The "Efficiency Concern": Exploring Wildfire Risk on Heirs' Property in Macon-Bibb County, Georgia, United States of America

Amanda Aragón
Center for Geospatial Research, University of Georgia
Athens, Georgia, United States

Cassandra Johnson Gaither[1]
USDA Forest Service—Southern Research Station
Athens, Georgia, United States

Marguerite Madden
Center for Geospatial Research, University of Georgia
Athens, Georgia, United States

Scott Goodrick
USDA Forest Service—Southern Research Station
Athens, Georgia, United States

Abstract

There is heightened interest in heirs' property research, as a burgeoning social science literature and recent popular press articles have drawn attention to the inequities of this insecure type of property ownership. Economists and legal scholars charge that heirs' property ownership inhibits the ability of owners to efficiently manage property. We developed a novel methodology combining LiDAR techniques, GIS mapping, and Fuel Characteristic Classification System data to compare vegetative understory accumulation and wildfire risk for heirs' and non-heirs' parcels in rural Macon-Bibb County, Georgia, United States. Paired samples t-test of LiDAR-detected understory amounts indicated no significant differences for heirs' and adjacent non-heirs' parcels. However, surface-level wildfire spread more rapidly on heirs' parcels, but heirs' parcels had significantly less available fuel. Identification of wildfire risk for heirs' property owners can help public land managers better understand wildfire risks for this type of socially vulnerable real property owners.

Keywords: heirs' property, land parcels, LiDAR, US South, wildfire risk

1 Corresponding author: cassandra.johnson@usda.gov

1. Introduction

This study considers potential inefficiencies associated with heirs' property, in terms of potential wildfire risk, in Macon-Bibb County in Georgia, a state in the southern United States (US). A tenancy in common or "heirs' property" describes inherited, real property, passed to subsequent generations via US state laws of intestate succession (Chandler, 2005; Emergency Land Fund, 1980; Mitchell, 2001, 2005). Property is usually classed as "heirs'" because someone dies without a will or other legal document formally conveying property to survivors. The joint co-heirs of these properties come to own fractional shares of the whole property. The lack of formal title stymies families' ability to generate wealth and then to transfer that wealth intergenerationally because heirs' property usually cannot be used as a financial leverage. Only rarely do creditors accept heirs' property as collateral for loans, for example. As well, heirs' property disqualifies owners from participating in various land improvement programs offered by state or federal governments, and can inhibit owners' ability to sell resources such as timber (Bailey et al., 2019). Heirs' property presents these difficulties because the titles are considered "clouded" or "unclear," arising from uncertainties about the identity of the many co-heirs who have fractional interests in and rights to property. For instance, the names of most living family members are not included on these property titles, only the names of deceased family members; this fact distinguishes heirs' property from "clear" or "marketable," outright ownership where property owners are explicitly named on property titles. These extended family members are in effect "undocumented" owners, and therein lies the messiness of this form of tenure.

Our study contributes to the heirs' property literature by considering the impact of heirs' property ownership and management on fuel loadings or understory accumulation on rural land. While it is clear that heirs' property owners have great difficulty in using these properties for financial purposes, it is less certain whether such co-ownership results in inefficient land management; in particular, inefficiencies that present in the form of excessive understory, resulting in increased wildfire risk. Our research is inspired by Deaton et al.'s (2009) qualitative research in the US state of Kentucky, which found that members of an heirs' property–owning family were constrained in their ability to reduce understory on their woodlands because family members could not reach consensus on whether to dissolve the heirship. We also base this inquiry on input from two professional foresters who, when asked if fuel loadings on heirs' property are greater than loadings on non-heirs' parcels, responded that the question merits empirical investigation (C. Bailey, South Carolina Forestry Commission, personal communication, December, 2016; S. Cook, North Carolina State University, personal communication, October, 2016). We are not aware of other studies that have examined this question.

