U.S. Department of the Interior

Unmanned Aircraft Systems (UAS) Program

2019 Use Report

BLM Firefighters conducting an aerial ignition mission in Florida.

Table of Contents

Background 4
2019 Program Highlights 5
Notable 2019 Accomplishments and Reports 6
Report Structure and Content 8
Reporting DOI UAS Adoption, Application and Integration 9
Measuring DOI UAS Program Success 10
2019 Statistical Overview and Discussion 12
Interior Bureaus, Offices and Interagency Partners 12
Call When Needed Contractor Flights for Wildfire Response 13
FY19 Flights by State / Territory 14
Fiscal Year 2019 DOI UAS Missions 15
Interior DOI Missions by Bureau 15
A Breakdown of DOI UAS Missions by Primary Flight Use 17
Fire and Incident Response 19
DOI Remote Pilots 22
Remote Pilot Training 25
DOI Aircraft 26
Pilot and Aircraft Utilization 28
DOI UAS Data Management and Risk Mitigation Strategy 29
2020 Outlook 31

Table of Figures

Figure 1. Annual growth of DOI UAS flights, 2010 – 2019. 5
Figure 2. The "Four Outcome S's" of DOI's "Drones for Good" UAS Program. 11
Figure 3. Call When Needed UAS support locations in FY19. 13
Figure 4. Department of Interior pilots flew UAS in 48 United States and territories in Fiscal Year 2019. 14
Figure 5. Area plot of total FY19 flights by state. The larger the box, the more flights in that state. 15
Figure 6. Count and percent of overall FY19 UAS flights by DOI Bureau. 16
Figure 7. Total DOI flights by aircraft model, broken down by Bureau. 17
Figure 8. Percent of UAS flights by primary use type for DOI in fiscal year 2019. 18
Figure 9. DOI FY19 UAS flights by aircraft model and primary flight use. 18
Figure 10. Similar to Figure 9 above, this graphic represents flight by primary use type and aircraft, over the past three years. 19
Figure 11. Number of incident flights by Bureau and response type. 20
Figure 12. Incident response flight percent broken down by response type and interagency fire response Bureau. 20
Figure 13. Incident response flights by bureau and incident type over the past three years. 21
Figure 14. Remote pilots in FY19 by bureau, office or interagency partner. 23
Figure 15. The distribution or DOI remote pilot duty stations, by bureau, across the United States. 24
Figure 16. DOI remote pilot counts by state and bureau. 24
Figure 17. FY19 DOI UAS flights by aircraft model. 26
Figure 18. Interior FY19 UAS fleet counts, flights, and program-total to date acquisition costs. 28
Figure 19. UAS Cost vs. Other Methods Across 811 DOI Projects in 2019. 29
Figure 20. Elements of Interior's UAS Data Management and Risk Mitigation Strategy. 31

Background

The U.S. Department of the Interior (DOI) is the largest land steward in the United States, responsible for management of 500M acres (~1 in 5) across the U.S and its territories and 1.7B acres on the Outer Continental Shelf (see DOI Strategic Plan). DOI manages resources that supply 30 percent of the Nation's energy supplies, manages water in 17 Western States and supplies 15 percent of the Nation's hydropower energy. The *"people's land,"* which DOI manages on behalf of the American Taxpayer annually hosts more than 450M visits annually (see the DOI Economic Report).

In carrying out its extensive responsibilities on behalf of the American Public, DOI utilizes a wide variety of aircraft (Office of Aviation Services website), including unmanned aircraft systems (UAS, aka drones; OAS UAS website). DOI missions, often conducted in remote areas, severe terrain, and weather conditions can be hazardous to personnel. These missions often require persistent presence and responsive deployment to address emergent events (e.g. wildfires, earthquakes, volcanos, floods, animal migrations, search and rescues, etc.). Mission goals include conducting them with no/minimal disturbance to native species and visitors to the lands that DOI stewards, while making the best use of appropriated funds to fulfill its chartered obligations for managing the *"people's land."* Since the initiation of DOI's current UAS program in 2006 (see DOI's UAS integration strategy plan), the Department has realized significant benefits from the safe and responsible integration of drone technology.

Office of Surface Mining Reclamation and Enforcement remote pilots train at DOI's Advanced UAS Workshop for Project Planning near Boulder, Colorado (Oct. 2019).

2019 Program Highlights

In 2019, the DOI UAS program continued its tradition of innovation, collaboration, and leadership in the drone space. Adoption and integration of UAS in missions by DOI's nine bureaus continued to grow with 11,442 UAS flights conducted across more than 25 mission applications in 48 States and U.S. Territories in 2019; an 11% increase in DOI UAS flights over 2018's record setting year.

Figure 1 illustrates ten years of programmatic growth signified by annual expansion in the number of flights. Future projections are questionable, however, with the majority of program flights being temporarily grounded by the Department Secretary pending a comprehensive review of the UAS program (see the DOI UAS news page).

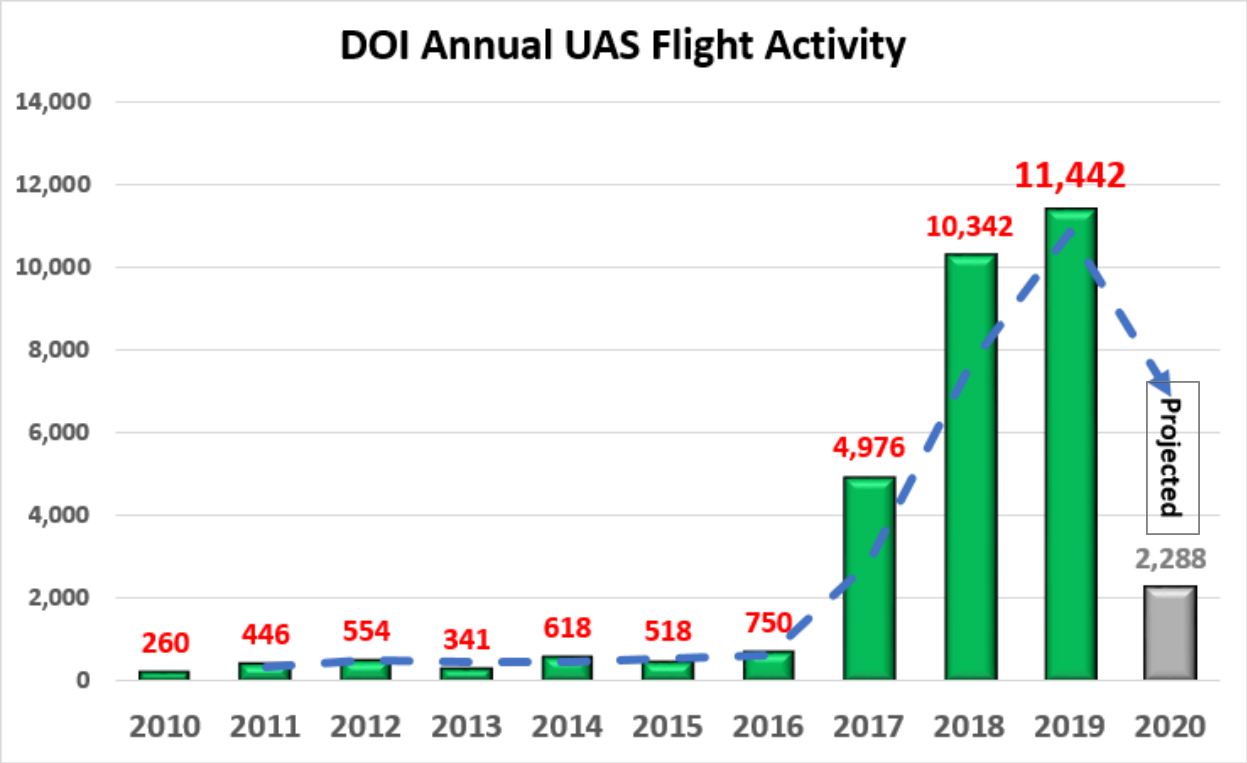


Figure 1. Annual growth of DOI UAS flights, 2010 – 2019. The program's grounding is expected to severely reduce the number of flights in FY2020.

Next to training and proficiency, the majority of FY19 flights were in support of scientific mapping and landscape monitoring missions followed by flights in support of interagency fire monitoring (see Figures 8-11).

Notable 2019 Accomplishments and Reports

1. **Joint U.S./Canada Oil Spill Exercise:** DOI OAS flew multiple UAS live-streaming video missions during CANUSLANT 2019, an exercise designed to test joint U.S./Canadian response to a theoretical oil spill off the coast of Maine. The UAS transmitted live-streaming video of an oil spill containment boom deployment to the exercise command post, providing incident command post personnel from NOAA, U.S. Fish & Wildlife, Maine's Department of Environmental Protection, and U.S. and Canadian Coast Guard commanders with invaluable real-time situational awareness during the containment boom deployment.

2. **Buenos Aires National Wildlife Refuge (NWR) Prescribed Burn Video Documentation and Imagery Acquisition:** DOI OAS flew video and still imagery collection missions during a prescribed burn at the Buenos Aires NWR in support of U.S. Fish & Wildlife and Southern Border Initiative goals, to include maintaining historical fire disturbance while enhancing visibility and access to the landscape for U.S. Border Patrol personnel. Video was captured during the prescribed burn, providing a unique perspective of the operations, while still imagery was collected and processed pre- and post-burn to allow analysis of the burn's effectiveness.

3. **2019 DOI UAS Training Resiliency Despite Government Shutdown:** Despite having to cancel several A-450 DOI basic remote pilot classes as a result of the 2019 government shutdown, the students trained in 2019 were only slightly behind the 2018 roster. There were 126 DOI remote pilots carded in 2019 compared to the 145 during the 2018 training schedule. Working in coordination with the Bureau UAS management, additional classes were added to the 2019 schedule to accommodate and alleviate the Bureau training demand.

4. **DOI Explores UAS as a Tool for Managing Wild Horses and Burros:** Partnering with the United States Naval Academy capstone engineering team, DOI explored utilizing UAS for monitoring populations and delivering medicine/birth control to wild horses through darting from the air. Use of UAS would help augment or replace manned flights to help reduce risk of manned aerial capture eradication and tagging of animal flights as well as reduce the expenses associated with aerial gunnery.

5. **The Department of Interior continued to test, evaluate, procure and train personnel with new UAS and payloads to expand capabilities for wildfire response:** DOI continued to implement the requirements of S.47 Public Law: 116-9, John D. Dingell, Jr. Conservation, Management, and Recreation Act of 2019 and Section 4 of Executive Order on Promoting Active Management of America's Forests, Rangelands, and other Federal Lands to Improve Conditions and Reduce Wildfire Risk. In March of 2019 a new Interagency aerial ignition course was presented to both DOI and USDA training 18 individuals. Additional information on the DOI UAS aerial ignition programs can be found in this news story regarding the aerial ignition program.

6. **DOI development and testing of security solutions:** In July, the Department completed a 15-month, >2,200 flight test and technical evaluation program in conjunction with the National Aeronautics and Space Administration (NASA), the Department of Homeland Security Cybersecurity and Infrastructure Security Agency (DHS-CISA), the Idaho National Laboratory (INL), and industry. The program examined Department of Defense and industry solutions to meeting published DOI data management assurance requirements as part of Interior's published layered approach to UAS data security and its best practices for responsible operations.

