranging from 45 contracts in 2002 to 9,205 contracts in 2018. The average contract value was \$57,289 and ranged from \$40,000 in 2013 to \$95,163 in 2020. The median sum of all contracts awarded during each fiscal year of the study period was \$124,841,651 and ranged from \$4,186,260 in 2002 to \$660,895,822 in 2020 (figure 1).

### Which Businesses Perform Labor-Intensive Forestry Work?

Non-SBSAMO businesses (those not minority owned and ineligible for small business set-asides, making up nearly 85% of businesses in the dataset) were awarded the majority of all contracts (67.6%) between 2001 and 2020. Minority-owned businesses made up only 9.3% of total businesses in the data but were awarded 16.1% of all contracts. Participants in the HUBZone Program were awarded 12.4%, women-owned small businesses were awarded 7.0%, participants in the 8(a) Business Development Program were awarded 6.1%, and service-disabled veteran-owned businesses were awarded 3.0% of total contracts (Table 2). Of minority-owned businesses, Hispanic American-owned businesses received the greatest number of contracts (11.5% of all contracts), followed by Native American and American Indian, other minority, Black American, and Asian Pacific or Subcontinent Asian (Asian Indian) American (3.6%, 0.8%, 0.5%, and 0.3% of contracts, respectively; Table 3).

Participants in the 8(a) Business Development Program were awarded the largest average contract value at \$97,917, followed by minority-owned businesses at an average value of \$77,760; participants in the HUBZone program at an average value of \$74,543; women-owned small businesses at an average value of \$56,713; and service-disabled veteran-owned businesses at an average value of \$40,948. The average contract value of non-SBSAMO businesses was \$50,370 (Table 2). Minority-owned businesses identifying as Hispanic American-owned received the highest average contract values (\$87,795), whereas businesses identifying as an



**Figure 1.** (a) Number of labor-intensive forestry contracts and number of unique businesses awarded contracts, 2001–2020. (b) Average labor-intensive forestry contract value, 2001–2020. (c) Sum of all contracts awarded each fiscal year, 2001–2020.

**Table 2.** Types of businesses receiving labor-intensive forestry contracts by number, percentage of total contracts and average contract value, 2001–2020.

Business type	Businesses (#)	Businesses (%)	Contracts (#)	Contracts (%)	Average contract value
Minority-owned (Table 3)	733	9.3%	9,913	16.1%	\$77,760
HUBZone program participants	661	8.4%	7,675	12.4%	\$74,543
Women-owned small businesses	465	5.9%	4,312	7.0%	\$56,713
Service-disabled veteran owned	255	3.2%	1,861	3.0%	\$40,948
8(a) program participants	201	2.5%	3,784	6.1%	\$97,917
Non-SBSAMO businesses	6,698	84.8%	41,704	67.6%	\$50,370
<b>All businesses</b>	<b>7,896</b>		<b>61,698</b>		<b>\$55,960</b>