Heirs' property ownership is especially prevalent among African Americans in the rural Black Belt South[2] (Craig-Taylor, 2000; Dyer et al., 2009; Johnson Gaither, 2016; Mitchell, 2005; Schelhas et al., 2017). In 1980, the Emergency Land Fund estimated that 41% of black-owned land in the South was heirs' property (Emergency Land Fund, 1980). These properties also appear to be pervasive in the mostly white, central Appalachian region of the US South (Deaton, 2007, 2012); they exist on Native American lands as a result of US government–instituted allotments (Bobroff, 2001); and are likely prevalent in Texas *colonias* along the US–Mexico border (Way, 2010). Members of each of these groups is more likely to be socially disadvantaged. Indeed, the spatial aggregation of such properties is cited as a primary factor contributing to persistent poverty in Appalachia and as a contributor to the generations-long wealth gap between African Americans and whites more generally (Deaton et al., 2009).

This kind of property ownership in the US is analogous to that described by de Soto (2000), who coined the term "dead capital" to reference real property in the developing world—assets that cannot be used to generate capital due to uncertain ownership and lack of written documentation. Consistent with de Soto (2000) and others' argument for secure property rights, Deaton et al. (2009) and Deaton (2012) raise the "efficiency" concern regarding heirs' property ownership. A basic tenet of heirs' property ownership is that co-heirs have the right to access and use property (similar to common property regimes); but also that any co-heir has the right to *exclude* activities of other co-heirs, which results, Deaton (2012) and Deaton et al. (2009) argue, in inefficient or less-than-optimal land uses from the perspective of maximizing revenue and quality of resources. They argue that such inefficiency may contribute to elevated risks for a variety of environmental threats, including wildfire.

We do not attempt to quantify via economic analysis efficiencies associated with excessive understory accumulation on heirs' and non-heirs' properties. Rather, we draw conceptually on the "right to exclude" stipulation of heirs' property ownership: any heir, no matter the size of her or his fractional ownership, can prevent any use of the property that requires all co-heirs to agree. In such scenarios, inefficiencies result because all co-heirs are made worse off (e.g., in economic or environmental terms) due to the obstinacy of a single owner or sub-group of owners. Heirs' property extent is difficult to assess because of the lack of record-keeping or uniform methods of identifying these properties (Pippin et al., 2017). However, county taxing

2 The Black Belt South covers a geographical subregion of the US South, from Virginia southward through the Carolinas and into east Texas (Wimberly & Morris, 1997). One of the first noted figures to describe the region this way was Booker T. Washington at the turn of the twentieth century, where he used it to refer to the region's abundant, black soil. The meaning of "Black Belt" has changed over time, such that it is now synonymous with southern (especially rural) counties with African American populations equal to or higher than the national average.

authorities sometimes include notations[3] in their land parcel records that can be used to make conservative estimates. Using these indicators, we identified roughly 238,000 heirs' parcels across 13 states in the US South, containing 1.42 million hectares (3.5 million acres) of land, with an assessed value of $28 billion.

1.1. Approach

The following sections review the heirs' property literature, as it relates to land management efficiency. This is followed by a non-exhaustive review of landowners' views and practices of wildfire risk mitigation. Next, we present the methodology for this project, where we first use remotely sensed data to assess understory vegetation for non-industrial, private heirs' properties and non-industrial, private, non-heirs' properties. Also relevant for this analysis of wildfire risk is understory composition; that is, the type of vegetation typical for the study area. To do this, we use the US Department of Agriculture Forest Service's Forest Characteristics Classification System to describe fuelbeds common across Macon-Bibb County. Combined, these two assessments indicate both the quantity and quality of fuel or understory and how these may vary depending on heirs' property status.