7. **DOI Fleet Selection:** To assist industry in understanding the factors and considerations that influence UAS procurement and services decisions, Interior developed and published a quad-chart of those considerations and resultant strategic directions: outsource, insource, commodity data product, or strategic investment/partnership. As part of its commitment to public and industry transparency within its UAS program, Interior published the DOI small UAS Selection and Acquisition Process and Decision flow diagram.

8. **Bureau of Land Management Story Map:** Interior's Bureau of Land Management (BLM) published an interactive visual report of its 2019 UAS operations for training, natural resources, and wildland fire.

9. **Bureau of Reclamation UAS report:** The U.S. Bureau of Reclamation (USBR) published a report of their UAS data collection as USBR sites over the past 3-years, demonstrating how UAS were able to collect data faster, cheaper, and safer than traditional methods. A total of nine demonstrations were conducted, comprising 39 UAS projects resulting in nearly 100 hours of UAS flight time. The report covered a total of nine demonstrations, comprising 39 UAS projects resulting in nearly 100 hours of UAS flight time. The data collected were both higher quality and in greater quantity than what had been collected with traditional methods. Cracks can be detected to 1/8 inch or better, topographical maps can be generated to 1-foot contours, and Infrared data (at 400 ft AGL) can be resolved to a resolution of 9 inches per pixel compared to satellite imagery that is around 36 inches per pixel. The demonstration projects discussed herein showed that the typical photogrammetric project required about 2 to 3 weeks to complete, from flight planning to data collection to data processing. Finally, the safety enhancements of operating a UAS is substantial. Because UAS can access areas that are hazardous for humans to access, or are otherwise impossible to reach, human hazards are significantly

mitigated. The report demonstrates how UAS is a critical component for agency managers, without which many mandates could not be accomplished.

10. **Comparison of DOI requirements to U.S. Army requirements:** Interior conducted a comparison of the draft specification for the Army Short Range Reconnaissance (SRR) UAS and comparable requirements from the published Master UAS Requirements for the DOI. A similar examination and comparison of UAS payload versatility requirements was also conducted and published.

11. **Compliance with the John D. Dingell Act:** The Department of Interior continued to test, evaluate, procure and train personnel with new UAS and payloads to expand capabilities for wildfire response as required by S.47 Public Law: 116-9, John D. Dingell, Jr. Conservation, Management, and Recreation Act of 2019 and Section 4 of Executive Order on Promoting Active Management of America's Forests, Rangelands, and other Federal Lands to Improve Conditions and Reduce Wildfire Risk. In March of 2019 a new Interagency aerial ignition course was presented to both DOI and USDA training 18 individuals. Additional information on the DOI UAS aerial ignition programs can be found at https://www.doi.gov/aviation/uas/doi-uas-aerial-ignition-aggressively-managing-fuels-enhanced-efficiency-and-safety.

12. **Office of Surface Mining Reclamation and Enforcement (OSMRE)** expanded inspection capabilities and rigor through thermal infrared payloads on their UAS. The addition of UAS to the OSMRE fleet has allowed for safer operations by reducing the requirement for min inspectors to taverse dangerous terrain on foot. Additionally they use of thermal imaging has allowed for the detection and monitoring of coas seam fires.

Report Structure and Content

This report is structured to provide insight for the public, high-ranking government officials, internal managers, pilots, and employees alike. Following this introduction, methods of data collection and analysis are provided, followed by a presentation of data results from FY 2019, a discussion of what the results mean, interpretations and a look to the future in conclusion.

The front line of DOI's effective incident response record are the countless hours of science and data collection upon which real time, in situ missions are designed and executed. The U.S. Geological Survey has applied decades of research related to understanding water, terrain, UAS and other factors to provide UAS assistance during Hurricane Dorian in 2019.

Reporting DOI UAS Adoption, Application and Integration

The adoption, application, and integration of UAS by DOI bureaus can be measured by the continued expansion of the number of bureaus engaged in the program, the number of pilots trained, the diversity of vehicles, payloads, and software available to the Department's remote pilots, and the expansion of the types of missions being completed for the Department. The goal of the Office of Aviation Services (OAS) and Departmental managers is to empower Interior remote pilots with the most advanced innovations being developed by the UAS industry. Leveraging nearly 1,000 cumulative years' experience in aviation and related management and decades of experience in UAS, OAS collaborates with bureaus to field new capabilities that meet current and projected future mission needs as well as the Department's legal, regulatory, policy, and safety obligations as a Public Aircraft Operator (see OAS Special Use Missions). Department's legal, regulatory, policy, and safety obligations as a Public Aircraft Operator.

At the core of the Department's ability to quantify annual program activity, are the thousands of flight use reports (online form OAS-2u) provided by DOI remote pilots. The *"2u"* entries are required after every flight and capture information about the pilot, aircraft, payloads and mission objectives, and provide a snapshot of flights as they occur throughout the year. At the end of the fiscal year, 2u entries are formatted for entry into Geographic Information Systems (GIS) and statistical analysis software. Flight information is then summarized according to metrics of interest to inform DOI senior leadership, managers, and field personnel through summaries such as this report. The *2u* entries provide an incredibly powerful set of metrics to examine how the department is using drones.

Measuring DOI UAS Program Success

Program success is best measured by measurable, **relevant outcomes**, not outputs. For UAS, these outcomes can be "bucketed" into DOI's "Four S's" of drone program success metrics;" ***Sensing, Safety, Savings, Service***.

Sensing is critical to fulfilling the Department's commitment to base its decisions on the best available science. UAS offer incredible enhancement opportunities relative to the amount, resolution, persistence, and analytics applied to collected data. Drones can be less disruptive to sensitive animal species than manned aircraft. They can carry sophisticated, high resolution sensors and possess the ability to transmit real-time data that can be recorded for future analysis or shared with the public for increased transparency. Drone borne sensors currently operated by Interior have provided image resolution improvements of **1,200%** over Landsat 8 satellite and **400%** better than manned aircraft acquired data. These unique sensing characteristics enable drones to gather repeatable, scientifically valid observations leading to better policy decisions, benefiting all Americans.

Safety is a priority in all DOI operations. DOI missions often expose personnel to significant safety hazards including severe terrain, adverse weather conditions, and hazards core to many of these missions (fire, flood, earthquake, landslide, etc.). **From 1937 to 2000, 66% of all field biologist fatalities in DOI were aviation-related.** Drones offer multiple opportunities to enhance employee and public safety by reducing requirements for manned aircraft flight in particularly hazardous mission situations. Additionally, drones have also been used to replace ground personnel in certain missions, reducing their risk to injury. Use of drones can increase the level of safety for personnel both on the ground and in the air by reducing their exposure to hazardous situations.

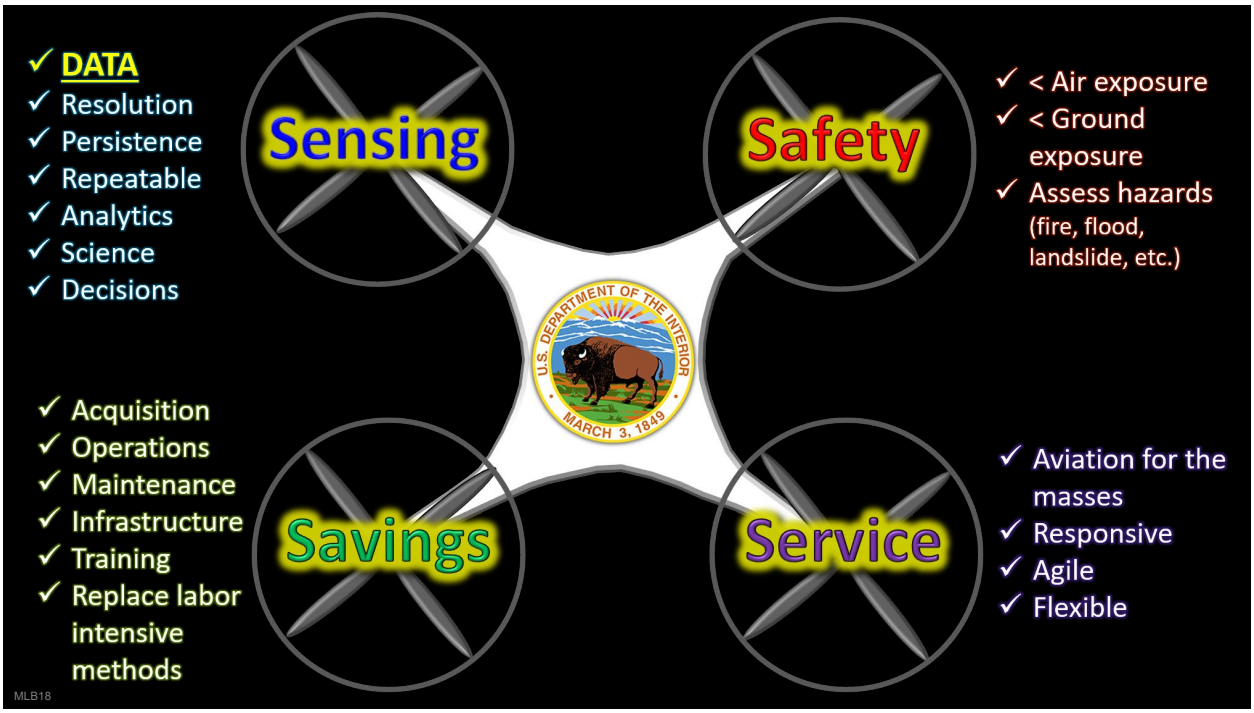


Figure 2. The "Four Outcome S's" of DOI's "Drones for Good" UAS Program.

Savings achieved by Interior through the integration of drones has included the cost to procure, train to, operate, support, and maintain these aircraft. As an example, the total acquisition cost of DOI's current fleet of 810 UAS **Link to slide** was less than the cost many of the individual DOI manned fleet aircraft. Where drones can adequately replace manned aircraft or significantly reduce other costs (i.e. replacing many man hours on the ground to perform the same mission), the savings to the Department and the American taxpayer is significant. Across nearly 30,000 drone flights flown to date, DOI has observed a rule of thumb that a drones can complete a given task in 1/7th the time and at 1/10th the cost of traditional means of accomplishing the same task. Savings also come from reduced loss. DOI UAS have been credited with saving $50M in property and infrastructure when one discovered and undetected spot fire and directed firefighters to extinguish it.

Responsive, agile, and flexible ***Service*** is critical to aviation's ability to support Interior bureau missions. Wildfire, floods, earthquakes, wildlife migrations, injured or lost guests, etc. don't occur on fixed or predictable schedules or locations. Drones provide service enhancements o ver traditional manned aviation. Small drones can easily be integrated with field personnel, enabling them to quickly react to emergent DOI/Bureau mission needs. They can often be deployed more quickly than traditional manned aircraft and their lower acquisition cost and operator training requirements provides the opportunity to deploy them more widely than possible with traditional manned aircraft. UAS have "democratized" the third-dimension for Interior bureaus and personnel, improving the Department's ability to adequately service the 500 million acres of the *"Peoples' Lands"* it is responsible for stewarding.