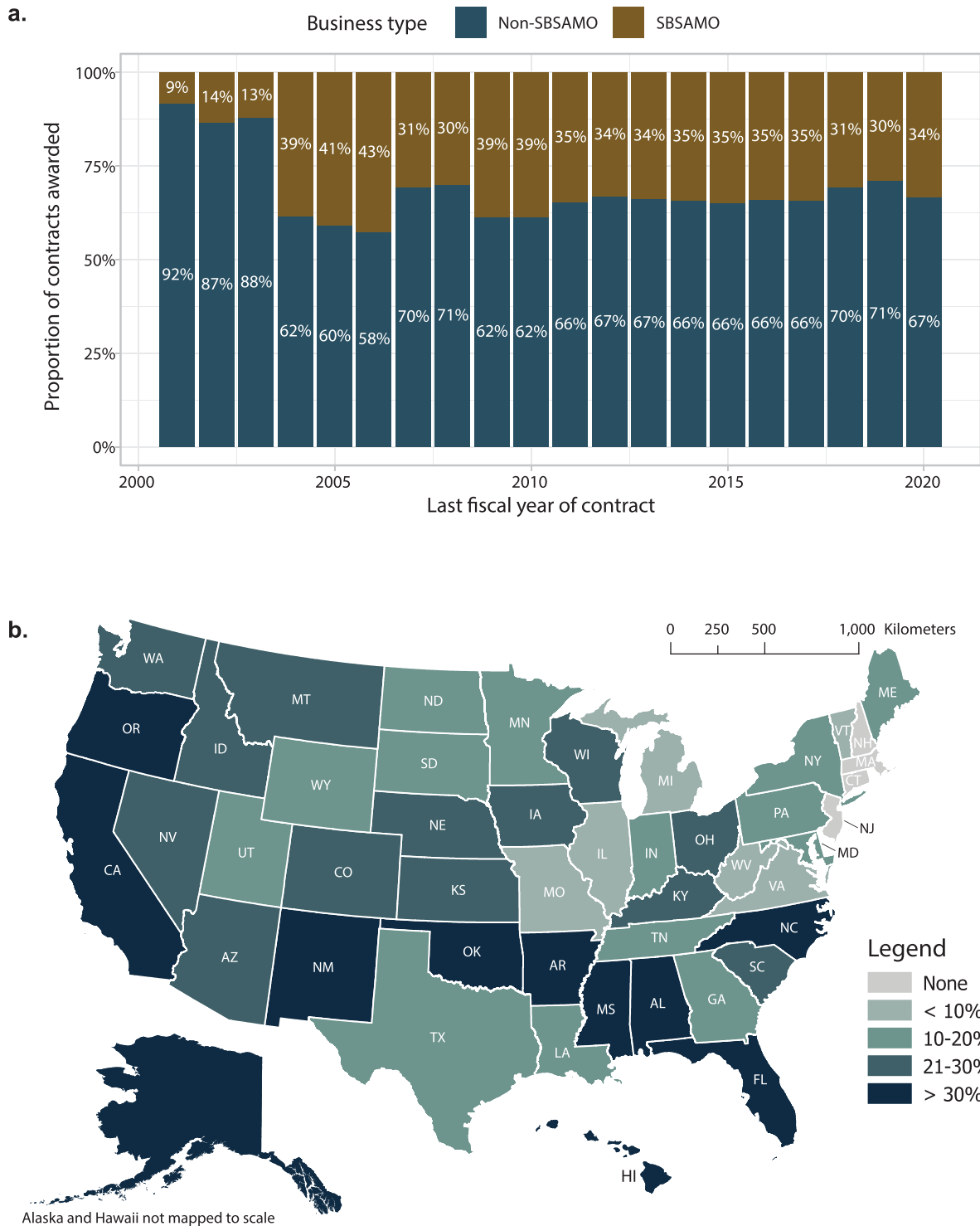
**Table 3.** Types of minority-owned businesses receiving labor-intensive forestry contracts by number, percentage of total contracts, and average contract value, 2001–2020.

Business type	Businesses (#)	Businesses (%)	Contracts (#)	Contracts (%)	Average contract value
Hispanic American	323	4.1%	7,106	11.5%	\$87,795
Native American or American Indian	257	3.3%	2,196	3.6%	\$54,141
Black American	41	0.5%	335	0.5%	\$80,857
Asian Pacific or Subcontinent	37	0.5%	181	0.3%	\$76,696
Asian (Asian Indian) American					
Other minority	111	1.4%	496	0.8%	\$41,531

“other minority-owned business” received the lowest average contract values (\$41,531).

