

# Characterizing Large Airtanker Use in United States Fire Management

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**Abstract**—The appropriate role of large airtankers (LATs) in federal fire suppression in the United States has been the source of much debate and discussion in recent years as the U.S. Forest Service (USFS) has faced impending decisions about how best to address an aging fleet of contracted aircraft. Questions of fleet efficiency are complicated by inadequacies in historical data on airtanker use. A need for improved data collection systems for LATs was a key recommendation to come from a 2013 U.S. Government Accountability Office (GAO) investigation into actions made by the USFS and the U.S. Department of Interior (DOI) regarding fleet modernization. Our research has also identified deficiencies in data collection regarding LAT use in federal fire suppression, particularly with respect to capturing the objectives and outcomes of individual retardant drops. Using spatially-explicit drop location data from 2010 and 2011 for the conterminous U.S., we linked retardant drops to fire occurrence and resource ordering records to identify whether LATs were used during initial attack (IA), and if so, whether or not the fire was contained at the IA phase. Our analysis showed that despite federal policy stating that the priority for use is on IA, 43% of drops from 2010 and 2011 occurred during extended attack (EA) operations. In addition, containment rates of fires associated with LAT use are low; 75% of all IA drops were on fires that escaped IA containment efforts. We expand on this by incorporating drop data from 2012. Further, in order to qualify where and when drops occur, we explicitly characterize the conditions of use for all drops, particularly with respect to terrain, fuels, time of day, weather, and proximity to identified values at risk and areas of restricted retardant use. Preliminary results suggest that approximately 35% of drops occurred in late afternoon (1500–1800 hours) and over 30% of all drops intersect with timber fuel models from the LANDFIRE dataset. Here we will elaborate on these results and discuss the potential implications related to the use of LATs in fire management operations.

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## Introduction

Large airtankers (LATs) are the highest profile fire suppression tool available to fire managers in the United States. These aircraft are ingrained in the public perception of effective fire suppression, due in part to the publicity and visibility of airtankers involved in suppression operations of wildland-urban-interface fires. In spite of this public sentiment, many unknowns remain regarding the specific conditions of LAT use (for example, what fires received drops, drop locations, and how much retardant per drop) and the effectiveness of retardant application under the range of mission objectives and spatial and temporal conditions under which they operate (Calkin and others 2014; Thompson and others 2013). In this abstract, we extend the work presented in Calkin and others by evaluating an additional year of LAT use (2012) and providing further detail regarding the specific characteristics of the drop environment.

Federal guidance on the use of aviation resources states that the priority for airtanker use is in initial attack (IA; Artley 2005, National Interagency Fire Center 2014),

generally, the first 24 hours following operational engagement. This is because they are rapidly deployable and can quickly reach inaccessible areas, often before helicopters or ground crews can be dispatched, to limit fire spread before the fire grows large (Ganewatta and Handmer 2009; National Wildfire Coordinating Group 2014; Plucinski and others 2007). LATs are also used in extended attack (EA), or operations that occur after the fire escapes initial containment efforts, although EA operations can span a range of missions beyond direct suppression (for example, indirect suppression and point protection of values or personnel). Calkin and others (2014) manually linked multiple data sources to provide a coarse summarization of LAT use for 2010 and 2011. However, because federal agencies have not systematically recorded the location, objective, or outcome of retardant drops from federally contracted LATs in the United States, the full historical extent of LAT use in IA versus EA is largely unknown, as is the volume of use tied to specific missions and the outcomes related to individual retardant drops.

The appropriate role of LATs in federal fire suppression in the United States has been the source of much debate and discussion in recent years as the U.S. Department of Agriculture, Forest Service (USFS) has confronted decisions to address an aging and dwindling fleet of contract LATs. Questions of fleet efficiency are complicated by inadequacies

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in historical data on airtanker use. A need for improved data collection systems for LATs was a key recommendation from a 2013 U.S. Government Accountability Office (GAO) investigation into actions made by the USFS and the U.S. Department of Interior (DOI) regarding fleet modernization (U.S. Government Accountability Office 2013). Our research has also identified deficiencies in data collection regarding LAT use in federal fire suppression (Calkin and others 2014; Thompson and others 2013). As a necessary step moving toward fleet efficiency, we pieced together historical datasets to link retardant drops to unique incidents, then incorporated dispatch and spatial data to associate the drops with temporal and spatial characteristics of drop conditions.