2019 Statistical Overview and Discussion

Overall trends point to continued growth in the adoption and utilization of UAS for all of the Department's diverse missions. The power of the "Four S's" is exemplified in Table 2 by growth in every variable measured in 2019.

Table 1. Overall DOI small UAS flight statistics for fiscal years 2017 and 2018.

	Total Flight Logs	Total Flights	* Incident Flights	Non-Incident Flights	Training Flights	Total Flight Hours	States/Territories Flown In
FY 2017	1,617	4,976	783	2,271	1,922	803	33
FY 2018	4,313	10,342	1,454	3,793	5,095	1,785	42
FY 2019	3,984	11,442	2,517	5,200	3,725	2,036	48
3-Year Total	**9,914**	**26,760**	**4,754**	**11,264**	**10,742**	**4,624**	

* - Incident flights included Interagency Fire, Law Enforcement, Search and Rescue, Hurricane, and Landslide recovery efforts.

Interior Bureaus, Offices and Interagency Partners

Interior's UAS program is comprised of nine major "Bureaus" in addition to supporting offices (AVSO and OWF) and interagency partners (U.S. Department of Agriculture Forest Service). Table 3 summarizes each agency's contribution to the program and report information.

Table 2 Interior UAS program agency composition.

Agency	Acronym	FY19 Flights	FY19 Aircraft	FY19 Pilots
Bureau of Land Management	BLM	3,637	265	144
U.S. Geological Survey	USGS	3,146	179	114
U.S. Fish and Wildlife Service	FWS	1,367	153	69
National Park Service	NPS	650	60	37
U.S. Dept. of Ag. Forest Service	USFS	791	15	36
Office of Surface Mining Reclamation and Enforcement	OSMRE	600	34	24
U.S. Bureau of Reclamation	USBR	815	51	24
Office of Aviation Services	OAS	218	39	10
Bureau of Indian Affairs	BIA	59	9	6
Appraisal and Valuation Services Office	AVSO	3	0	3
Office of Wildland Fire	OWF	1	0	1

UAS in Support of Wildland Fire Operations

The Interior's effectiveness of UAS operations for wildland firefighting expanded in 2019 with the addition of the Ignis 2.0 Plastic Sphere Dispenser (PSD) which increased capabilities from dropping 30 spheres per minute to 120 per minute. Additionally, the transition to Dragon Egg spheres increased the capacity of the ignis system by 300% to 450 spheres.

Call When Needed (CWN) contractors continued to play an important role in wildfire monitoring in 2019. Table 4 summarizes the fiscal year 2019 CWN flights, which proved very effective in detection and suppression activities.

Table 3. Call When Needed (CWN) contractor flights for fiscal year 2019.

	Total Incident Flights	Fires Supported	Total Flight Hours	States with Flights	Aircraft Types Flown	Months of the year Flown in
FY 2018	86	16	382	6	4	4
FY 2019	43	7	77	4	3	2
2-Year Total	**129**	**23**	**459**	**7**	**5**	**4**

The DOI mobilized Bridger Aerospace Latitude FVR90, BYE UAS Silent Flacon, Insitu Scaneagle and Precision Stalker utilizing the Call When Needed (CWN) services contract to support wildland fire operations. The 4 vendors flew a total of 43 flights for 77 hours across the west during the FY19 fire season. The missions included data collection to provide near real-time data as well as live video feed that provided situational awareness to operation personnel.

Figure 3. Call When Needed UAS support locations in FY19.

FY19 Flights by State / Territory

The Department's UAS activities expanded into more states and territories in 2019 (48 in FY19 up from 43 in FY18), driven by the overwhelming utility and effectiveness employees engaged in the UAS technology have experienced. This leaves Delaware. New Jersey, New Hampshire and Rhode Island as the only U.S. States where DOI UAS did not fly in FY19. The following section breaks down project and incident flights across the United States and territories.

Figure 4 illustrates the almost nation-wide coverage DOI remote pilots have flown. Figure 5 is an area box map which correlates the size of the box with the number of flights in each state. Alaska hosted the greatest number of flights (1,661) with Colorado second, followed by California and Arizona rounding out the states with 1,000 or more flights.

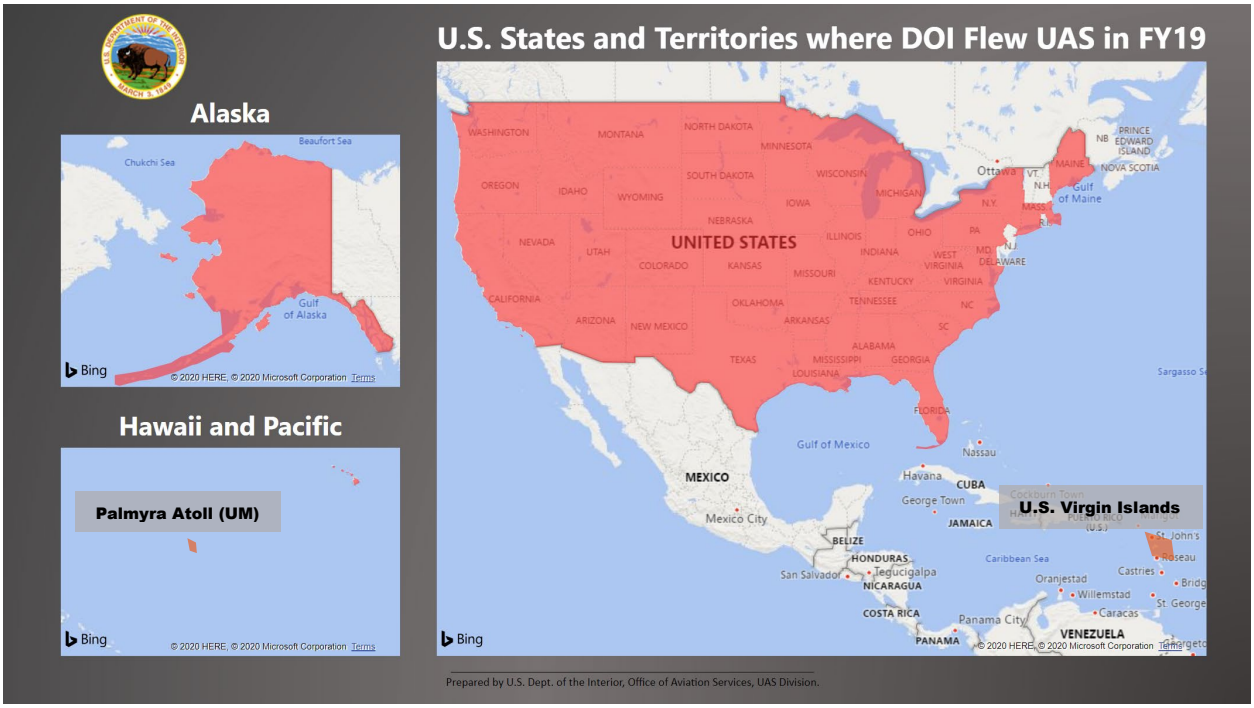


Figure 4. Department of Interior pilots flew UAS in 46 States and 2 U.S. Territories (U.S. Virgin Islands and Palmyra Atoll) in Fiscal Year 2019.

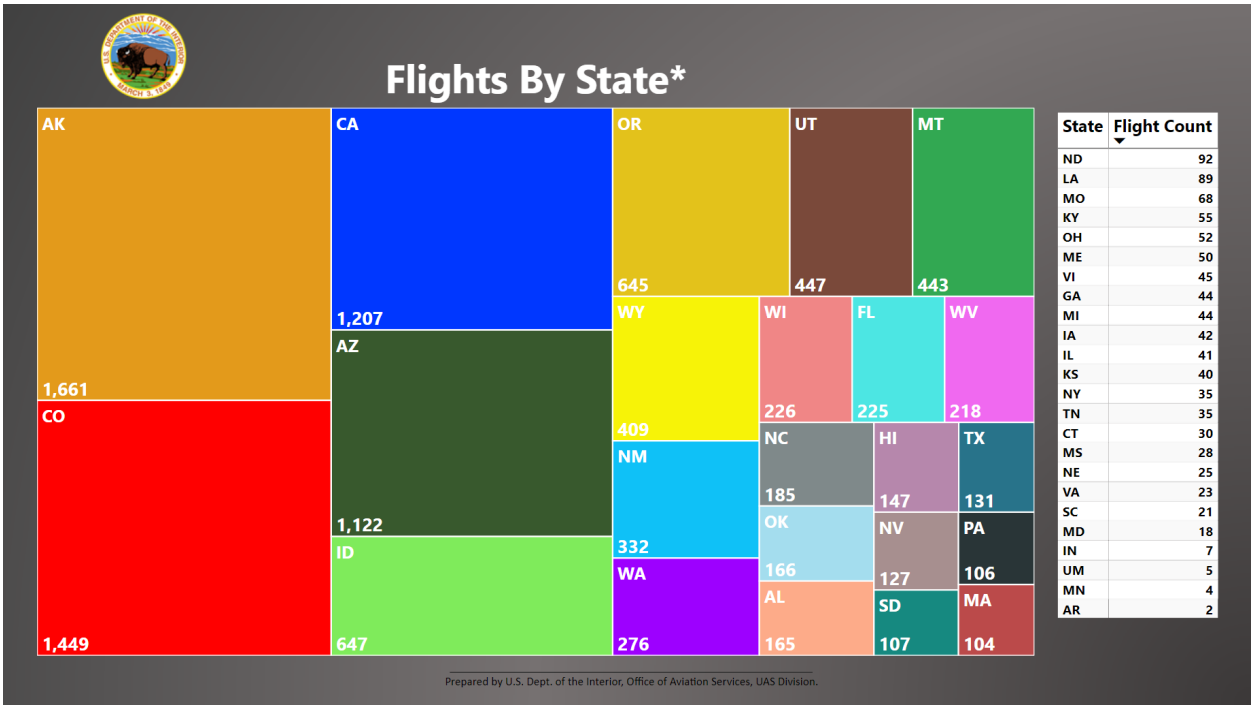


Figure 5. Area plot of total FY19 flights by state. The larger the box, the more flights in that state.

* The box chart shows all states where DOI had 100 flights or more in FY19. The table at right shows all states with fewer than 100 flights.

Fiscal Year 2019 DOI UAS Missions

Interior DOI Missions by Bureau

The number of flights and UAS mission diversity varies greatly according to the size, overall mission, and level of UAS program engagement of individual bureaus. Figure 6 illustrates FY19 UAS flight activities across DOI's nine bureaus and offices. For example, the Bureau of Land Management's (BLM) large contribution stems from their large land holdings, diverse scientific and firefighting missions, and legacy of involvement with the UAS program since its beginnings in 2006.