Although non-SBSAMO businesses were awarded most of the contracts over the 20 year timeframe, the proportion of contracts captured by these businesses varied through

time and geographically (figure 2). Prior to fiscal year 2004, SBSAMO businesses captured 14% or less of total contracts. Following fiscal year 2004, this proportion increased, varying from 30% of contracts in 2008 and 43% of contracts in 2006. Spatially, a higher proportion of contracts was awarded



**Figure 2.** (a) Change in the proportion of contracts captured by SBSAMO and non-SBSAMO businesses, 2001–2020. (b) Proportion of contracts awarded to SBSAMO businesses by state, 2001–2020.

to SBSAMO businesses in the western and southern United States; states in the Midwest to New England had a smaller proportion of labor-intensive forestry contracts awarded to SBSAMO businesses. The ratio of minority-owned businesses, specifically, receiving contracts within each state was not clearly associated with the larger US demographics (US Census Bureau, 2020). Some states with larger minority populations, such as California and Arkansas, and states

with lower minority populations, such as Oregon, had higher-than-average proportions of minority-owned businesses awarded contracts.

### What Kinds of Work Were Performed?

The majority (59.8%) of the labor-intensive forestry contracts awarded over the 20 year period went to contractors performing work with the F003 PSC (defined as “forest-range

fire suppression/pre-suppression”). Given contracting data was filtered to exclude wildland fire suppression work, these results indicate that a large majority of labor-intensive forestry work is being conducted for pre-suppression or fuels management activities. The second most common code was F099, defined as “other natural resources/conservation” (10.7%), followed by F018 (“other forest/range improvements (non-construction),” 10.1%; Table 4). Over time, contracting by the USFS shifted towards forest-range fire suppression/pre-suppression work, with total contract dollar values increasing from \$1,607,050 in 2001 to their highest point of \$469,781,138 in 2020. Since 2017, the number of contracts with PSC F003 has increased whereas contracts with other PSCs, such as tree thinning services (PSC F014), have decreased.

### What States Specialize in Labor-Intensive Forestry Work?

The locations of businesses receiving USFS labor-intensive forestry contracts were unequally distributed across the United States, with businesses most likely to be located in western and southeastern states. The state with the largest number of businesses performing labor-intensive forestry work was Oregon, with 1,334 businesses (16.9% of all businesses contracted nationwide), followed by California (1,231 businesses, 15.6%) and Montana (1,205 businesses, 15.3%). However, the number of businesses located within each state was not indicative of the total number of contracts received. Businesses in some states, such as Arkansas, received a relatively large number of contracts in relation to the number of businesses located in the state. In other states, such as Colorado, New Mexico, and Arizona, there was a disproportionately large number of businesses relative to the number of contracts being performed within the state (figure 3).

Similarly, the place of performance for most contracts occurred in western states. Oregon, California, and Montana had the largest number of contracts awarded for labor-intensive forestry work, often performed by in-state businesses. For example, 79% of the 16,909 contracts with a place of performance in Oregon were awarded to businesses located within the state. However, this varied across states. For example, New Mexico had a relatively large number of businesses

performing labor-intensive forestry work ( $n = 629$ ), yet only 30% of contracts were awarded to in-state businesses for work performed within the state (figure 4).

The location quotients were calculated for all states for both number of contracts awarded and the dollar value of labor-intensive forestry contracts going to in-state businesses to identify potential areas of specialization in labor-intensive forestry work within all forestry work (Tables 5 and 6). States with specialization (e.g., an LQ > 1.0) in labor-intensive forestry work included almost all the states with a high number of businesses and contracts (figure 2a). Oregon and Arkansas had the highest location quotients for contract numbers, each over 2.0; however, Oregon captured almost 31% of all contracts awarded, whereas Arkansas captured only 3.6%. Although Arizona and Colorado had high numbers of contracts and businesses, they did not specialize in labor-intensive forestry contracts within forestry contracts in general (e.g., location quotients less than 1.0).

