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AFUE
MOVING TOWARDS MORE EFFECTIVE AERIAL FIREFIGHTING

HOW TO EAT AN ELEPHANT

GOING GREEN WITH THE Q400AT
NEW AIR TANKER FOR QUEENSLAND

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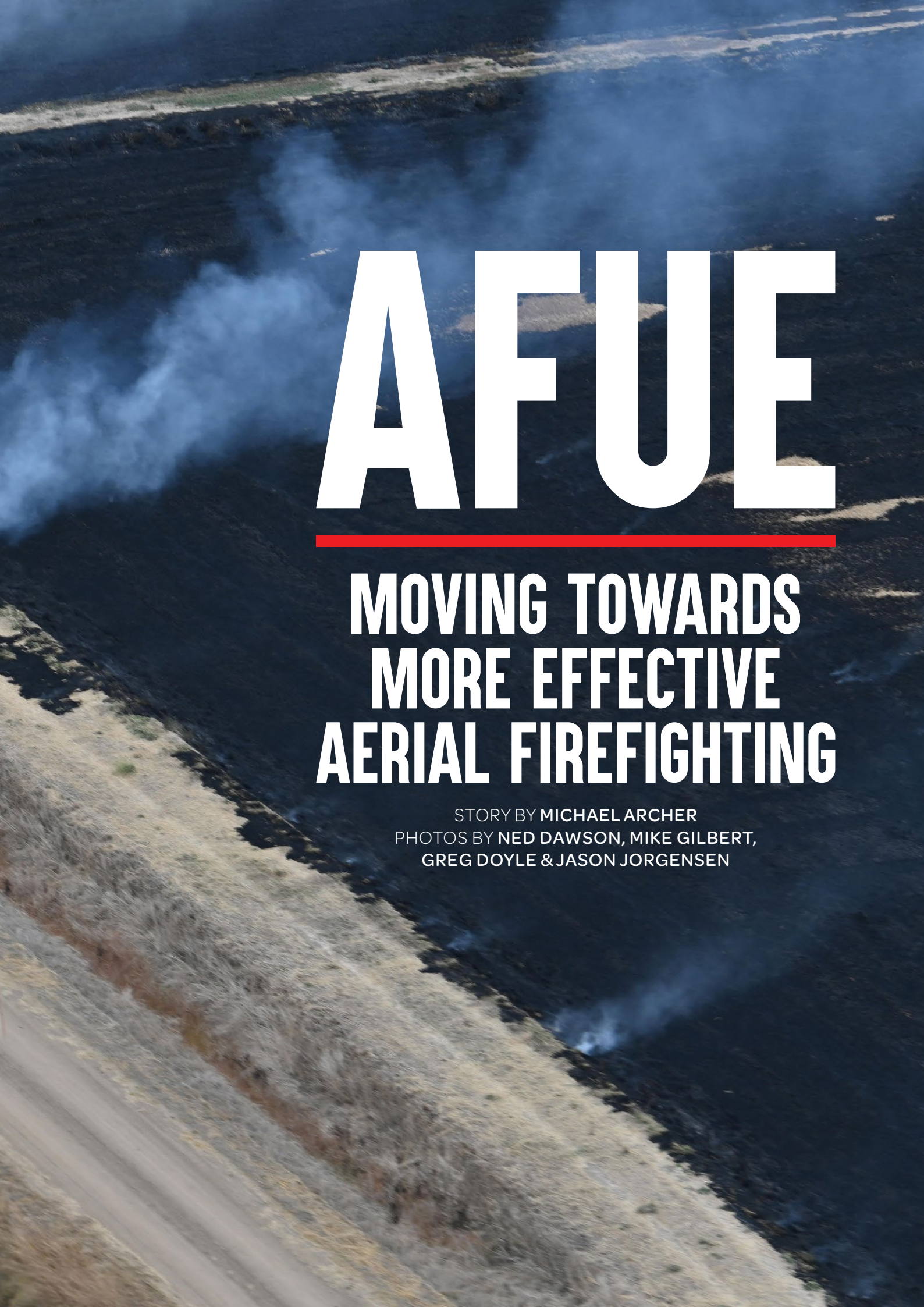