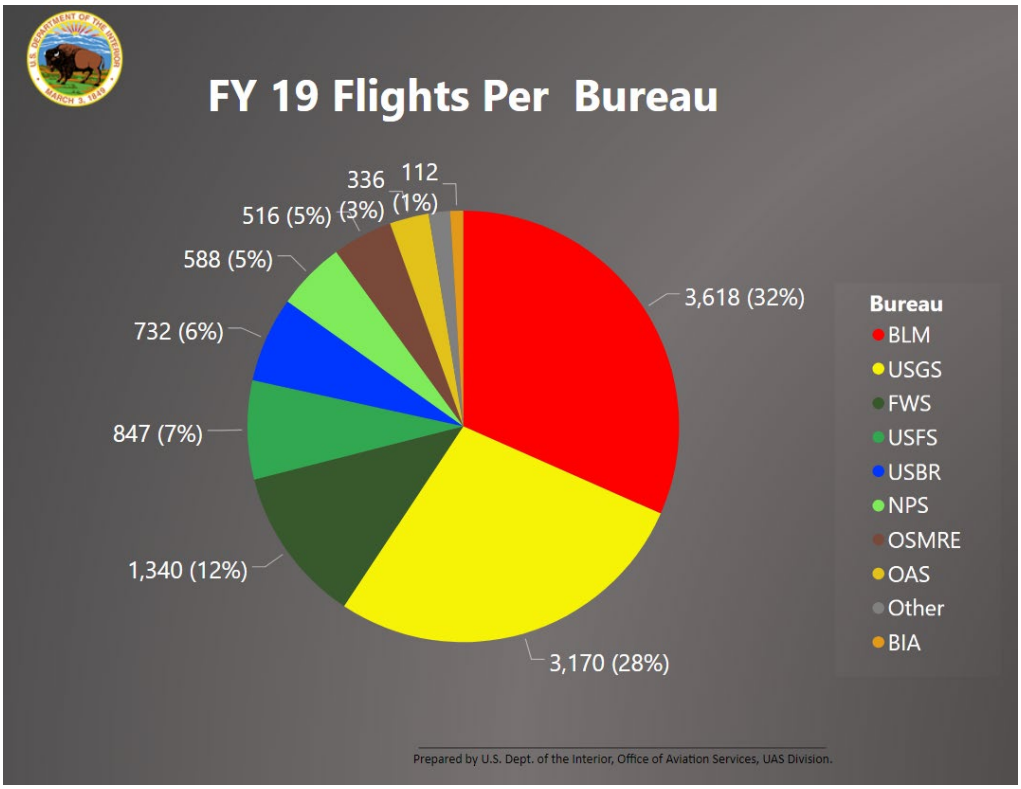


Figure 6. Count and percent of overall FY19 UAS flights by DOI Bureau.

Figure 7 breaks Bureau flights down further by aircraft. The 3DR solo remains the most popular aircraft with several hundred in the fleet. The BLM's disproportionate number of flights with the DJI M600 stems from the aircraft's Ignis Payload and the bureau's mission related to firefighting.

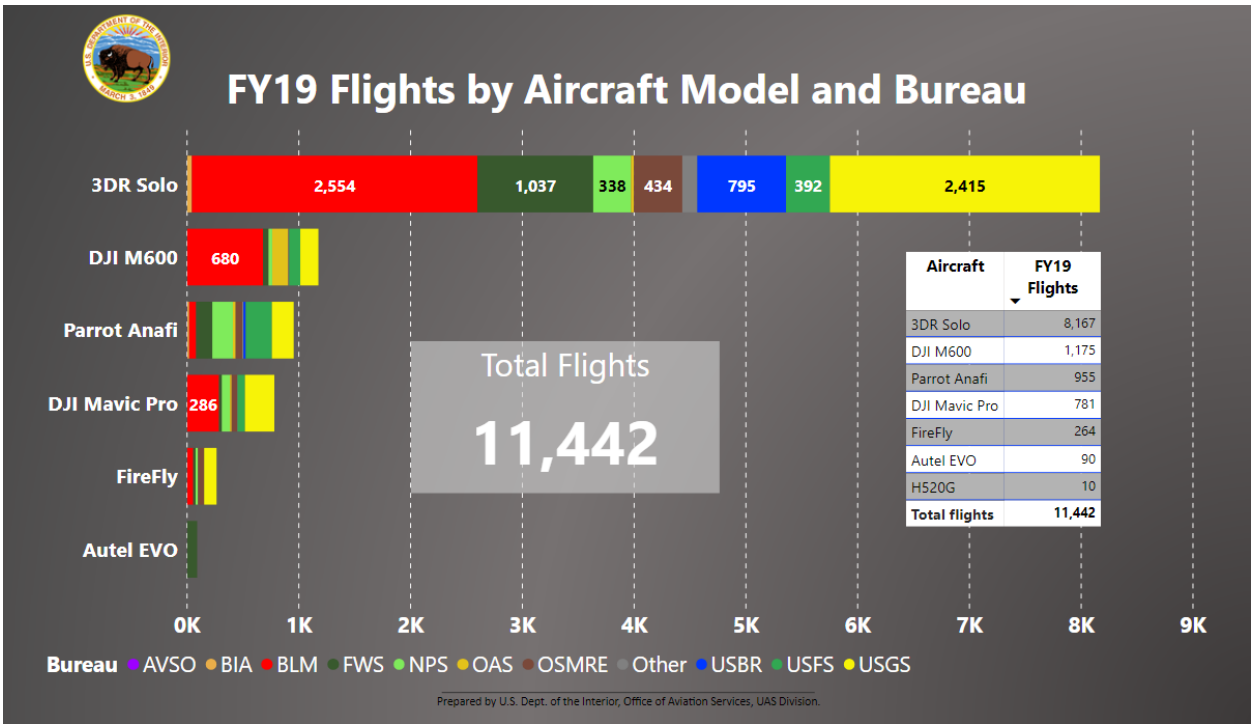


Figure 7. Total DOI flights by aircraft model, broken down by Bureau.

A Breakdown of DOI UAS Missions by Primary Flight Use

Department of the Interior employees are tasked with fulfilling an extremely diverse set of missions. Traditionally, UASs have created great efficiency among remote pilots increasing work effectiveness, expanding capability, and increasing safety all while reducing the cost of doing business. Across Interior's nine bureaus, 7 of which are currently active in the UAS program, UAS missions range from providing situational awareness through video or still photos, integration of precise landscape survey instruments to create centimeter-level accuracy 3-dimensional models, to using drones to position sensors where no other means exist. The combination of DOI mission diversity and a UAS industry poised with ingenuity has fueled the program expansion.

Figures 8 – 11 illustrate flights broken down by the type of mission. Training and proficiency will always be the most important types of flights where DOI remote pilots ensure their skillset is up to whatever challenges await. The large number of training flights in 2018 and 2019 are due to the explosive growth of the program in the past 2 years. There ratio of training to operational flights dropped in 2019 as the pilots who were trained in 2018 started to fly operational missions. Figure 8 illustrates training and proficiency flights to be most common followed by mapping projects, flights in support of interagency fire, and landscape monitoring. Figure 9 further breaks down flights by aircraft. Again, the 3DR Solo dominates most types of flights for DOI except for interagency fire where the increased payload capacity, endurance, range and reliability make the DJI aircraft competitive in popularity given the mission's high stakes and demands.

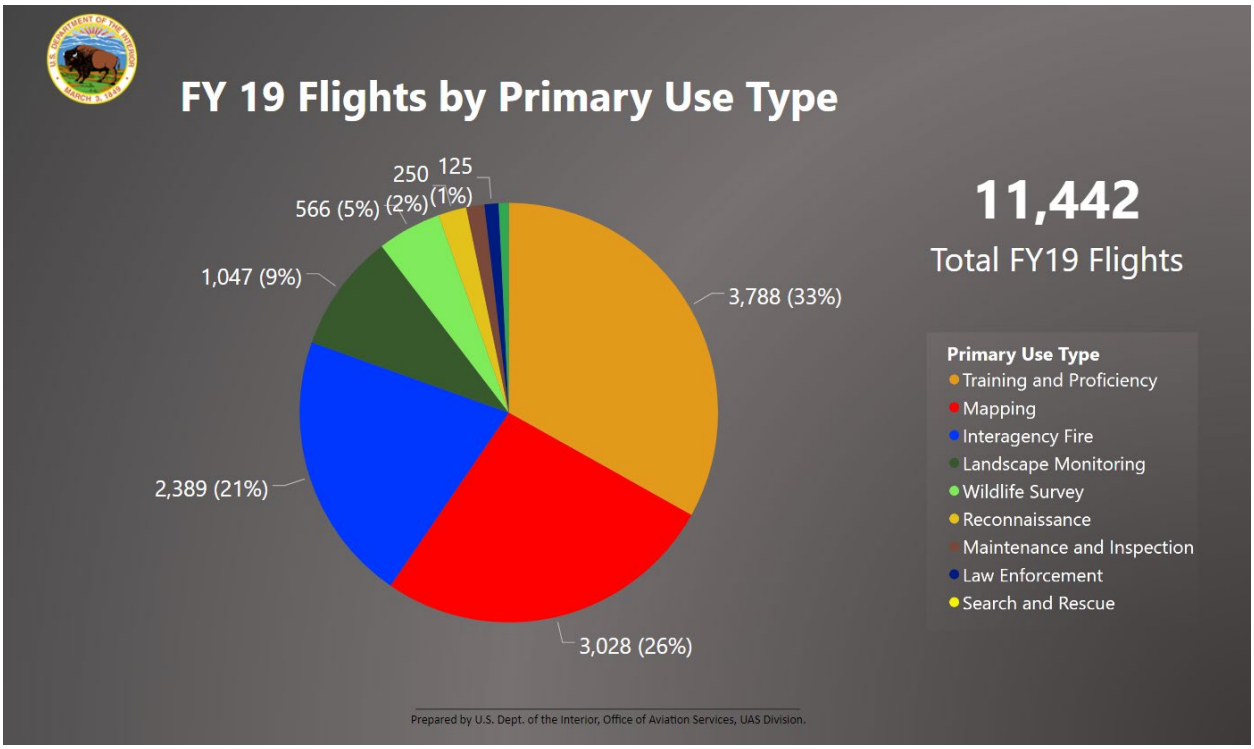


Figure 8. Percent of UAS flights by primary use type for DOI in fiscal year 2019.