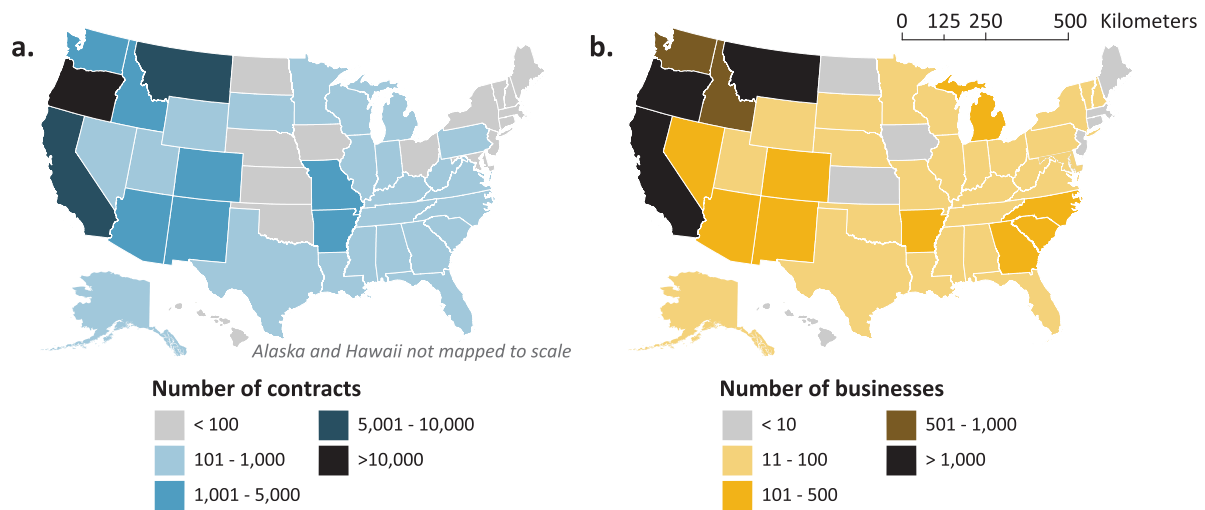
Almost all the states capturing the highest dollar value of labor-intensive forestry contracts were in the western United States; the only exceptions were Missouri and Arkansas. Of these, just five states showed specialization in dollar capture of labor-intensive forestry work: Oregon, California, Colorado, New Mexico, and Arkansas. Like the contract number LQ, Oregon and Arkansas showed the highest specialization in contract value capture, with LQs greater than 2.0. However, Oregon captured 37% of all value in labor-intensive contracts nationally, whereas Arkansas captured 2.2%. In fact, Oregon and California captured most of the value of all labor-intensive forestry work nationally; businesses located in these two states accounted for almost 58% of all USFS labor-intensive forestry contract dollars between 2001 and 2020.

### How Far Are Businesses Traveling to Accomplish This Work?

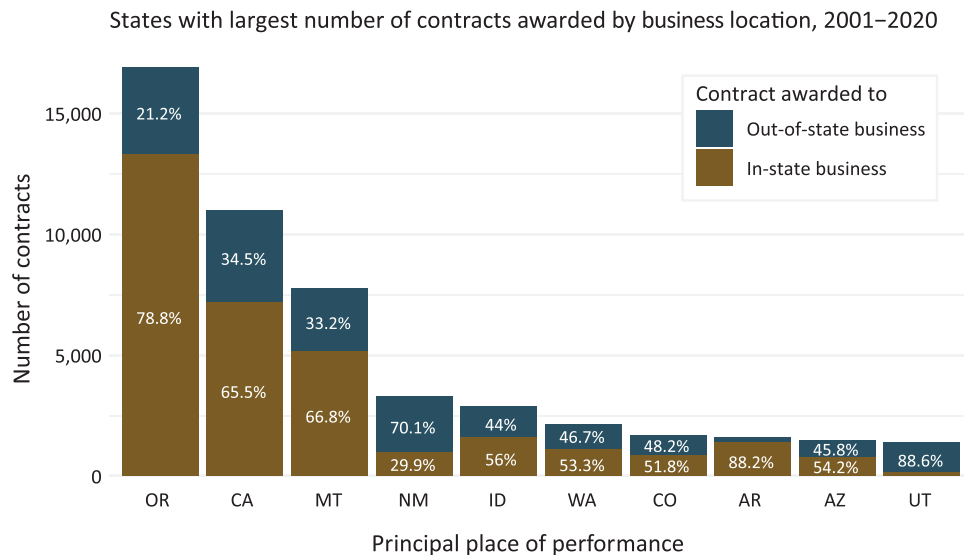
The average distance traveled by businesses to a contract's place of performance was 629 km (standard deviation of 931 km). Over the timeframe of this analysis, average distance traveled increased from 158 km in 2001 to 1,051 km in 2020 (figure 5). When compared across 5 year increments of the study period, the median distance traveled by businesses