AFUE

MOVING TOWARDS MORE EFFECTIVE AERIAL FIREFIGHTING

STORY BY **MICHAEL ARCHER**
PHOTOS BY **NED DAWSON, MIKE GILBERT, GREG DOYLE & JASON JORGENSEN**

As the numbers of acres burned, structures destroyed, lives lost, and dollars spent continue to increase, the U.S. Forest Service has finally taken the first steps towards revamping their way of conducting aerial firefighting operations and the result is called the Aerial Firefighting Use and Effectiveness (AFUE) study. **Michael Archer** reviews.

s wildfires worsen across the western U.S., there have been many debates about how better to deal with them. Over the years, a number of studies have been done on the effectiveness of aerial firefighting, but seldom have they had much impact on strategy and tactics on the firelines. In some cases, newer technology has not been embraced, but simply shifted off to the side while tried-and-true methods of firefighting, while possibly less effective, were used to battle fires that have continued to grow in acreage year after year.

A LITTLE HISTORY

As early as 1930 the U.S. Forest Service was dreaming about fighting wildfires from the air. In that year, they used a Ford Tri-Motor airplane to drop a wooden beer keg filled with water over a fire. Not much more was done until after World War II, when numerous former military aircraft became available to non-military concerns. Still, there was no immediate rush by the Forest Service to acquire any firefighting aircraft.

But in 1953, Joe Ely, a forest control officer working on the Mendocino National Forest, was appalled at the death of 15 firefighters caught in a burnover while battling the 1,300-acre Rattlesnake Fire in Grindstone Canyon. Casting around for a way to ensure that this never happened again, Ely approached a Willows pilot and asked if he could adapt a crop-dusting plane for aerial firefighting. The pilot cobbled together a gate, a dump valve and a mechanism to operate them from the cockpit of a Stearman 75 Kaydet – and the first air-tanker was born.

Following a preliminary drop over Willows Airfield to ensure that everything worked correctly, the Stearman dumped 100 gallons of water on a crashed logging truck that had touched off a wildfire near Covelo in August 1955. Testing had shown that water evaporated too quickly when dropped on a fire, so sodium calcium borate was added to the water to deliver more of the wet stuff on the hot stuff.

With the success of that first airstrike, seven more planes were converted into air-tankers and the first squadron of seven pilots began flying fires in the summer of 1956. From those modest beginnings, today's billion-dollar aerial firefighting industry was born.

PREVIOUS STUDIES

With the proliferation of air-tankers and helicopters over wildfires, the Forest Service decided it would be a good idea to have someone evaluate the effectiveness of aerial firefighting.

A number of studies have been done on the effectiveness of gel, the cost of retrofitting contractors' fleets with newer, more reliable aircraft, and replacing the air-tanker fleet altogether with brand new C-130s equipped with MAFFs (Modular Aerial Fire Fighting) units, something which would have cost over $1 billion.

In 1984, Chuck George, a researcher at the Missoula Fire Lab, published a study titled “An Operational Retardant Effectiveness Study,” which recommended creation of an “Aerial Retardant Program Improvement Plan” by the U.S. Forest Service’s Aviation and Fire Management branch.

The RAND Corporation was asked to conduct an aerial firefighting study. In 2012, they reported, “The U.S. Forest Service should acquire an initial attack fleet that is predominantly composed of water-bearing scoopers.” That study was shelved and there was no movement towards retrofitting the land-based air-tanker fleet with scoopers.

Though each of these studies provided some insight on

how to improve aerial firefighting, no significant changes were made to the fleet of aircraft fighting wildfires.

THE PRIVATE SECTOR STEPS IN

Since the vast majority of the air-tanker fleet was composed of aircraft flown by private contractors who operated anywhere from a couple of aircraft all the way up to multi-million-dollar giants like Conair, Neptune Aviation, and Aero Union with a dozen or more air-tankers, profitable operation was an important business consideration.

Visionaries like Rick Hatton saw the need for aircraft that could carry more than the Large Air-Tanker (LAT) capacity of 3,000 gallons, so he retrofitted a DC-10 to carry 11,000 gallons of retardant to a fire at jet-plane speeds.