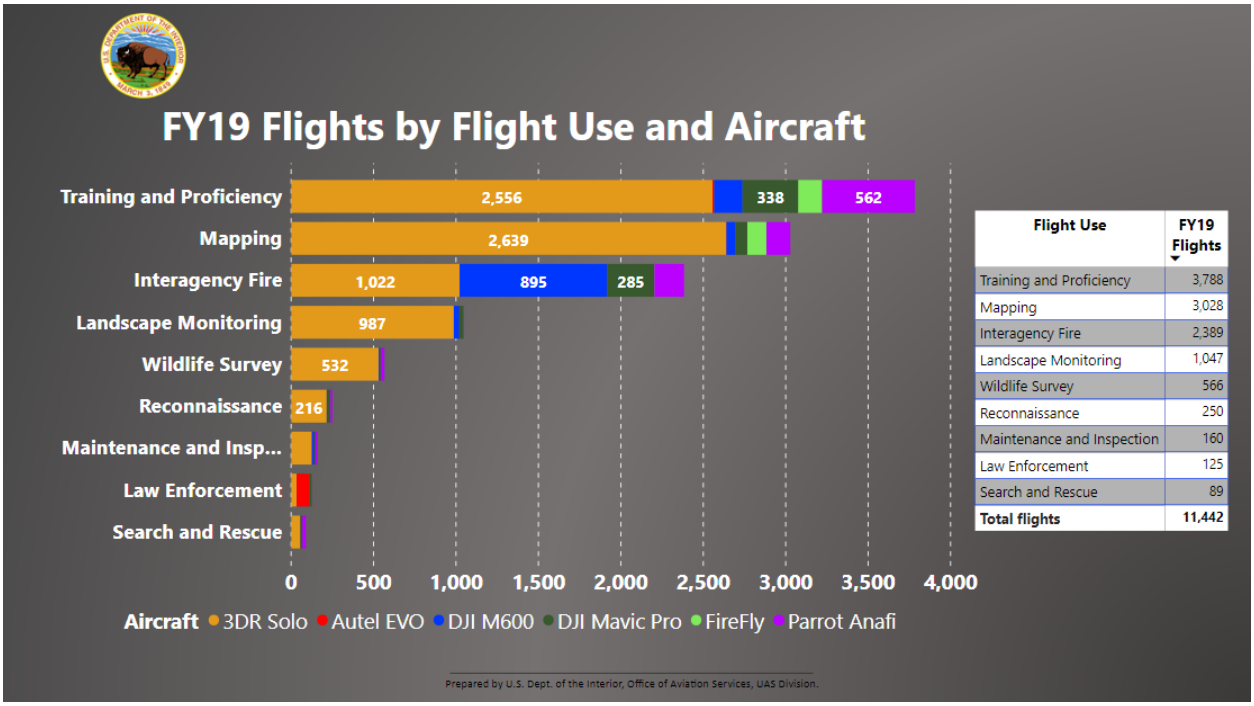


Figure 9. DOI FY19 UAS flights by aircraft model and primary flight use.

Figure 10 breaks down of total DOI UAS flights by use type over the past three years, since digital records have been regularly available for the department. It is evident from Figure 10 annual missions have been reliably consistent over the years. A larger proportion of overall flights were completed using the 3DR Solo in the 3-year summary since most additional aircraft have become available to DOI remote pilots over that period.

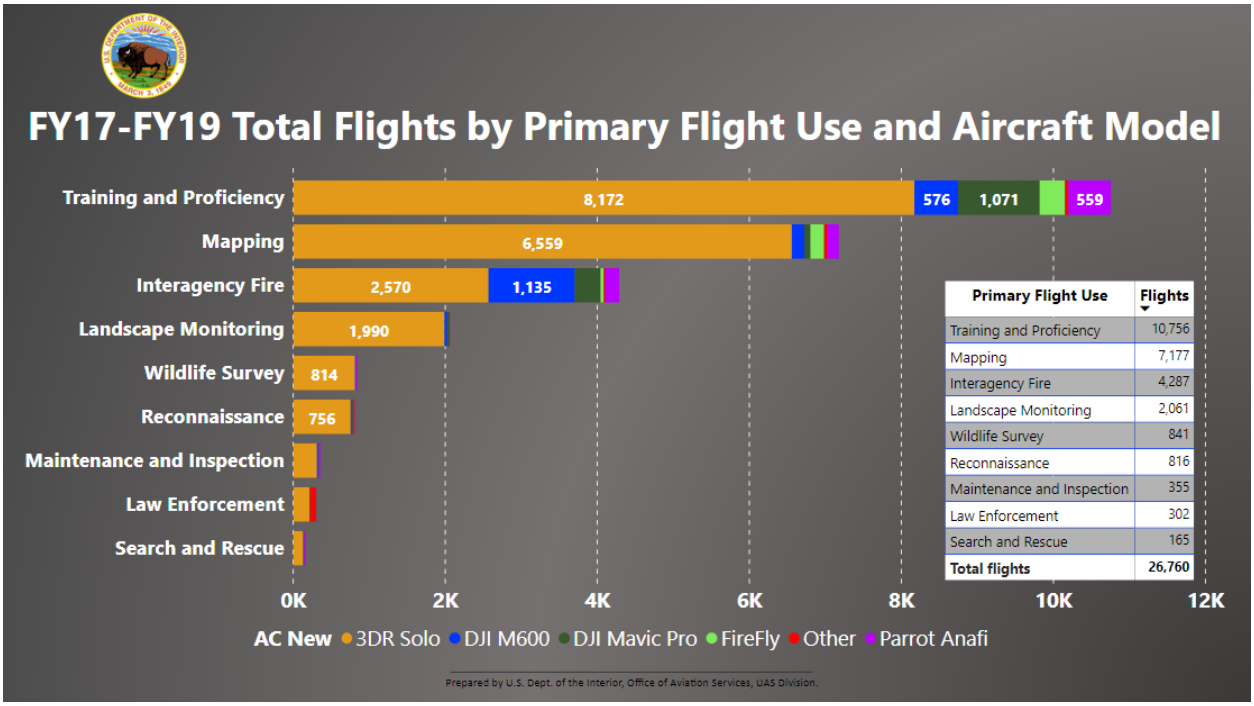


Figure 10. Like Figure 9 above, this graphic represents flight by primary use type and aircraft, over the past three years.

Fire and Incident Response

UAS support for interagency firefighting and incident response is a central focus for DOI UAS program managers and leadership to keep the American people safe while also increasing safety and effectiveness for first responders. Currently there are 128 firefighters trained to use UAS across multiple bureaus, offices, and agency partners. Interior pilots have been involved with many types of incident response, most notable interagency fire response (91% of all FY19 incident response flights).

Other incidents where UAS were deployed in FY19 include flood response below the McKay dam in Oregon, hurricanes Michael and Dorian, tornado response in Texas, and the USGS's monitoring of Hawaii's active Kilauea volcano. Figures 11 through 13 provides a break-down of response-related UAS flight activities. Figure 11 demonstrates the importance and leadership the BLM plays for interagency fire in cooperation with other interagency partners (U.S. Forest Service; USFS). Figure 12 illustrates the focus on interagency fire, stemming from the program's early roots in DOI's manned aviation program, specifically in the realm of wildland firefighting.

Figure 13 provides a similar break down of incident flights by bureau and incident type for flights over the past three years.

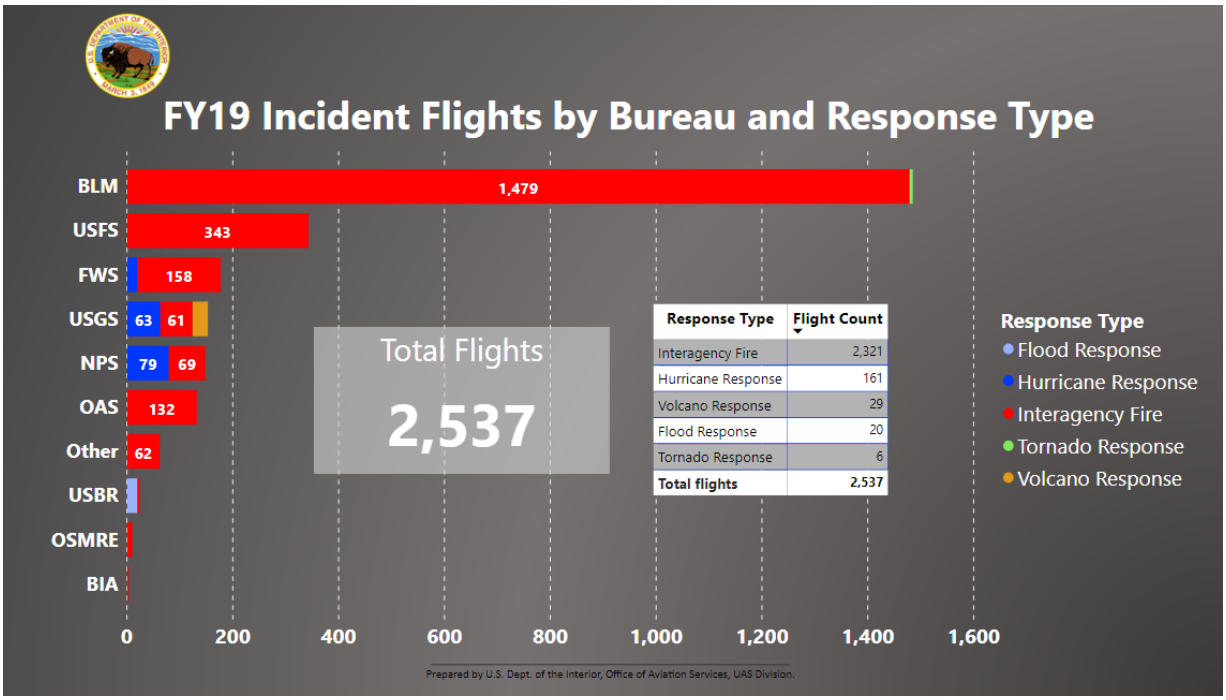


Figure 11. Number of incident flights by Bureau and response type.

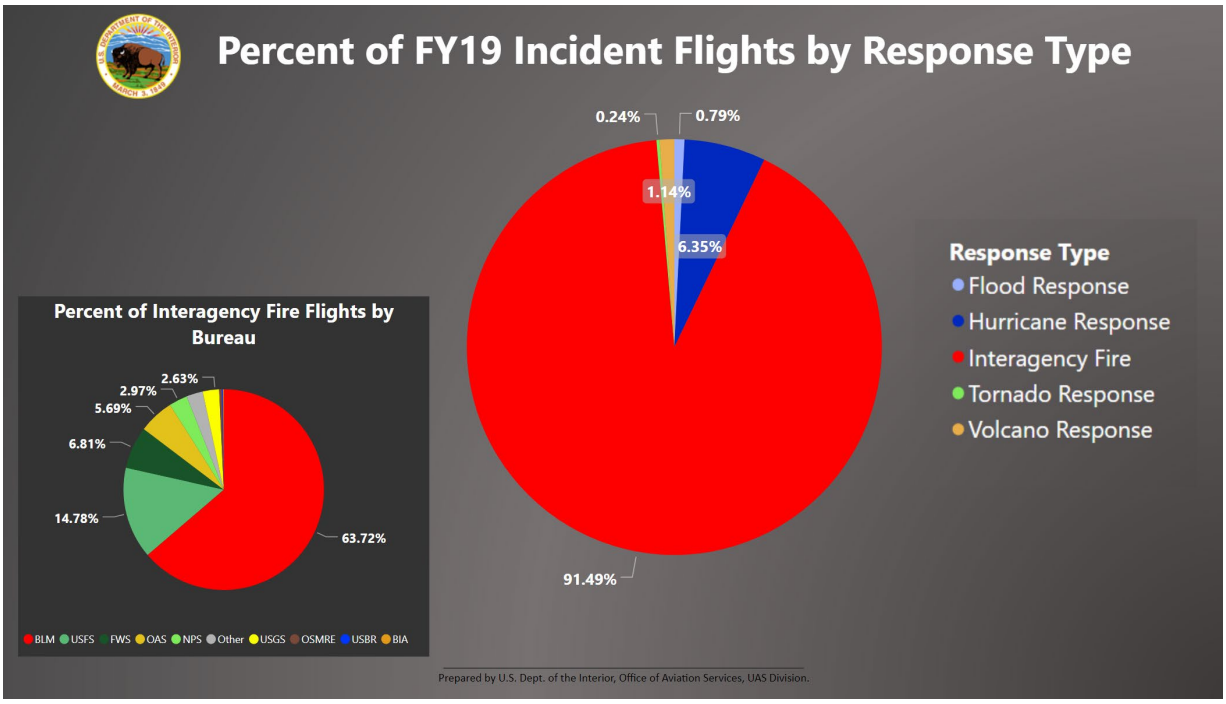


Figure 12. Incident response flight percent broken down by response type and interagency fire response Bureau.