2. Literature review

2.1. The efficiency problem

The familiar tragedy of the commons situation occurs when multiple users of a common resource have the right to use that resource but do not have the right to exclude others from using the same. Consequently, the resource is overused and degrades to the point where net returns to users are zero. Heller (1998), Buchanan and Yoon (2000), Deaton (2007), and Deaton et al. (2009) characterize a sort of mirror image of commons inefficiency, what they describe as the "anticommons" problem, which exists when co-owners exercise their exclusionary right.[4] In the case of heirs' property ownership, a co-heir can exclude other co-heirs' use of the property by an outright refusal to consent to an activity; or a co-heir can set his or her "price" for participation (i.e., the transaction cost) prohibitively high, such that the proposed action is not carried out (Fennell, 2011). This may not involve

3 These estimates are from an analysis of Digital Maps Products and CoreLogic data for tax years 2016–2017. CoreLogic used the notations "heirs' of," "et al.," "estate of," "deceased," and indicators of multiple or fractional ownership (e.g., ½ interest, 33% interest) to identify heirs' parcels. The validity of such notations in the identification of heirs' parcels was discussed with attorneys with the Georgia Heirs' Property Law Center, with county-level taxing authorities in Leslie County, Kentucky; Maverick County, Texas; and Macon-Bibb County, Georgia. Each of these sources confirmed our use of at least one of these descriptors to identify heirs' properties.

4 Chang (2012) makes this argument conditional, asserting that tenancies in common are "tragic" (as per "tragedy of the commons") *only* in cases when property is not optimized due to co-owners' inability to exit the tenancy at will.

monetary costs alone but also the time and energy to convince other co-heirs of the benefits of a proposed project. Non-agreement by co-heirs that hold out and high transaction costs reduce the benefits that might otherwise be realized for all co-heirs (e.g., wildfire risk reduction).

Generally, timber management activities such as thinning are not a priority for non-industrial, private forestland owners in the southeastern US, even for landowners with clear title. But, not surprisingly, larger, industrial landowners invest more in management activities than do smaller, non-industrial, private landowners (Arano & Munn, 2006). Still, Deaton et al.'s (2009) case study of two central Appalachian counties in Kentucky offers insight into the underutilization dilemma faced by heirs' property owners. In the case of the "Jones" family, very little was done to improve or manage the property for 24 years following the death of the family patriarch. One family member commented that the lack of timber harvesting on the property had resulted in excessive accumulation of understory, which he believed detracted from the overall quality of the mature trees.[5]

Underscoring Deaton's Appalachian findings is Baba et al.'s (2018) analysis of African American heirs' and non-heirs' property landowners in Alabama, which found that heirs' property owners were less likely than owners with clear title to engage in long-term land management planning. However, Walters (2012) did not find that "family land" (analogous to heirs' property) in Saint Lucia, West Indies, differed significantly from other land tenure regimes in terms of apparent conservation; but Ojanen et al.'s (2017) comprehensive review of 103 studies from 1990 to 2014 addressing environmental impacts of various property rights regimes (e.g., state, private, community, mixed, open-access—access and harvesting rights open to all) found that open-access property regimes were less favorable than any other system. Specific to forest operations, comparisons between private and state land management showed that in five of six cases, privately owned properties had better outcomes.

2.2. Wildfire risk in the US South

Wildfire risk is important to consider for the southern US because wildfire occurrence is consequential in the region—the South leads the nation in terms of annual number of wildfires (Andreu & Hermansen-Báez, 2008). Roughly 423,000 wildfires were recorded in the South Atlantic, East South Central, and West South Central between 2002 and 2013, which accounted for 48.9% of all wildfires in the US during the period (Brusentsev & Vroman, 2016). These fires consumed 6,236 hectares (15,410 acres) (Brusentsev & Vroman, 2016).

5 Under certain circumstances, land that is left to regenerate naturally may improve ecologically, and this may be true for heirs' properties in some cases. However, it is also true that some intervention is necessary to maintain the integrity of the land. Because of inattention to the land by absent or disincentivized co-heirs, the land could be ravaged by invasive plant or animal species that hinder more desirable species (Barlow & Bailey, 2017).