Other contractors either started from scratch, such as the 747 Supertanker, or retrofitted their ageing

propeller-driven air-tanker fleet with new aircraft, like the BAe146 or RJ85 – jet aircraft that could get to the fire faster, and for which spare parts were still available (Neptune Aviation had to keep a full-time shop crew on hand to manufacture replacement parts for their Korean War-era P-2V Neptunes because no spares were commercially available).

Private aircraft manufacturers, such as Texas-based Air Tractor, jumped at opportunities to innovate existing fixed-wing aircraft for initial attack, like the single-engine Air Tractor AT-802 which was outfitted with amphibious floats by the Wipline Float Company, creating the first single-engine scooper, called the Fire Boss.

New firefighting chemicals were also being brought to market from time to time. PHOS-CHEK, which has produced tons of retardant since the early 1960's, started offering gel products to their aerial firefighting customers,

as did other gel manufacturers. Foam was another popular chemical used to quell the flames. Even newer chemicals like Fortify offer the promise of not only quelling today's wildfires after aerial application, but of creating a barrier through which fire can't burn until the rainy season washes it into the soil.

Some contractors, like Coulson Aviation, fielded their own retardant drop evaluation assets. Coulson outfitted an S-76 helicopter to monitor retardant drops and report back to the fire agencies they served on their effectiveness. Firms like TracPlus and Aircraft Maintenance Solutions (AMS) fielded new equipment, like their AFDAU (Auxiliary Flight Data Acquisition Unit) module, which could be retrofitted to helicopters or air-tankers to provide statistics on airstrike effectiveness.

But despite all of the studies and innovations various organizations produced, aerial firefighting improved, but

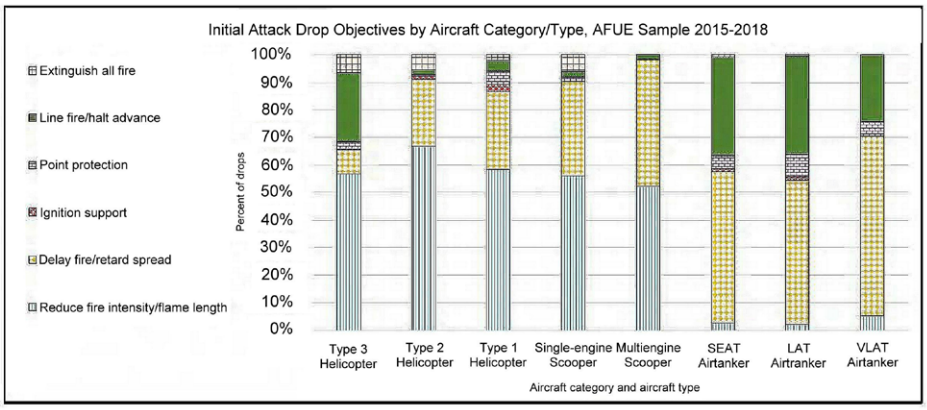
not enough to quell worsening wildfires that, each year, burned more acres and took more lives.

AERIAL FIREFIGHTING USE AND EFFECTIVENESS (AFUE) REPORT

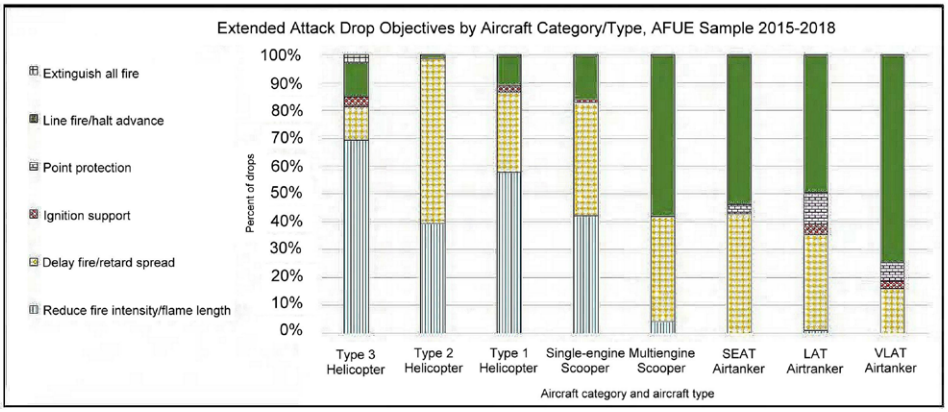
In 2012, the Forest Service began work on a ground-breaking new study which took a comprehensive look at a number of aspects of aerial firefighting. In August 2020, to little fanfare, the Aerial Firefighting Use and Effectiveness (AFUE) Report, was published. The goal of the report was summed up in a single paragraph:

"To systematically document the operational utilization and tactical contribution of aerial firefighting resources that have the ability to deliver water and wildland fire chemicals in support of incident objectives."