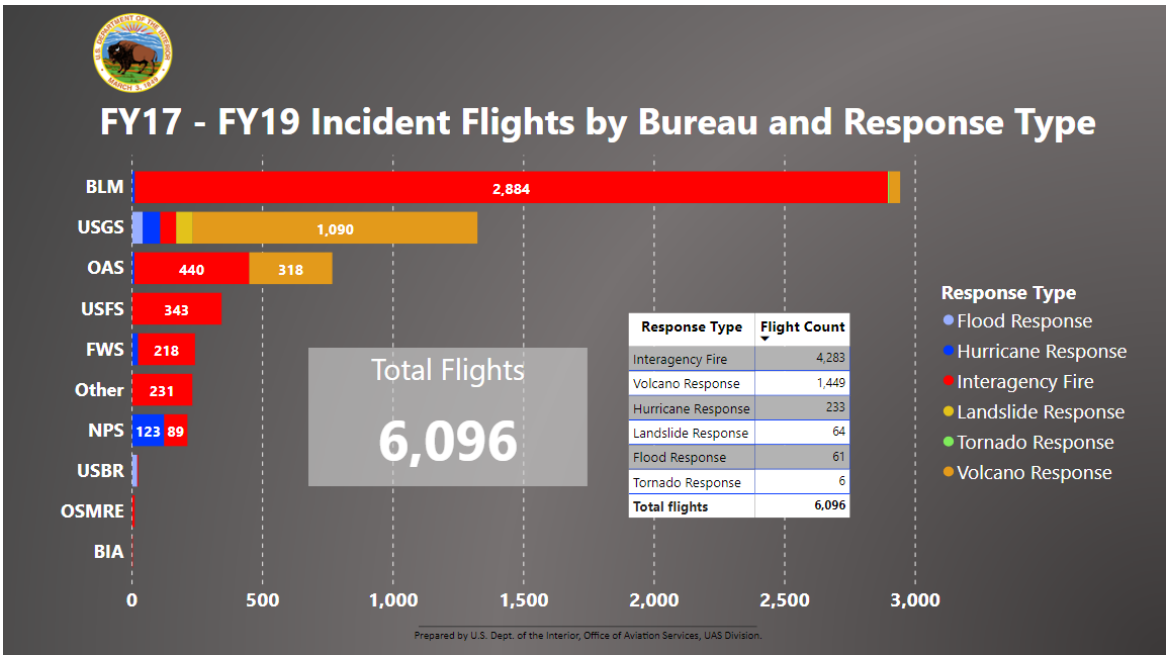


Figure 13. Incident response flights by bureau and incident type over the past three years.

Ignis Aerial Ignition System Improves Capacity by 400%!!!

The Drone Amplified Ignis payload has ignited *DOI's utility for fighting wildfire with UAS. This Plastic Sphere Dispenser (PSD) provides firefighters the ability to build miles of fire-containing backfires in a short time, and activity previously conducted slowly on foot, or dangerously with a manned helicopter. In FY19, Drone Amplified released the Ignis 2.0 (in action left and smaller carrying case on the right of the right image) which provided greater capacity and utility.*

Factor	Ignis 1.0	Ignis 2.0
Max PSD Capacity	150 spheres	450 spheres
Loaded Weight	12lbs	12 lbs
*Max Drop Rate	30/min	120/min

DOI Remote Pilots

At the end of Fiscal Year 2019, the Department was comprised 468 remote pilots across nine bureaus, offices and interagency partners (Figure 14). Remote pilots can be individually qualified across any or all of six main airframes as well additional qualifications such as flying Beyond Visual Line of Site (BVLOS), operating for incident response, flying at night and using special payloads. For most remote pilots, these qualifications are collateral duty, making formal training and informal flight and crew training an essential component to maintaining safety and proficiency for all systems, qualifications and flight activities.

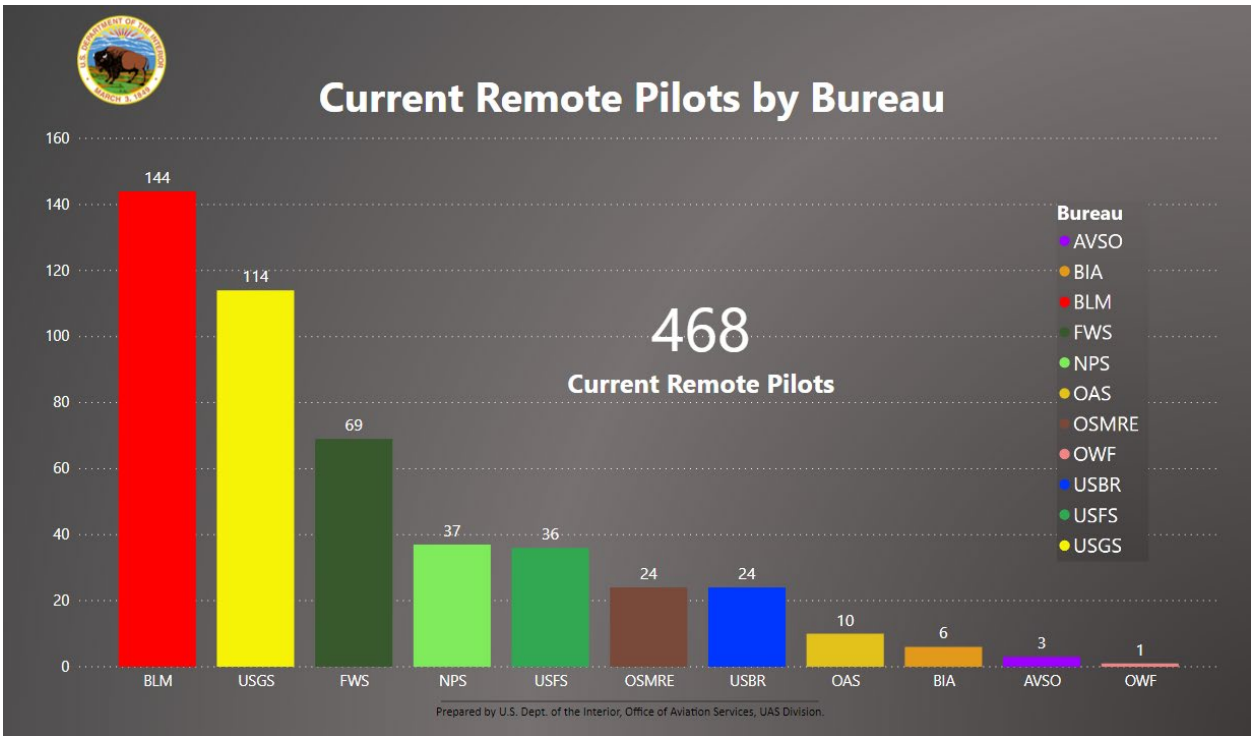
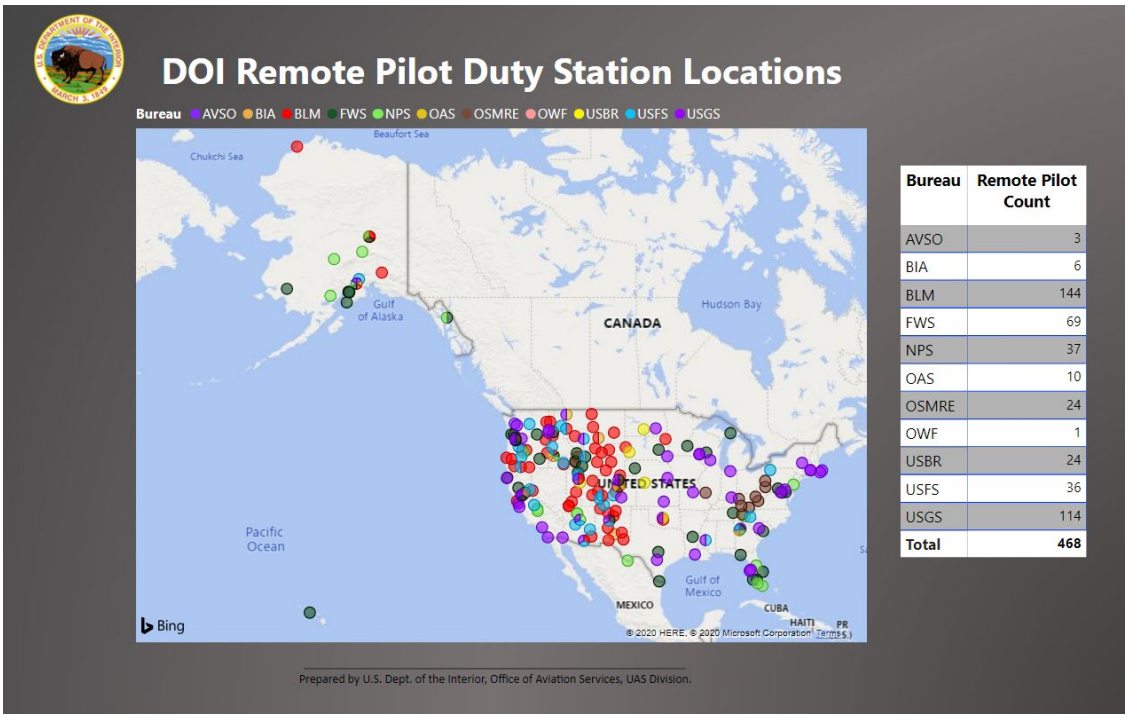


Figure 14. Remote pilots in FY19 by bureau, office or interagency partner.

The distribution of remote pilots across the United States may make DOI the most capable UAS force in the nation to respond to domestic emergencies (see Figure 15). While most remote pilots are trained for scientific missions, the program's rigorous training and currency requirements means skilled and capable pilots are only a few hundred miles (at most) from being able to respond. Figure 16 illustrates pilot count by bureau distributed across more than 40 states.



Bureau	Remote Pilot Count
AVSO	3
BIA	6
BLM	144
FWS	69
NPS	37
OAS	10
OSMRE	24
OWF	1
USBR	24
USFS	36
USGS	114
Total	**468**

Figure 15. The distribution or DOI remote pilot duty stations, by bureau, across the United States.