Important to these calculations is that roughly 86% of forestland in the South is owned by non-industrial, private landowners. Wildfire mitigation efforts by this segment of forestland owners is an important consideration in wildfire risk reduction, which is crucial to efforts such as the Keeping Forests as Forests (KFAF) initiative, a forest conservation project across the 13 states of the South. Long-term, private forestland ownership and management are key KFAF goals, which necessarily include the identification of socioecological risks for forestlands, with perhaps special efforts needed to identify elevated risks for minority and/or lower-wealth, underserved rural landowners such as heirs' property owners (Bailey et al., 2019; Collins, 2005; Goyke et al., 2019; Johnson Gaither et al., 2011; Schelhas et al., 2016). Fischer (2011, p. 260) underscores this need: "Understanding factors in private forest owners' decisions to reduce hazardous fuels is … important. The practices of non-industrial private or family forest owners are of particular interest because of the location and extent of their lands." We would add that the high proportion of private land ownership in the South compels more strongly the need to evaluate private landowner risks in this part of the country, particularly risks for lower-wealth and underserved populations.

An extensive literature on attitudes regarding non-industrial, private landowner wildfire mitigation has developed in recent years. McCaffrey's (2015) review of the literature on the social acceptability of fuel management and, more generally, people's attitudes during and after wildland fires found four main factors influenced landowner engagement with mitigation: (1) social context of mitigation, (2) trade-offs with alternative amenity values, such as aesthetics and or wildlife habitat, (3) apparent effectiveness of actions, and (4) ability to implement specific activities. The opportunity to receive payments from bioenergy feedstock has also been reported as an incentive for thinning overstocked forest stands (which could include understory reduction). However, Gan et al. (2013) report on the difficulty of engaging landowners in the task—there were more than 2 trillion kg (2,226 million dry tons) of biomass on the ground across the 13 states of the South in 2013, but fewer than 10% of private landowners surveyed indicated they could be induced to reduce fuel loadings even if given technical assistance, the ability to sell biomass, or the chance to participate in government cost-share programs.

Further, Schelhas et al.'s (2016) qualitative study (n = 60) of African American property owners in selected Alabama, North Carolina, and South Carolina counties indicated that only about 13% had conducted a prescribed burn. And while about 52% had thinned or harvested timber, it is not clear whether the reference here is to timber harvesting primarily for revenues or whether landowners consciously thinned to reduce wildfire risk. Half of these landowners had heirs' property, but there was no comparison of mitigation activities for heirs' and non-heirs' owners. Research also indicates that landowners who live on their land are more likely to implement wildfire mitigation practices (Fischer, 2011). This is instructive for understanding heirs' property owners' participation in fuel reductions, as some research indicates that absentee ownership is indicative of heirs' status (Dyer et al., 2009; Georgia Appleseed Center for Law & Justice, 2013).

3. Methodology

3.1. Heirs' property estimation

We selected Macon-Bibb County as our study area because at 32.7866° N, 83.7199° W, the county is situated in the northernmost area of Georgia's Upper Coastal Plain, an area of the state with high wildfire risk. The county covers a total land area of 646.87 km^2 (249.76 $miles^2$). Also, we were able to obtain Computer Assisted Mass Appraisal data sets for Macon-Bibb County, with heirs' parcels clearly indicated for the county for the tax year 2016 (Pippin et al., 2017). Parcels identified as heirs' (those with the notation "HEIRS OF" next to the owners name in the tax records) are based on information held by local tax officials about landowners and the intestate transferal of these properties. We verified with the Macon-Bibb County tax assessor's office (see footnote 3) that the notation "HEIRS OF" denotes jointly held, private property. The term "et al." is also used in Macon-Bibb County, but these parcels were not included in our analyses because we did not discuss this specific notation with the county taxing official.

3.2. Understory density estimation

Understory accumulation was estimated using remotely sensed light detection and ranging (LiDAR) techniques, which use an active sensor, often mounted on an airplane, to send narrow bands of light in the form of laser pulses to the ground (Renslow, 2012). Pulses are reflected off objects and surfaces of the earth and, much like radar, the distances to objects are calculated based on the timing of the returned pulse to the sensor. The resulting LiDAR data are processed as three-dimensional points, referred to as 3D point clouds, that locate or identify solid objects on the earth's surface. In our case, we wanted to identify vegetative understory in the 1- to 6-meter height range (Figure 1). We used 2011–2012 LiDAR data downloaded from the National Oceanic and Atmospheric Administration by the Georgia Department of Natural Resources and the Environmental Protection Division of Georgia (OCM Partners, 2019).