The report describes project achievements, preliminary results, and opportunities for the Forest Service, its partners, and its cooperators to strategically improve aerial firefighting, with the information generated addressing three of the U.S. Government Accountability Office report GAO-13-684 recommendations:



Percentage of drops for different groups of drop objectives by aircraft category and type in initial attack -aerial firefighters applied water, water enhancers, or long-term retardant with theinitial responding resources only; and the fire was smaller than 100 acres in timber or 300 acres in grass/shrub

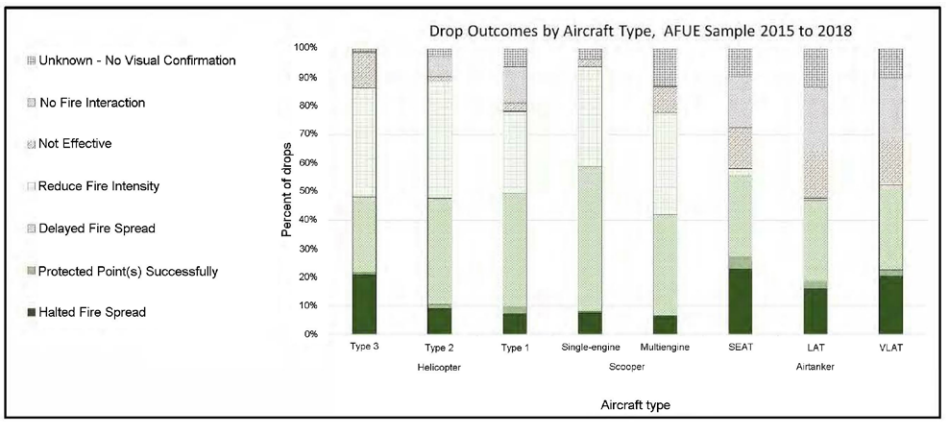


Percentage of drops for different groups of drop objectives by aircraft category and type in extended attack - additional ground resources supported the initial response, and the fire was smaller than 100 acres in timber or 300 acres in grass/shrub or when the fire duration exceeded 24 hours since engagement.

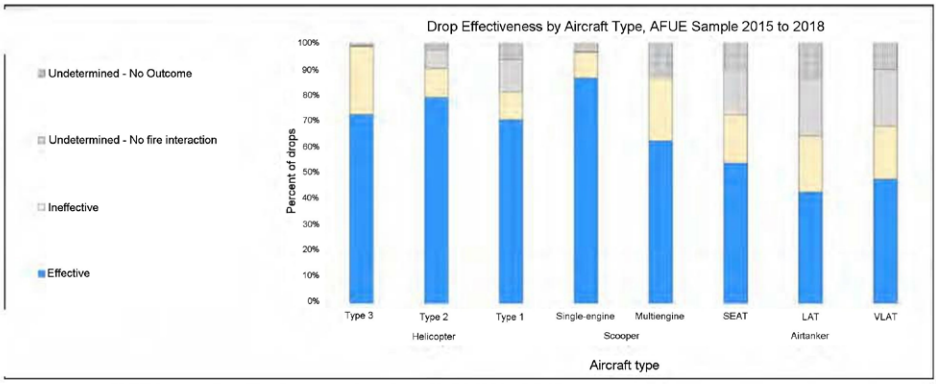
- **Performance and Effectiveness:** Collection and analysis of data, along with definition of evaluation criteria, were anchored into the objective to quantitatively document aircraft performance and effectiveness.
- **Risk Management:** AFUE supported best risk management practices, including generating best available information, supporting organizational learning, and summarizing performance in a dynamic and uncertain management context in terms of probability of success.
- **Transparency:** AFUE reports clearly identified study strengths and limitations, including potential sources of error and bias.