**Table 4.** Product or service codes (PSCs) contracted nationally and selected as labor intensive forestry work, 2001–2020.

PSC	Description	Number of contracts	Percent of contracts
F003	Forest-range fire suppression/pre-suppression	36,909	59.8%
F099	Other natural resources/conservation	6,630	10.7%
F018	Other forest/range improvements (non-construction)	6,229	10.1%
F014	Tree thinning services	5,044	8.18%
F005	Forest tree planting services	1,711	2.77%
F006	Land treatment practices	1,602	2.60%
F021	Site preparation	1,593	2.58%
F019	Other wildlife management services	592	<1%
F004	Forest-range fire rehabilitation	533	<1%
F008	Recreation site maintenance (non-construction)	288	<1%
F010	Seedling production-transplanting	209	<1%
F012	Survey line clearing services	52	<1%
F013	Tree breeding services	32	<1%



**Figure 3.** (a) Number of labor-intensive forestry contracts awarded by businesses' registered state of address (b) number of businesses performing labor-intensive forestry work by businesses' registered state of address.



**Figure 4.** States with the largest number of contracts awarded between 2001 and 2020, based on place of performance. Bars are stacked by whether the contract was awarded to businesses with addresses within or outside the state where the work was performed.

increased significantly through time ( $P < 0.001$ ) and differed by business type ( $P < 0.001$ ). When further analyzed using a Dunn's test for multiple comparisons, minority-owned businesses traveled a significantly greater median distance (332 km) than SBSAMO and SBSA businesses (both with median distances of 288 km). However, the median distance traveled by SBSAMO and SBSA businesses were not significantly different.

Businesses located in the Alaska and Eastern USFS regions were also traveling greater distances than businesses in other USFS regions to perform work, with median distances traveled of 1,968 km and 2,729 km, respectively, compared with a median distance of 276.8 km for all businesses in other regions combined. Distance traveled by businesses were significantly different between each region ( $P < 0.001$ ). On further comparison with the Dunn's test for multiple comparisons, distance traveled by businesses located within the Intermountain and Pacific Northwest regions were the only

businesses found to not be traveling significantly different distances from one another ( $P > 0.05$ ).

## Discussion

### Changes in the Labor-Intensive Forestry Contracting Sector

Over the 20 year timeframe studied, over 61,000 contracts for nearly \$13 billion (adjusted to 2020 dollars) were awarded to almost 8,000 different businesses across forty-eight states, Puerto Rico, and the District of Columbia. Two noticeable shifts occurred over our study time frame: an increase in contracting in the forest-range fire suppression/pre-suppression work categories and an increase in total contract dollar values. These changes may be due to several factors. First, shifts in PSC in labor-intensive forestry work contracted by USFS and reported in SAM.gov might reflect changes in the agency's business rules and code definitions rather than an



**Table 5.** Forestry and labor-intensive forestry contracts awarded to in-state businesses, and location quotients for states with the largest number of labor-intensive forestry contracts.

Business state of address	Forestry contracts (#)	Labor-intensive forestry contracts (#)	Location quotient
Oregon	34,413	18,788	2.28
California	32,480	8,541	1.10
Montana	17,155	6,390	1.55
Washington	12,925	4,313	1.39
Idaho	12,709	3,632	1.19
Arkansas	4,475	2,191	2.04
New Mexico	5,122	1,743	1.42
Arizona	8,645	1,701	0.82
District of Columbia	5,515	1,615	1.22
Colorado	10,494	1,210	0.48

**Table 6.** Forestry and labor-intensive forestry contract values awarded to in-state businesses, and location quotients for states with the largest total contract value of labor-intensive forestry contracts.