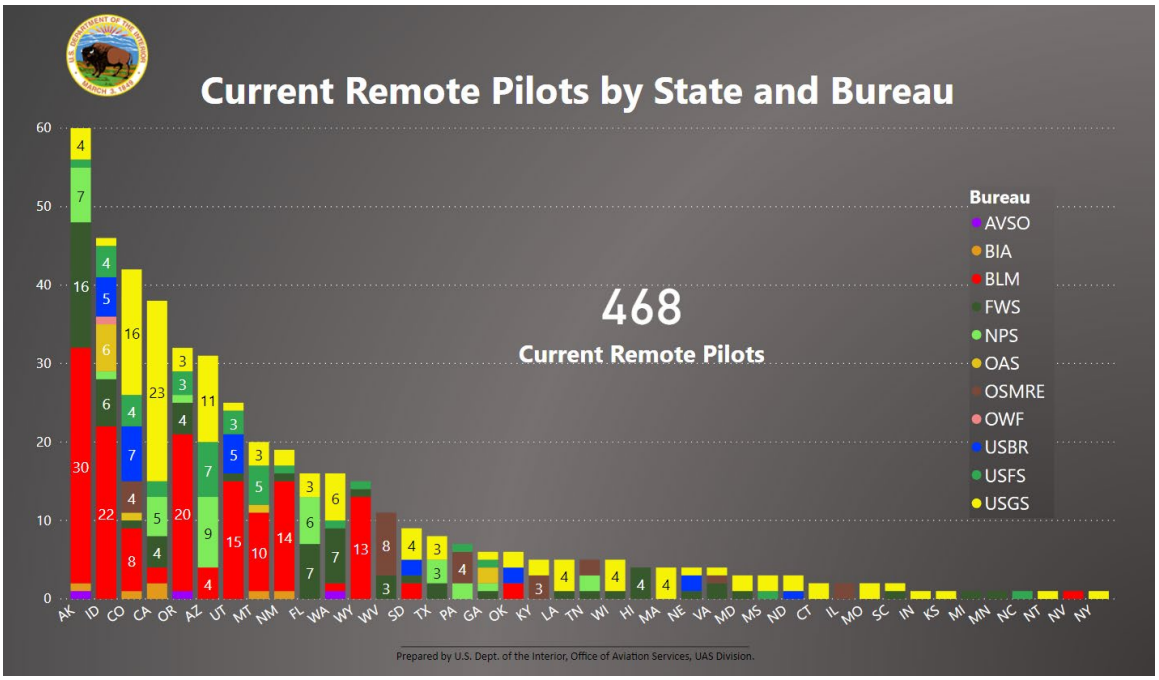


Figure 16. DOI remote pilot counts by state and bureau.

Remote Pilot Training

The Office of Aviation Safety (OAS) and other Dept. training personnel offer several formal training courses from basic remote piloting to advanced equipment training like the Ignis 2.0 Plastic Sphere Dispenser (PSD; Table 4).

Table 4. DOI UAS training courses held in fiscal year 2019.

Course Description	Bureau / Office Lead	Classes Held in FY19	*Remote Pilot Attendees
A-450 Basic Remote Pilot Training	OAS, BLM, FWS, USFS	16	126
Incident Response Training	BLM	2	40
Advanced Processing and Planning	OAS, BLM, FWS, USGS	3	73
A-452R – Basic Refresher	OAS, BLM	11	101
Totals for FY19		32	340

There are several different training courses in DOI related to the use of UAS. The A-450 Basic unmanned aircraft operator's course is a prerequisite for additional training, providing student guidance for basic UAS flight controls and aviation safety. The course is 32 hours of instruction with an average class size of 14. It can be offered in any part of the country depending on the requirements of the bureau.

In addition to the basic operator's course, advanced UAS training is available from OAS, BLM, USGS, and FWS. Advanced UAS courses focus on UAS project planning, data collection and advanced data processing methods. This course is 32 hours of instruction with average class size of 15.

There are currently two courses offered through DOI specifically for wildland fire fighting with UAS. S-373 provides training specifically for UAS pilots operating on a fire or other emergency incident. An advanced course for wildland fire training focusses on utilizing the aerial ignition payload from the front lines of the fire. Both courses are 40-hours and have an average class size 15.

DOI remote pilots are required to take a refresher course once every 2 years. This course is designed to give the employee the most up-to-date information on the UAS program and prove them with the opportunity to learn best practices and to provide feedback on how their use of UAS going. This 2-hour course is offered as a webinar or in person, class size varies.

DOI Aircraft

The Interior's UAS program growth has parralelled the expansion of capability and reliability of available aircraft. The 3D Robotics Solo, DOI's first micro-rotor category aircraft capable of interchangeable payloads, remains the most widely used across all bureaus and most mission types.

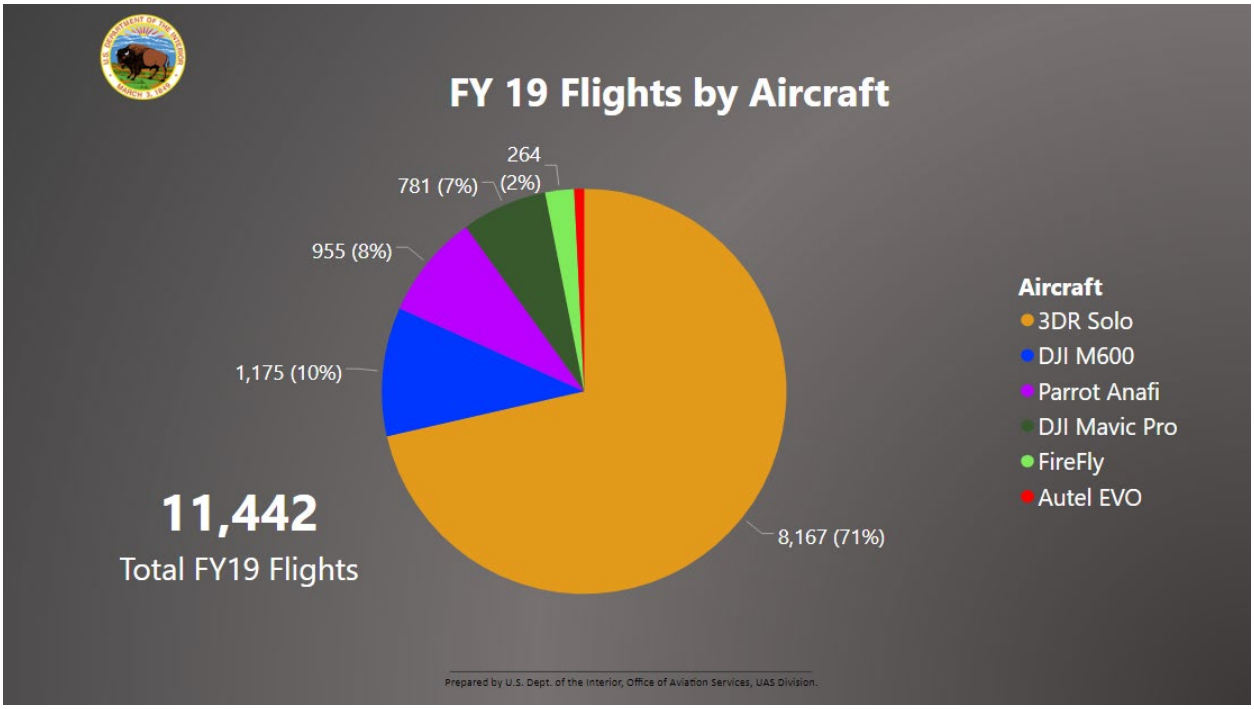


Figure 17. FY19 DOI UAS flights by aircraft model.

Table 5. Current fleet count, manufacturer and investment.

Company	HQ Location	Location Assembled	Chinese Componentry	Model	Count of DOI Aircraft	Total Investment
3D Robotics	USA	China	Yes	Solo	486	$767,811.21
BirdsEyeView Aerobotics	USA	USA	Yes	FireFly 6 Pro	24	$355,724.50
DJI	China	China	Yes	Matrice 600 Pro	45	$273,144.00
DJI	China	China	Yes	Mavic Pro	74	$116,525.26
Parrot	France	China	Yes	Anafi	144	$89,467.55
Parrot	France	China	Yes	Anafi Thermal	24	$40,480.00
DroneVolt	France	France	Yes	Hercules	1	$12,823.20
DJI	China	China	Yes	Mavic 2 Enterprise	2	$6,736.00
Autel	China	China	Yes	Evo	5	$6,013.97
Sky-Hero	Belgium	Belgium	Yes	Loki	2	$3,401.33
Skydio	USA	USA	Yes	R1	1	$1,499.95
E-Flight	USA	USA	Yes	Apprentice	2	$539.98
				Total	**810**	**$1,474,166.95**

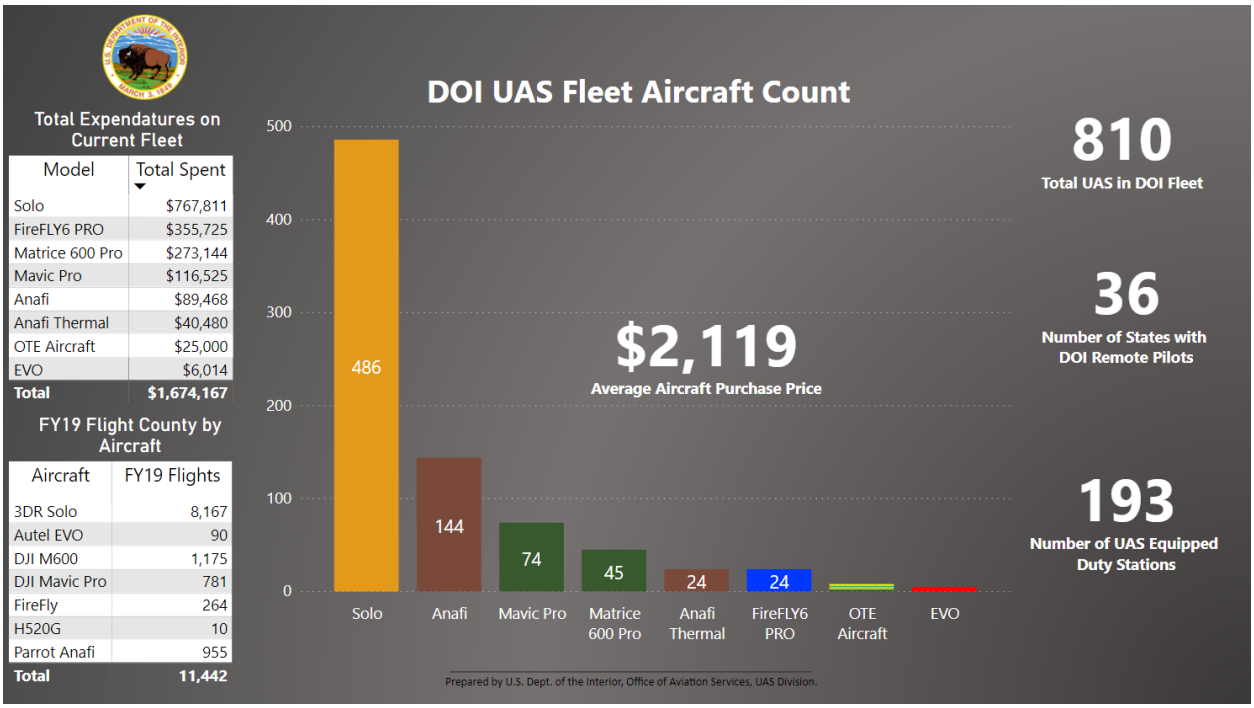


Figure 18. Interior FY19 UAS fleet counts, flights, and program-total to date acquisition costs.