AN INDUSTRY PERSPECTIVE

Since late August, Brett L'Esperance, CEO of Dauntless Air, has been digesting the AFUE report. Having written a blog post on the topic, he shared some of his thoughts on the report and what it means to the future of aerial



AFUE sample outcomes by aircraft type, 2015 to 2018. The shades of green represent positive contributions and the red represents different reasons for failure (burned through the line, outflanked, spotted outside the line, failed to contribute-unknown reason, change in tactics/priority, jettison).



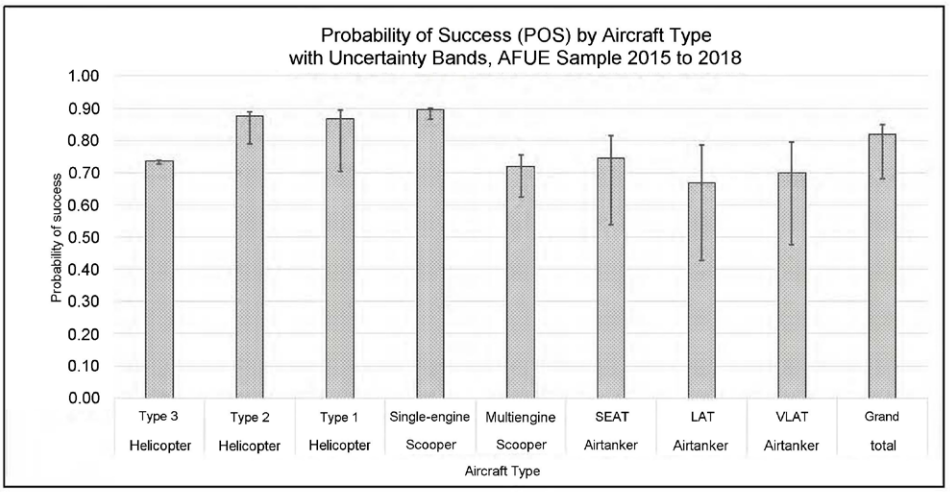
AFUE sample effectiveness by aircraft, 2015 to 2018

firefighting, as well as some other issues that need to be addressed to unfetter the aerial firefighting industry.

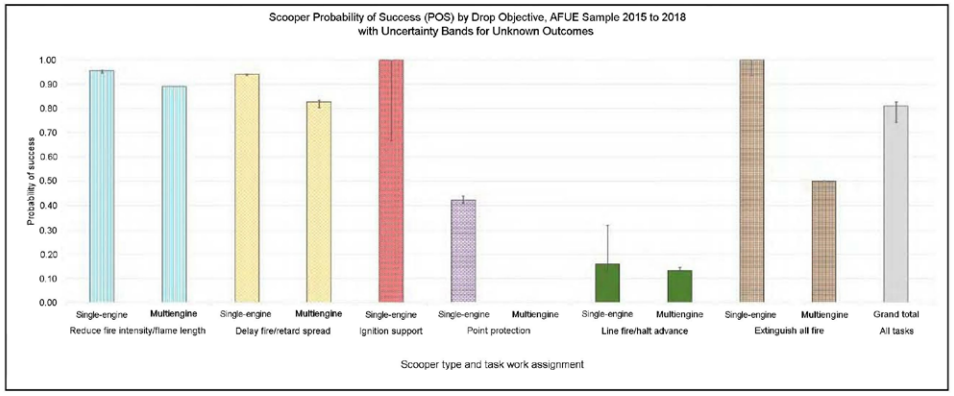
"There's a lot to unpack in this 46-page report, but what jumps off the page right away is the fact that the AFUE findings reinforce a lot of what we already know about how aerial firefighting is used in today's Managed Fire approach," began L'Esperance.

"In Managed Fire, non-threatening wildfires are allowed to run their natural course within defined perimeters so that the area within those perimeters can burn naturally, creating healthier landscapes that are less prone to intense wildfires in the future," said L'Esperance. "To do this, fire agencies rely heavily on numerous large and expensive retardant-dropping air-tankers working together on the same large fire to draw containment lines and steer the fire away from homes and businesses and toward areas in need of treatment."