Business state of address	Forestry contracts (\$)	Labor-intensive forestry contracts (\$)	Location quotient
Oregon	\$3,558,446,849	\$1,215,794,884	2.08
California	\$3,143,141,544	\$687,480,781	1.33
Montana	\$1,696,431,774	\$207,436,991	0.74
Washington	\$1,097,771,157	\$173,484,699	0.96
Idaho	\$975,936,199	\$144,191,699	0.90
Colorado	\$689,791,774	\$115,307,410	1.02
Arizona	\$857,678,213	\$93,545,818	0.66
Missouri	\$656,908,718	\$79,406,980	0.73
New Mexico	\$397,984,314	\$73,601,076	1.12
Arkansas	\$173,872,617	\$72,804,528	2.54

actual change in work. In other words, some of the changes we note in types of work contracted might be associated with how contracts were categorized rather than what work was performed. For example, the PSC description for PSC F003 (fire suppression) was changed in 2010 to include “pre-suppression” in its description, presumably changing what was captured in this code, but we were unable to obtain documentation of the specific changes made, so we cannot track cause and effect. Related to this, since 2017, the number of contracts with PSC F003 (fire suppression/pre-suppression) increased, while contracts with other PSCs, such as tree thinning services (PSC F014), decreased. Decreases in recent years, in states such as Alaska, for labor intensive tree thinning services has been attributed to changes in state labor law and declining availability of crews (Huber-Stearns et al. 2020), which could be the case for other states and regions as well. We also underscore the importance of the need to be able to accurately track wildland fire suppression contracting expenditures, not all of which appear in FPDS data. In light of Congress’ 2018 “fire funding fix,” there is a clear need for more research, and better, separate, tracking of fire suppression and pre-suppression contracts in federal data systems to enable that research in the context of this dilemma.

The dominance of contracting for labor-intensive fire suppression/pre-suppression work indicates the importance of contracting for wildfire mitigation on National Forest System

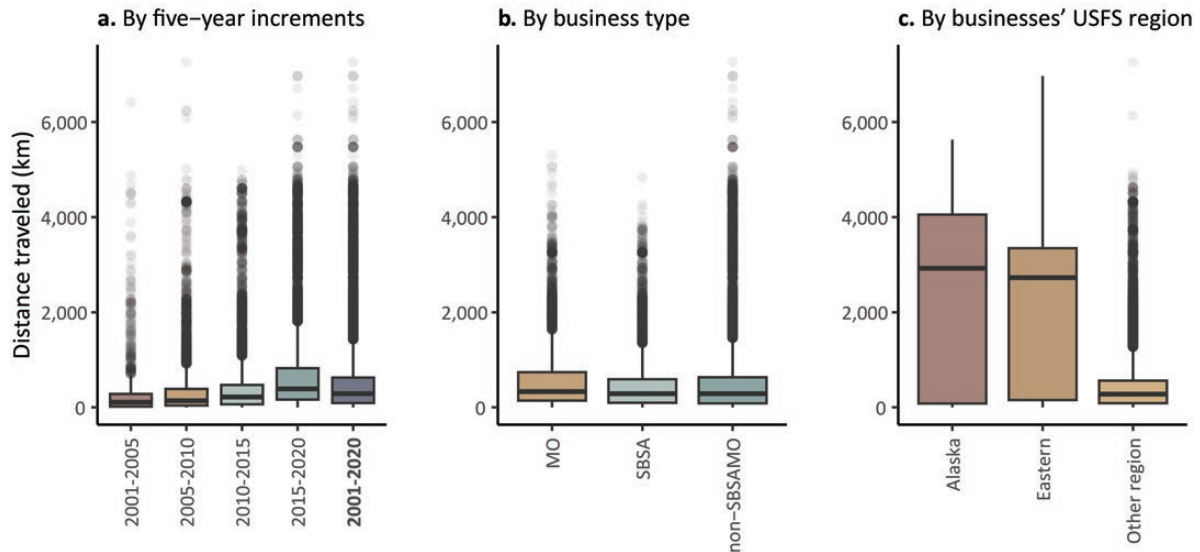
lands. Additional process tracing and qualitative research with USFS personnel could further explore the origins of these changes over time at a depth beyond what is provided in the FPDS contracting database.