Using ArcMap 10.3, LiDAR point clouds detecting understory were converted to a raster layer, aggregated at 1 m^2 resolution. Raster data are GIS-specific information in the form of pixels, organized into rows and columns that form cells comprising a grid or matrix. Each cell contains information; in our case this was number of point clouds. Vegetation density for each 1 m^2 pixel was calculated by dividing the number of LiDAR points within a given pixel by the total number of points for the entire parcel, resulting in proportional values of understory for each pixel, for each parcel. These proportions were reclassified into three classes using natural breaks of low, medium, and high, coded 1, 2, and 3, respectively.

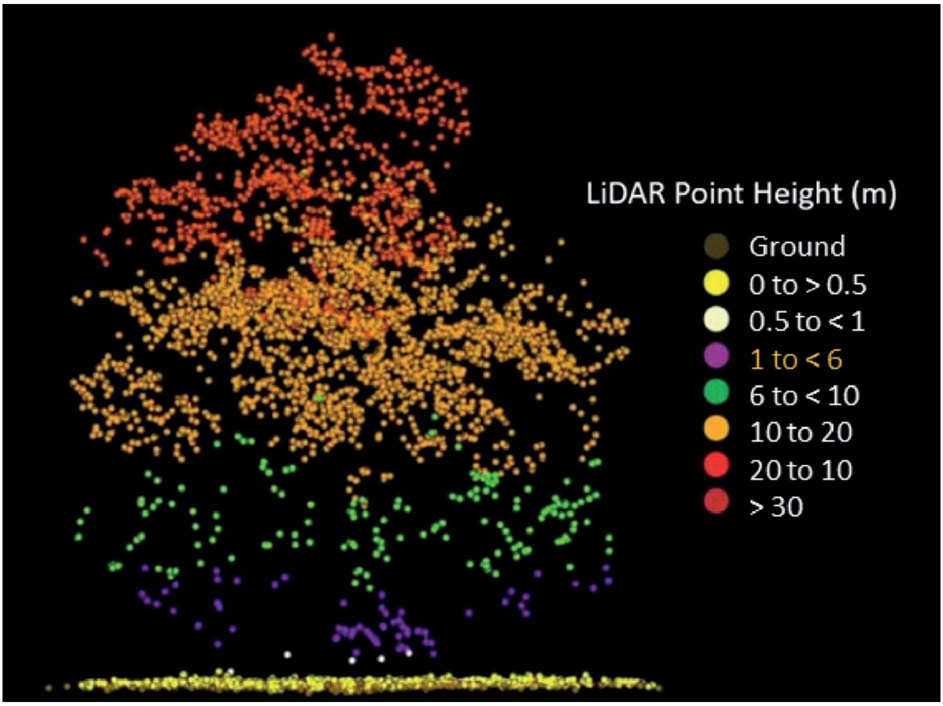

Figure 1. Illustration of 3D LiDAR point cloud displaying light pulses from ground to 30-meter height

Note. This study estimated number of pulses in 1- to 6-meter layer (understory).

For classification purposes, heirs' parcels were assigned a value of 10 and non-heirs' a value of 20. Both types of parcel data were then converted to a raster layer so that the understory and parcel values could be combined. For example, after the attributes of the two raster layers were added, pixels located in an heirs' parcel (HP) were assigned values of 11, 12, or 13, indicating low (11), medium (12), and high (13) vegetation density, respectively; and pixels in a non-heirs' parcel (NHP) were assigned the values of 21, 22, or 23, indicating the same low to high density.

We then compared the proportion of low, medium, and high-density vegetation for HP and NHP. Comparisons were made for heirs' property "neighborhoods," which consisted of an HP and adjacent NHP within a 250-meter buffer of the HP perimeter. For each HP neighborhood, the respective proportions of high, medium, and low vegetation density pixels for both the HP and adjacent, aggregated NHPs in that neighborhood cluster were calculated.