The widespread use of this Managed Fire approach, which is the strategy of the U.S. Forest Service, is evidenced in the AFUE's aircraft usage results: The vast majority of the drops assessed in the study were completed by large aircraft – LATs, VLATs (Very Large Air



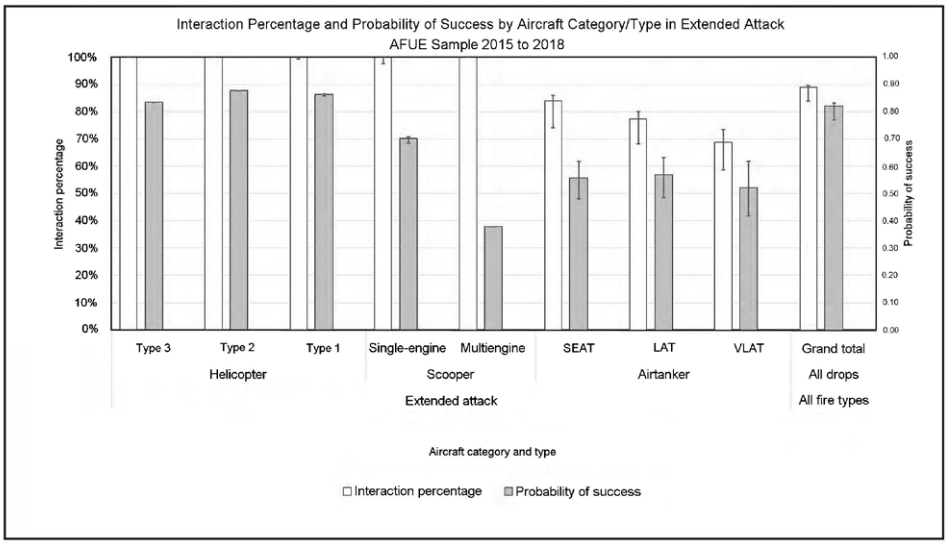
AFUE sample probability of success (POS) results by aircraft, 2015 to 2018. The POS for each aircraft is the result of dividing the sample counts of effective drops by the total of effective plus ineffective drops, in other words the proportion of effective to all interacting drops. Bands indicate the range between the worst and best cases possible, assigning all unknown outcomes as either ineffective or effective.



AFUE sample probability of success (POS) results by scooper type, 2015 to 2018. The POS for each aircraft is the result of dividing the sample counts of effective drops by the total of effective plus ineffective drops, in other words the proportion of effective to all interacting drops. Bands indicate the range between the worst and best cases possible, assigning all unknown outcomes as either ineffective or effective.

Tankers), multi-engine scoopers, and Type 1 helicopters – during Large Fire operations. Conversely, the study found smaller aircraft – single-engine scoopers (Fire Bosses), type 3 helicopters, and retardant-dropping wheeled single-engine air tankers (SEATs) – were predominantly used during Initial Attack, defined by the AFUE as a fire smaller than 100 acres in timber or 300 acres in grass or shrub. “Since Initial Attack and rapid response to small wildfires are not the stated primary goals of today’s Managed Fire approach, drops from smaller aircraft were not as prevalent in the study as drops from large aircraft,” noted L’Esperance.

With the state of US forests today, it’s clear there is a time and place where Managed Fire is necessary. “There are about 84 million acres that need treatment on federal lands, so if we can use some naturally occurring fires to reduce risk in the future, it’s worth doing,” asserted L’Esperance. “That said, it’s hard to find many areas in



AFUE sample interaction percentage (IP) and probability of success (POS) results by aircraft in extended attack, 2015 to 2018. The IP for each aircraft is the result of dividing the sample counts of interacting drops by total of interacting (effective plus ineffective) plus those with no fire interaction, in other words the proportion of drops interacting with the main fire to all drops with known outcomes. Bands indicate the range between the worst and best cases possible, assigning all unknown outcomes as no fire interacting or fire interaction. The POS for each aircraft is the result of dividing the sample counts of effective drops by the total of effective plus ineffective drops, in other words the proportion of effective to all interacting drops. Bands indicate the range between the worst and best cases possible, assigning all unknown outcomes as either ineffective or effective.

the West where you're not going to run into endangering property values or people's lives when wildfires break out."