### Changes in Business Types and Locations Over Time

Although SBSAMO businesses represented a smaller proportion of the number of awarded contracts than non-SBSAMO businesses, participants in the 8(a) Business Development and HUBZone programs, woman-owned small-businesses, and minority-owned businesses all received larger average contract values than their non-SBSAMO and service-disabled veteran owned business counterparts. The geographic variation in the contracted business types in each state over time did not reveal a clear pattern of business distribution, although businesses were generally located in states with more labor-intensive forest restoration needs, such as the western states of Oregon, California, and Montana, states that were also awarded the largest number of contracts. Oregon was identified in this research as a hub of businesses that leads the nation in contract capture, value of contracts captured, and specialization in labor-intensive forestry work within the forestry contracting sphere.

The dominance of businesses in western states capturing both contract numbers and values is shown by the

## Distance traveled by businesses to place of performance



**Figure 5.** Distribution of distance traveled by businesses to place of performance. Vertical lines represent the median distance traveled. (a) The distance traveled by businesses over five-year increments and all years in the study period. All five-year increments are significantly different from each other ( $P < 0.001$ ). (b) The distance traveled by minority-owned businesses, small-business set-asides, and non-minority-owned businesses and businesses qualifying for small business set-asides (non-SBSAMO) businesses throughout the study period. Distances traveled by business type are significantly different ( $P < 0.001$ ). (c) The distance traveled by businesses located within the Alaska, Eastern, and all other Forest Service regions to place of performance throughout the study period. Distance traveled by businesses located in different USFS regions are significantly different ( $P < 0.001$ ).

predominance of high LQs in these states. Although eight of the ten states with the largest number of contracts had work largely performed by in-state businesses, contracts with a place of performance in New Mexico and Utah were mostly awarded to out-of-state businesses, suggesting lower in-state labor-intensive forestry contracting capacity. Similarly, although Arkansas was also specialized in labor-intensive forestry work as a proportion of all forestry contracts awarded, Arkansas businesses accounted for a low proportion of all contract numbers and values awarded, especially relative to Oregon and California. This shows a disconnect between contract place of performance and the location of businesses awarded contracts for some states. This might have some bearing on where workforce capacity exists for these types of jobs, which can vary by region, state, and other conditions beyond the scope of this study dataset. When looking at distance travelled by USFS region, the two clear points that emerged were that businesses located in the Alaska and Eastern regions were traveling further to do work.

We also note that these patterns described here have not emerged in a vacuum; specifically, states vary in their geographic size, acreage of available forest land for contracting, wildfire risk or other forestry needs, business environments, population size, proximity to major road networks, level of development near forest boundaries, and ecotypes. Although it is outside the scope of this study to draw out these comparisons with this dataset that includes a wide range of labor-intensive forestry work, some of these factors might be drivers underlying these findings. For example, more labor-intensive forestry businesses might choose to base themselves in areas with higher wildfire risk or need for large-scale crew work. Understanding such business motivations could be better explored through future qualitative exploratory research. In addition, exploratory research to try to identify the broader

potential population of federal and state contractors with labor-intensive forestry crews could help shed light on where and how businesses are contracting in this labor force, and why.