We also used Google Earth to visually inspect each neighborhood to help ensure that land cover for HPs and NHPs were similar. As stated, only non-industrial, private landowners were included in the analysis. The visual inspection allowed for further refinement of the data by identifying properties that had different cover and uses. In 15 cases, HP with forest cover was adjacent to large, private agricultural operations with little or no forest cover. These HP neighborhoods were excluded from the analyses.

3.3. Fuel characteristic classification system (FCCS)

The FCCS organizes and categorizes fuelbeds (measured or averaged physical fuel characteristics depicting a particular fire environment) to assess potential fire behavior (Ottmar et al., 2007; Riccardi et al., 2007). FCCS stratifies fuelbeds into six major types: canopy, shrubs, nonwoody vegetation, woody vegetation, litter–lichen–moss, and ground fuels (also duff) (Ottmar et al., 2007).

To classify fuels (understory), we utilized a 30-meter resolution geospatial data layer of FCCS fuelbeds developed as part of the Landscape Fire and Resource Management Planning Tools program, LANDFIRE (Rollins & Frame, 2006), based on Landsat satellite imagery. Data for each parcel in Macon-Bibb County was extracted (www.landfire.org). Forty distinct fuelbeds were identified for Macon-Bibb County, which included loblolly pine and slash pine plantation; longleaf pine, three-awned grass, and pitcher plant savanna; pond pine, gallberry, and fetterbush shrubland; smooth cordgrass and black needlerush grassland; and red maple, oak, hickory, and sweetgum forest.

Fuelbed data are input into fire behavior models to predict fire potentials—surface fire behavior, crown fire potential, and available fuel potential (Riccardi et al., 2007; Sandberg et al., 2007). Each dimension of fire potential can be broken down into component parts. *Surface fire behavior potential* consists of surface reaction, spread, and flame length (Sandberg et al., 2007). *Crown fire potential* ranks the potential for surface fire to move into the canopy—it comprises crown initiation, transmissivity, and spread. *Available fuel potential* is an estimate of combustible biomass, assuming extremely dry conditions, which consists of flame, smolder, and residual components (Goodrick & Stanturf, 2012; Sandberg et al., 2007). Each subcomponent is measured on a scale of 0 to 9. With the exception of surface reaction and surface spread,[6] the measures are to be understood as potentials only and hence defined as unitless measures.

6 Surface reaction is measured in kilowatts per square meter (kW/m^2). Surface spread is measured in meters per minute (m/min).

We calculated mean parcel scores for each of the nine measures using the zonal statistics tool in ArcMap 10.3. Mean scores were computed for each HP and its adjacent, aggregated NHP neighbors. Because of overlap between neighborhoods, analyses were restricted to only those neighborhoods that did not intersect with others. This reduced the sample size to 34.

4. Results

4.1. Heirs' parcel distribution

The total number of HPs in our study area was 820, roughly 1% of the 69,369 Macon-Bibb County taxed parcels for 2016. Similar to the findings in Dyer et al. (2009), we found a greater concentration of heirs' parcels (n = 618, 75.4%) in the larger, incorporated area of the county, in the city of Macon. However, for our study, we analyzed properties outside of incorporated areas only, as we expect that any significant amount of fuel accumulations would occur outside of cities and subdivisions. Total land area in unincorporated parts of the county is 419.58 km^2. There were 113 HPs in unincorporated areas of the county, but 15 of these were excluded from the analyses because of insufficient forestland cover.

4.2. Understory density of heirs' and non-heirs' parcels

Mean low, medium, and high-density understory vegetation for HPs and NHPs were compared using a paired samples t-test. The analysis failed to find a significant difference between HP and NHP for any level of vegetation density (Table 1).

Table 1. Mean percent vegetation density of heirs' and non-heirs' parcels in Macon-Bibb County, Georgia

	Mean vegetation density (%)		
	Low	Medium	High
Heir	72.67 (17.78)	21.53 (14.72)	5.80 (4.37)
range	0.01–93.90	4.95–84.10	0.31–17.02
Non-heir	73.43 (13.21)	20.68 (9.65)	5.89 (3.99)
range	39.44–100	0–40.77	0–19.79
p value	Not significant	Not significant	Not significant

Note. n = 34. Standard deviation is in parentheses.