MEASURING AIRCRAFT EFFECTIVENESS

An important factor in the report was that a variety of aircraft were needed and that all current air-tankers and helicopters have their place. "What the AFUE does is help uncover which aircraft are most effective at achieving which aerial firefighting objectives," L'Esperance pointed out. "Scoopers and helicopters were the best at reducing fire spread and fire intensity early on in the fire, which gives your boots on the ground a chance to suppress it quickly and reduce WUI impact and the amount of wildfire smoke released into the atmosphere. When things go sideways, and a fire grows too large to be quickly suppressed, the LATs and VLATs are really good at painting line around the fire to halt fire spread and for point protection of certain areas."

The AFUE includes numerous graphs that present effectiveness findings by aircraft type, grouping together and presenting separately the data from helicopters (types 1, 2, and 3), scoopers (single- and multi-engine), and air tankers (SEATs, LATs, and VLATs).

"If you take all of the graphs in the report together and think of them as a puzzle, it paints a very interesting picture," continued L'Esperance. "When wildfires threaten

communities, the findings indicate that the best mix of aircraft for the job are single-engine scoopers and helicopters that are dispatched during Initial Attack. These resources are more effective and cost efficient at this stage of wildfire suppression compared to LATs and VLATs during Large Fire operations. Facing little public pressure right now to discuss this Study, the obvious question is, 'when will Federal fire agencies alter their response tactics based on a Study they've authored?' In the past, reports like RAND's Air Attack Against Wildfires have been written off as out-of-touch, but what about this study, chartered and conducted by the Forest Service?"

CHANGE IN APPROACH

Part of the goal of the AFUE is to support evidence-based resource deployment decisions and inform strategies for future aviation budgeting and contracting. "The report supports the need for a conversation about using the aircraft we already have in a more strategic and effective way. While over the long term

we will continue to need to grow and modernize our aerial firefighting fleet, in the very near term the AFUE Study shows us that we can utilize our current fleet of aircraft in more effective ways to generate better results and outcomes. The learnings should enable our fire aviation managers to more strategically deploy these assets and build a future fleet that is more cost and firefighting effective," stated L'Esperance "We have to pay attention to important aircraft effectiveness reports like the AFUE and start thinking differently about how we use and pre-position aircraft for maximum coverage and rapid response across a region."

"Think of a hub-and-spoke distribution model. The 'spokes' are the small aircraft spread through the WUI. When a fire breaks out, they're close by, cost efficient and able to jump quickly on threatening fires while the fires are still small. Separate, the 'hub' is more centrally located in the middle of these "spokes" and where the LATs and VLATs would standby and be available when an incident commander needs them. This is a more efficient way to position and use these assets. We've seen the concept

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work in Washington State, although no one calls it a hub-and-spoke model."

L'Esperance continued, "This model makes even more sense when you think about the ecosystem of aerial firefighting resources available in the U.S. There are literally hundreds of small, cost efficient aircraft that could serve as the 'spokes' and be stationed at small airports and landing strips throughout the WUI. On the other hand, there are only about 28 LATs and VLATs, plus a handful of CL-415 Super Scoopers. Why are we taking these limited large and expensive resources and spreading them thin across wildfire-prone regions when we have hundreds of smaller resources that are less expensive and, as indicated by this study, probably better at initial response?"

According to L'Esperance, a rapid response, hub-and-spoke distribution model complements the Managed Fire approach. "In the rare instances where a wildfire can burn with no impact to lives or property, it should be allowed to burn. In the much more common situation where an uncontrolled wildfire could threaten WUI communities, it should be suppressed quickly, during

Initial Attack and when it is still small. Doing so saves significant suppression expense, which can be spent on forest health initiatives, such as prescribed burns and forest thinning. This has the potential to create thousands of jobs nationwide while reducing the wildfire threat and associated health impacts for years to come."

SBA LIMITATIONS AND OTHER ISSUES

Archaic laws also will have to be changed. "SBA [Small Business Association] conditions were put in place back when aerial firefighting was a very small business. This was done to protect the guys who were farmers who had converted their aircraft to fight fires. If these farmers were going to convert some aircraft and do wildland firefighting for the government, they understandably wanted some protections for their investment in case bigger companies came in and tried to squeeze them out. Fast forward to today and aerial firefighting is an $800 million to $1 billion business. SBA protections are more a hindrance now than a benefit. I know this would probably generate some disagreement in the industry because some operators like the protection, but if the country is serious about using and improving aerial firefighting resources, the SBA restrictions have to go or they'll limit our long-term, collective effectiveness."