## Influences and Potential Impacts on Businesses and Forest Workers

New funding through the Bipartisan Infrastructure Law (H.R. 3684, 117<sup>th</sup> Congress 2021) and strategic plans such as the Wildfire Crisis Strategy (USDA Forest Service 2022) may drive increased interest in understanding workforce capacity, retention, and working conditions in labor-intensive forestry work, as this workforce will likely be relied on to meet treatment goals set by the USFS. As the largest average contract values were awarded to SBSAMO businesses during our study period, our research demonstrates they are an important component of how this work is being accomplished across the nation.

Work in restoration and wildfire risk reduction on federal lands contracted out to private businesses has the potential to partially offset employment losses from declining jobs in timber and logging while also contributing to wildfire risk reduction for human communities (He et al. 2021; Spies et al. 2019), although the comparability of job quality or wages between the timber industry and labor-intensive forestry work varies. This labor-intensive work is frequently performed by marginalized populations—including immigrants and, increasingly in some areas, guest workers on temporary work visas. Thus, the distribution of USFS contracting dollars has the potential to affect both income and equity of places and people, depending on the recipient business type and location. These potential impacts on both forest workers and emerging minority-owned businesses are areas of research that warrant further investigation, particularly at a time when the nation

is poised to invest hundreds of millions of dollars in federal land wildfire risk reduction activities, much of which is labor intensive. Challenges in the bidding structure for these contracting jobs raises questions about the influence that the bidding structure for projects has on worker retention and job quality (Mosely and McDaniel 2006; Moseley and Stone 2007; Moseley and Reyes 2008).

Labor-intensive forestry is a key component of the new natural resource economy, which has been proposed as a way to innovate new forms of employment in many rural communities (Hibbard and Lurie 2013). However, our results show that the work is not evenly distributed across space, with some places potentially benefitting more from contract capture than others, given the location of businesses performing this work. Many states were reliant on out-of-state businesses to perform labor-intensive forestry work occurring within their boundaries, and businesses traveled increasingly further distances to perform this work through time. This may also pose further equity issues, given minority-owned businesses were found to travel greater distances and previous research documenting that those workers performing labor-intensive forestry work, especially Latino/a/x workers, are unlikely to be paid for travel time (Moseley and Shankle 2001; Moseley et al., 2014). Due to the growing need and funding for restoration work on National Forest System lands, changes in mobility and other aspects of job quality could have implications for worker retention.

## Conclusion

This article documents the labor-intensive forestry contracting sector in the United States between 2001 and 2020, an era of increasing investment in forest restoration and wildfire risk reduction. Despite limits in data availability and extent, our study offers new perspectives on this sector through insights into trends in work activities, business types, and places of performance. We found that this sector was generally growing in its focus on wildfire-related activities (both response and mitigation), as well as in its size as measured by number of contracts and businesses. It was also a sector with varied connections to local communities, as businesses traveled greater distances to perform contracted work, not all work was captured by in-state businesses, and in some states, most work was performed by out-of-state businesses. Continued research will be necessary to further explore the interconnections of these businesses with both local community economic outcomes and the diverse workforce that sustains this important work. Understanding how different communities and businesses have structured themselves to capture these contract dollars and recruit and retain workers is essential to help identify other places that may be able to benefit from this work and ways in which marginalized populations may be better able to engage with these opportunities. In particular, these factors affect worker safety and working conditions (e.g., low bid contracting awards disincentive stable, family-wage, jobs with benefits). In addition, future research building off this nationwide view of contracting can further explore how labor-intensive forestry contracts can contribute significantly to local entrepreneurial opportunities and economic development in the new forest economy. Finally, although it was impossible to disentangle fire suppression product service code changes and documentation of suppression spending changes, our

results raise questions about whether and how tracking the effectiveness of the fire funding fix might be accomplished through changes in types of forestry-related contracting records.

## Supplementary Materials

Supplementary data are available at *Journal of Forestry* online.

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## Conflict of Interest

The authors have no conflict of interest to declare.

## Data Availability

The data underlying this article are available in the Dryad Digital Repository at <https://doi.org/10.25338/B8GS95>.

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