4.3. FCCS fire potentials

Scores for the nine fire potential subcomponents of surface, crown, and available fuels are presented in Table 2. For all three surface measures, there is a pattern of slightly higher scores for HPs for each subcomponent, although the paired samples t-test indicated that HPs were significantly higher for surface spread only. Given the low sample size, we chose a significance level of $p = 0.10$. There were also significant differences for available smolder and available residual, but in both cases NHPs had higher scores.

Table 2. Mean fire potential estimates based on fire characteristic classification systems for Macon-Bibb County, Georgia

	Land parcels	
	Heir	**Non-heir**
Surface reaction p = not significant	2.82 (0.98)	2.66 (0.61)
range	0.71–5.96	0.77–3.70
Surface spread $p = 0.07$	4.66 (1.81)	4.02 (0.88)
range	1.56–9.00	1.73–9.00
Surface flame length p = not significant	2.61 (0.77)	2.41 (0.46)
range	0.75–4.22	0.79–3.17
Crown initiation p = not significant	0.56 (0.72)	0.60 (0.29)
range	0–2.77	0.10–1.29
Crown transmissivity p = not significant	1.39 (1.88)	1.42 (0.85)
range	0–9.00	0.28–3.60
Crown spread p = not significant	0.52 (0.69)	0.54 (0.27)
range	0–3.21	0.10–1.25
Available flame p = not significant	0.43 (0.28)	0.49 (0.14)
range	0.01–1.40	0.11–0.74
Available smolder $p = 0.03$	0.32 (0.29)	0.40 (0.22)
range	0–1.05	0.12–0.84
Available residual $p = 0.01$	0.16 (0.16)	0.24 (0.15)
range	0–0.59	0.07–0.61

Note. $n = 34$. Standard deviation is in parentheses.

5. Discussion and conclusion

This exploratory analysis of wildfire risk for heirs' properties is the first attempt of which we are aware that examines this association. Although most indicators of potential wildfire risk were not significantly different for heirs' and non-heirs' parcels, one measure—surface spread—could be distinguished by tenure. And this particular indicator, because it is an actual physical measurement of surface-level wildfire risk, is fundamental to overall wildfire risk. The other potential risks (crown behavior and available fuel) could not occur without surface fire. Still, our findings are limited to just one county, so the question of how heirs' property ownership impacts environmental risk remains.

Again, while heirs' property is bona fide private property (as opposed to open or common property), heirs' property also contains elements of common property ownership—and herein lies the potential for inefficiency, or what Heller (1998) refers to as the "tragedy of the anticommons." Fennell (2011, pp. 10–11) argues that an anticommons problem (such as heirs' property ownership) is one of *assembly*—for example, gaining permission from co-heirs to conduct an activity such as hazardous-fuels reduction on family land on which none of the co-heirs currently lives. Fennell (2011, p. 10) makes the point that in any anticommons scenario "the worry is the same: that a value-enhancing assembly—one that could leave every party better off than the status quo—will fail to occur as a result of strategic holdout behavior and other transaction costs." Related, we have had numerous discussions with attorneys with the Georgia Heirs' Property Law Center who relay that one of the biggest challenges in resolving heirs' property ownership cases is identifying legitimate heirs—that is, collecting defensible information about who the actual heirs are. Heirs' property resolutions begin with the creation of family trees that help to clarify how co-heirs are related. This task can be difficult because in many cases co-heirs may not even know one another.

In the present case, understory clearing is probably non-controversial. But while the benefits of understory clearing may be uncontested by co-heirs, implementation can be inhibited in cases where funds are needed to accomplish this task—for instance, corralling co-heirs—who, even where familiarity and co-ownership can be established, may be dispersed across the country or the globe—to assume a loan to hire a crew for the work, or convincing them of the need to pay for specialized equipment or chemicals used for thinning. Non-monetary costs such as attending meetings to get information about publicly funded cost-sharing agreements can also prevent the assemblage needed to move forward on environmental risk reduction activities.