L'Esperance discussed the SBA limitations in the context of the AFUE report's call for innovation and improvement. "Aerial firefighting operators that are impacted by these SBA limitations won't be able to attract the capital needed to invest in all the important advances identified in the AFUE report. We need to remove the outdated restrictions if we want our nation to be in a position to create the robust and technologically advanced wildfire response system that can match an evolving wildfire threat."

Another limitation is the lack of Exclusive Use (EU) contracts. "When I've talked with other operators, they've said 'Well, our fire agency customers have to issue contracts that make it worthwhile to invest in the necessary equipment. But, agencies seem to be going the other way these days.' Although it's difficult to justify having EUs in a year in which we don't have a lot of fires, like 2019, it's insurance against bad fire years like 2017, 2018, and late 2020, because EU contracts ensure aircraft availability which is critical during the first 1-2 hours of a wildfire. If EU resources are available to dispatch right


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L.A. COUNTY FIRE
N160LA

away during Initial Attack, they can support the hub and spoke model and make all the difference in preventing a small wildfire from growing into a larger disaster that threatens lives and impacts air quality."

L'Esperance continued, "Fortunately, the aerial resources found in the study to be most effective for Initial Attack, single-engine scoopers and Type 2 helicopters, are significantly less expensive to contract with than LATs, VLATs and the CL-415s, making these smaller assets the most cost- and fire-effective tools to include in state and federal budgets for EU contracts."

The AFUE found that single-engine scoopers had the highest percentage (87%) of effective drops among all aircraft. As an operator of single-engine scoopers (known more specifically as Fire Bosses), L'Esperance knows the aircraft's effectiveness first-hand, but also acknowledges there's a lack of awareness surrounding the aircraft. "There's an educational process that needs to take place. There are still many states that have never had a Fire Boss operate within their borders but are prime for scooping operations. The AFUE Study should be the genesis of conversations in these states to further consider single-engine scoopers. For this to happen, decisions makers need to hear from wildland firefighters that they want to see a rapid response, hub and spoke model like the one I've described."

MOVING FORWARD

L'Esperance knows more work needs to be done. "There should be more studies and an ongoing commitment to capturing and evaluating aircraft effectiveness."

"One area in particular where the AFUE could have gone even further is around cost analysis. The rapidly increasing annual cost of wildfire suppression in this country is one of the issues that prompted this study in the first place. Aircraft cost analysis shouldn't be a direct comparison because every aircraft in our nation's arsenal is important and needed, but AFUE leaders could have applied some kind of cost metric on a per drop basis. This would have added another layer of critical information to help inform strategies over the long-term, especially around the cost benefit of smaller drops earlier in a fire's development versus bigger drops later on."

Even the drafters of the AFUE report counseled that more needs to be done, both in research and education

of the industry, stating “Future AFUE work may proceed along a number of lines, including developing additional performance metrics and exploring options to provide incident managers with dashboards and maps that show drop activity on their incidents. A particularly promising avenue is expanded collection and analysis of Additional Telemetry Unit (ATU) data, which provide a mechanism for gathering basic aviation use information and allows managers to perform real-time oversight to ensure ongoing use aligns with strategic objectives and Agency goals. Further, building a comprehensive archived ATU data repository could improve national scale accountability by providing opportunities for post-incident analysis and learning of fleet workload and usage patterns.”

The report continues, “The AFUE study has effectively and comprehensively responded to recommendations from GAO-13-684 and has opened the door for additional learning and system improvement. Results will help the Agency implement performance measures, support evidence-based resource deployment decisions, and inform strategies for future aviation budgeting and contracting.”

An important step has been taken by the U.S. Forest Service in determining how and where to improve aerial firefighting in the U.S. But it is only a first step in the right direction. Much will depend on their following through with more studies on all aspects of this means of fighting wildfires. Since this report was internally generated, many hope that it will gain more attention than past studies done by outside firms. In the long run, that could lead to some real gains in the ongoing fight against wildland fire, not only across the U.S., but across the globe. ■