## Characterizing Airtanker Use

To first characterize conditions of historical airtanker use, we used door-opening events, logged by aircraft sensors designed to monitor airframe stress, to identify retardant drop locations from 2010 to 2012 for the conterminous United States. We then manually linked retardant drops to fire occurrence and resource order records from the Resource Ordering and Status System (ROSS) to identify whether LATs were used during IA, and if so, whether the fire was contained at the IA phase. Our analysis shows that despite federal guidance stating that the priority for use is in IA, 45 percent of drops from 2010 to 2012 occurred during EA. In addition, containment rates of fires associated with LAT use are low; 75 percent of all IA drops were on fires that escaped containment efforts. This containment rate is in stark contrast to the general initial attack success rate of approximately 97 percent for all fires on USFS and DOI lands (Tidwell 2012; U.S. Department of Interior, Wildland Fire Management 2012).

To describe where and when drops occur, we employed a variety of geospatial datasets to explicitly characterize the conditions of use, particularly with respect to terrain, fuels, time of day, and proximity to human populations and identified values at risk. It is generally accepted that retardant effectiveness from LAT drops diminishes with increasing flame length, fire intensity, canopy cover, slope, and wind speed (National Wildfire Coordinating Group 2014). Preliminary results show that LATs are frequently used under conditions where they are thought to be less effective. Approximately 35 percent of drops occurred in late afternoon (1500 – 1800 hours), which is generally the hottest period of the day with potentially the most active fire behavior. Only 14 percent of all drops occurred before noon. When intersecting drops with 30 m fuel model data from the LANDFIRE 2010 dataset (U.S. Department of Interior, Geological Survey 2013), drops intersected timber fuel models (38 percent) almost as frequently as grass fuel models (43 percent). Fourteen percent of drops were in timber in the late afternoon. Slope steepness at the drop location was derived from 10 m digital elevation models (Gesch 2007; Gesch and others 2002), and slopes were categorized according to general land use and zoning regulations defining

slope steepness. From this, 45 percent of drops occurred on the steepest slopes (extreme slopes category, greater than 25 percent). When comparing time of day to slope steepness, the highest category of use was in late afternoon on extreme slopes. Finally, drops also occurred most frequently on fires in close proximity to human populations. For example, median distance to the mapped wildland-urban-interface (SILVIS Lab, 2012) was 2.8 mi and median distance to a major highway (U.S. Department of Transportation, Federal Highway Administration 2013) was 4.7 mi.

## Discussion

The airtanker modernization strategy (U.S. Department of Agriculture, Forest Service 2012) highlighted cost-effectiveness as the fundamental principle guiding both the replacement strategy and the use of aerial firefighting resources; however, an understanding of LAT usage conditions is a prerequisite for any cost-effectiveness analysis. Our efforts provide a detailed picture of the historical conditions and frequency of use for 2010 to 2012. Unfortunately, the nature of the available data precludes automation of the methods for additional years, and the absence of data on drop objectives and outcomes prevents analysis of the effectiveness of suppressants in meeting stated objectives. The Agency is recognizing this critical need for enhanced data collection to move toward cost-effectiveness and has increased support for the ongoing Aerial Firefighting Use and Effectiveness (AFUE) study. This project will document objectives and outcomes of suppression missions, through field observation and remote sensing of a sample of actual retardant and water delivery operations on active wildfire incidents. AFUE will initially focus on airtankers, but will eventually include data from helicopter and water scooper drops. The data from the AFUE efforts will improve our ability to assess the range of conditions of LAT use and the effectiveness of meeting objectives under specific conditions.

Currently, aviation costs account for approximately 25 percent of USFS fire expenditure (Calkin and others 2014) and aviation accidents are responsible for roughly half of all federal and federally contracted wildland fire related fatalities from 2000 to 2012 (National Wildfire Coordinating Group 2000 to 2012; Stonesifer and others, accepted). Despite guidance stating priority of use in IA, our analysis shows that only half of drops occur during IA, and that for the fires with those IA drops, escape is the typical containment outcome. This suggests that managers are restricting the use of LATs in IA to only those fires with the highest potential to escape. Unfortunately, at this time we do not have the ability to identify how many of these drops resulted in containment of fires that would have otherwise escaped in the absence of aviation use. It is important to note that we are not suggesting that retardant drops under challenging fire environments are ineffective; however, given the high-risk, high-cost nature of aviation missions in fire suppression, it is critical to utilize LATs in the most effective manner possible. To ensure effective use, information regarding the

effectiveness of LATs in meeting a range of objectives under variable conditions could be incorporated into improved resource allocation models, particularly for use during periods of high resource demand.

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