Fortunately, for heirs' property owners, the inertia of co-owned property management can be overcome by the dissolution of the tenancy in common, as any heir may petition a court for partition of the heirship. The dissolution may be done in a way that provides unambiguous ownership of physical portions of the property, called a "partition in kind." In such cases, each co-heir receives a separate title to a portion of the property, which resolves the problem of fractional ownership interests. Land partitioning in this manner is supported by African American and other land rights advocates who argue that individual co-owners can then use their "clear" property titles as leverage for wealth building. Also, for historically disenfranchised groups such as African Americans, this solution helps to stabilize land losses by keeping land within black family networks.

However, Heller (1998, 2008) argues that physical partition can result in land being divided into very small parcels,[7] or what Heller (1998, p. 77) refers to as "big inch" parcels that render land useless from both an economic and ecological perspective. So, while a court-ordered physical division of heirs' property may solve the assembly problem in social terms, these divisions could produce an ecological disassembly with negative consequences for longer-term environmental sustainability. Haines et al.'s (2011) findings from the US state of Wisconsin lend support to this caution. That research compared changes in forestland for land that was divided into smaller parcels and land that was not divided. Results showed that forest parcelization leads to fragmentation, which makes it more difficult and expensive to harvest timber, for example. Also, additional landowners may have conflicting land management goals that thwart goals of optimal ecosystem management.

Since Heller's (1998, 2008) writing, changes have been made by the US Uniform Law Commission to address heirs' property partitions in a way that reinforces family members' ability to both clear heirs' property titles and retain land *intact*. This is codified in the 2010 Uniform Partition of Heirs Property Act.[8] An important stipulation allows family members who do not want to partition the property to purchase the interest of family members who do. This helps families to assemble the disparate shares while changing the quasi-common property regime (the classification applicable to heirs' property) to a legal form with clear, unambiguous title—still held by the family. This increases the chances that the value of long-held family land can be increased both in economic and ecological terms.

Fennel (2011, p. 10) notes that anticommons scenarios do not always result in inefficient outcomes. Landowners in general do not adhere to strict and distinct actions regarding the stewardship of their lands (Walters, 2012). Even if land is

7 Haines et al. (2011) clarifies the distinction between land "parcelization" and "fragmentation." The former involves the legal process of subdividing land, and the latter is specific to ecological outcomes, which can result in diminished ecosystem services.

8 www.uniformlaws.org/committees/community-home?CommunityKey=50724584-e808-4255-bc5d-8ea4e588371d

collectively held, for instance, in some seasons or cases, a more individualistic approach is applied to land activities, but in other cases, decisions may be made by the wider collective of extended kin. Indeed, the heirs' property phenomenon and its impact on risk reduction is too complex an issue to be restricted to the simple question of whether a property is classified as heirs'. For instance, Dyer and Bailey (2008) and Schelhas et al. (2017) highlight the multilayered meanings and ad hoc caretaking of heirs' property by family and concerned others that, while not systematic, can result in efficient land management for some properties. Relevant to this study is that wildfire risk may be reduced for heirs' parcels in instances when family members live on the property, as indicated by Fischer (2011). For roughly 58% of our sample, the physical location of the heirs' parcel was the same as the mailing address for the owner, indicating that at least one heir lived on the property; and 20% had an out-of-state mailing address for the owner, which indicates that the remaining 22% of these property owners may live relatively close to these properties. It may be that on-site residence (although we do not know how this rate compares to NHP owners) and the relatively high percentage of in-state heirs' property owners in Macon-Bibb County effectively reduce understory accumulation, compared to situations where fewer owners are living on the property or in-state.

There is no commonly understood and practiced response to the maintenance of heirs' property in the US because no statutory or customary tradition informs either its physical or financial upkeep. As a result, co-heirs' efforts to mitigate natural disaster may be situational, varying greatly by factors such as internal family relations and attachment to the land among family members.

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