Pilot and Aircraft Utilization

During FY 2019 the **468 active DOI UAS pilots conducted 811 unique projects not including training missions**. The estimated in-house costs for these projects including, equipment, training, travel, and salary was **$2.4M**. Modeling and analysis indicate the cost of in-house UAS operations is to **be ~68% less than the cost of doing the same number of projects utilizing end-product contracts**, based on the average price per end-product contract DOI completed in FY18. This is not to say that end-product contracts are not appropriate, but that managers should consider whether in-house operators would be more cost effective for a given project. Analysis also indicates that if the same 811 projects had been completed using manned aircraft that the cost to department would have been significantly higher. When compared to using a Top Cub for example (one of our lowest cost fleet aircraft), the operating cost of using UAS is approximately **28% less for a given project.** Compared to utilizing a larger aircraft like the Kodiak K100, UAS operating costs are approximately **73% less for a given project**. Using a Bell 2016 Jet Ranger, operations would have cost **6 times more than using UAS**. This is not to say UAS are appropriate in all situations, but that a consideration must be made during project planning as to whether a project could be done by a UAS in a more cost-effective manner. UAS are particularly well suited for smaller scale projects when compared with manned aviation. For landscape scale projects, manned aircraft are still likely the most efficient method of collecting data. **One area in DOI that UAS have proven especially useful is using UAS to capture data that is traditionally captured using employees on foot.** For projects such as those, **UAS have proven to be 7 times faster and roughly 1/10 the cost of traditional ground-based methods**. The following chart depicts the estimated cost to DOI if the **811** projects completed using UAS in 2019 were transitioned to other aircraft, contracts or to ground based data collection.

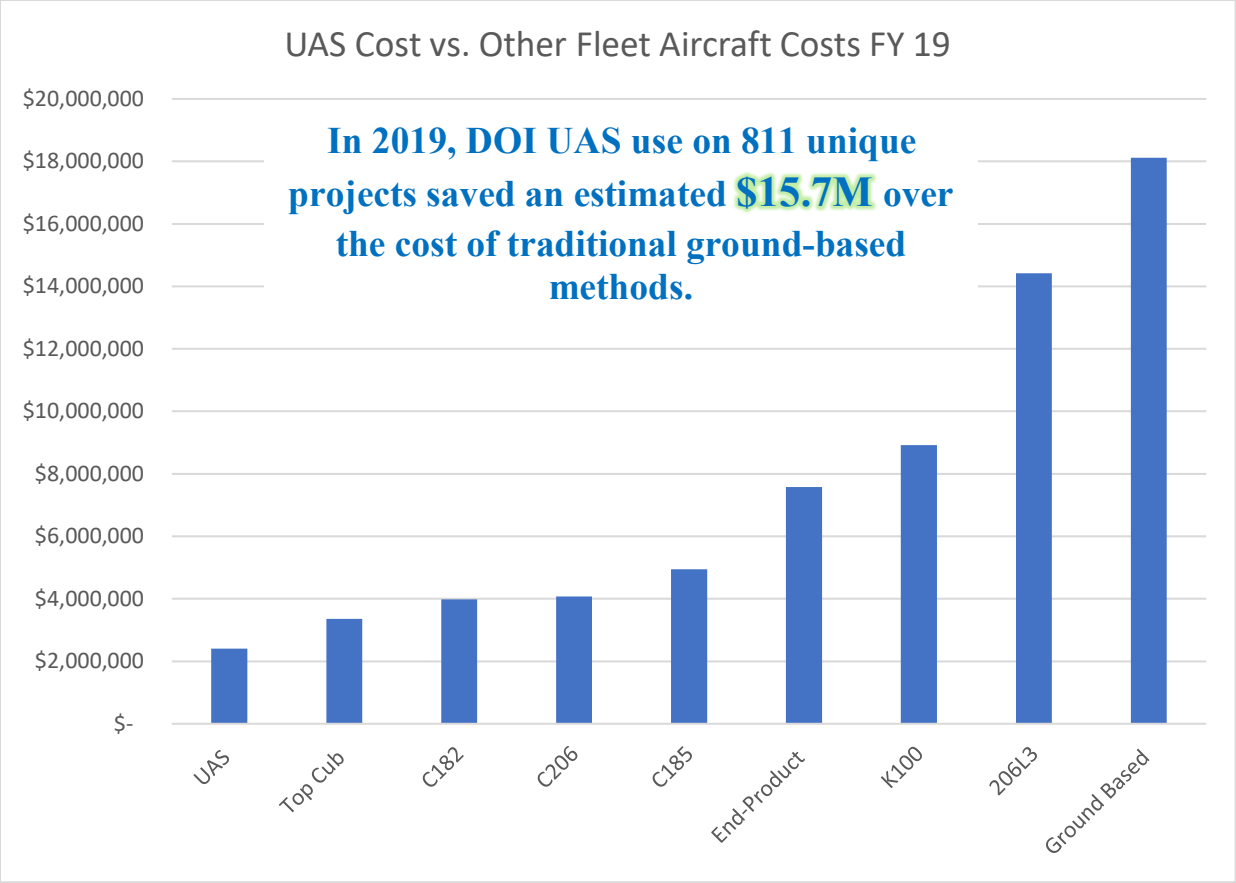


Figure 19. UAS Cost vs. Other Methods Across 811 DOI Projects in 2019.

*Assuming all missions completed by UAS in 2019 were transitioned to the other method.

DOI UAS Data Management and Risk Mitigation Strategy

For most UAS applications, acquired data and the products derived from it which enable better, more agile, and transparent action are central to mission success. Effective management of UAS acquired data and mitigation of the risks of unintended distribution is a characteristic of a professional UAS program. Public experience with government and private sector data breaches and privacy concerns related to drones reinforce the importance of having a data management and risk mitigation strategy for all UAS programs. Although DOI has longstanding policy and procedures for the management of collected data within traditional IT systems and mission methods, UAS present additional, non-traditional challenges and vulnerabilities.

Unlike manned aircraft, most UAS and their sensors are controlled through active links with a ground control station (GCS). If the vehicle and/or sensor control link is overtaken by an unauthorized operator and the drone is flown outside the intended area of operations (or the sensor is slewed to where it should not be pointed), significant security, safety, or privacy incidents could result.

Likewise, unlike manned aircraft, most UAS actively transmit data from the vehicle/payload system to the GCS. If the payload data link is intercepted by unauthorized parties similarly

significant security, safety, or privacy incidents could result which could cause embarrassment or damage to the operating organization.

Lastly, unlike manned aircraft conducting similar missions, some UAS automatically collect flight and payload data, which is often shared with the manufacturer through flight control and/or data acquisition/processing applications that connect to the internet through the GCS or other means. UAS programs unaware of whether their data is being collected, where it is going and for what purposes it is being used also risk exposure to security and privacy incidents.

From the beginning of the DOI UAS program data security has always been a priority. DOI has taken positive steps for data assurance by requiring that no data be shared with a manufacture without the express permission of DOI. By using best practices for cybersecurity and privacy assurance DOI UAS have conducted over 30,000 flights with no data being compromised and no complaints from the public.

Elements of DOI's UAS Data Management and Risk Mitigation Strategy

Interior's UAS data management and risk mitigation strategy is founded, like the rest of its program in solid, mission-focused requirements determination and adherence. From 2010-2014, OAS leveraged a diverse array of excess DOD small UAS (valued at $25M, but acquired at no cost) to conduct hundreds of operational test and evaluation (OT&E) flights across dozens of Interior mission applications. Based on experience and data collected during this OT&E program, over 300 Interior bureau and OAS subject matter experts came together to develop a series of Master UAS Requirements that continue to guide Interior fleet and contract UAS acquisitions.

Common across the Interior Master UAS Requirements for various small UAS were three data management and risk mitigation requirements: encrypted control link, encrypted payload link, and enterprise level data sharing control Subsequent market research indicated that outside the military UAS market, there were few consumer/professional UAS that met all three of these requirements. Unfortunately, tested military UAS did not meet other critical Interior mission requirements (e.g. sensor resolution, versatility) and were cost prohibitive for Interior bureaus' available funding levels (military drones are up to 10X the price of similarly capable consumer models). Interior identified and acquired an initial inventory UAS that met the three data management and risk mitigation requirements, but for only two of the UAS types identified in the Interior master UAS requirement.

In 2015, OAS began working with federal partners and the drone industry to develop solutions that met Interior's three data management and risk mitigation requirements for other small UAS types listed in DOI's Master UAS Requirement. OAS has also engaged relevant industry and government partners to assess the security of UAS that claimed to meet these three requirements.

The layered approach to UAS security has proven to be successful within the Department of the Interior. In over 30,000 flights conducted since 2010 no data has been transmitted or leaked to any location other than where it was intended to reside.

DOI Unmanned Aircraft Systems (UAS) Layered Data Management Assurance / Security Approach

DOI's layered approach to data management assurance/security parallels the same construct used in the operational risk management of aviation safety:

1. Identify the hazard.
2. Analyze the hazard.
3. Make risk decisions.
4. Implement independent controls that together as a layered defense, greatly reduce the probability of the hazard occurring.
5. Monitor and adjust based on documented results.

The illustration to the right depicts some of the layered security measures DOI employs. Others include policy, training, top-to-bottom personnel accountability, regular external audits, etc.

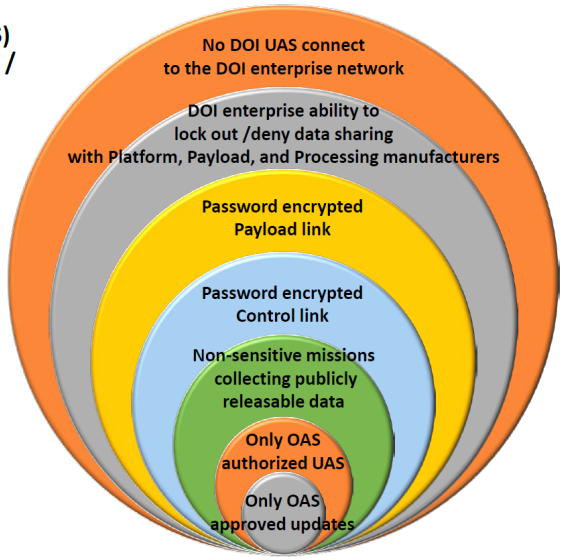


Figure 20. Elements of Interior's UAS Data Management and Risk Mitigation Strategy.

2020 Outlook

At the beginning of FY20 the Secretary of the Interior enacted a temporary grounding of all non-emergency UAS missions to complete a comprehensive review of the program. Assuming the grounding of non-emergency missions extends through FY20 it is expected that the number of UAS missions will be reduced by 80-90% for the fiscal year.