U.S. Forest Service Explores Use of UAS In Fire Management

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On August 27, 2013, an unusual resource order was placed for the Rim Fire in southern California, which by that date had burned more than 160,000 acres of the Stanislaus National Forest, Yosemite National Park, and land under the jurisdiction of CALFIRE; had destroyed more than 20 structures; was only 20% contained with no estimated containment date; and had nearly 4,000 personnel assigned to it. A "Request for Assistance" was placed to the Department of Defense (DoD) for an "Aerial platform capable of 24 hour persistent non-interrupted Incident Awareness and Assessment (IAA) operations." The aerial platform was "…required to have infrared and video capability along with GIS referenced production onto the Rim Fire Incident Command Post (ICP) and would be used for fire perimeter detection though smoke and containment line construction, and wildland firefighter safety."

The "Request for Assistance" was placed to the DoD for the Rim Fire due to its size, potential for additional growth, and values at risk, which created a need for more extensive and current information and intelligence about fire activity to ensure firefighter and public safety than most wildfires. The DoD approved the request for assistance and provided an MQ-1 Predator Remotely Piloted Aircraft (RPA) operated by the California Air National Guard's 163rd Reconnaissance Wing in Riverside, California. The MQ-1 was launched on August 28th and flew more than 150 hours in support of the Rim Fire before it was demobilized on September 4th.

During that time, the MQ-1 provided Electro-Optical/Infrared (EO/IR) Full Motion Video that enabled members of the Southern Area Blue Type 1 Incident Management Team and CALFIRE, which were managing the Rim Fire under unified command, to view events while they were happening. The MQ-1 flew in support of a variety of fire management missions, including reconnaissance and monitoring during burnouts; verification of new hotspots detected outside of the fire perimeter during traditional nighttime infrared flights; verification of the location and size of known spot fires; and mapping of the fire perimeter during daytime hours. Live, real-time images provided by the MQ-1 supplemented traditional nighttime infrared flights that provided incident managers with a static, large scale image of the entire fire at a specific point in time every 24 hours.

According to Mike Wilkins, Incident Commander, having the capability to obtain Full Motion Video of the fire at virtually any time of day or night was very valuable. "We had one or two large nighttime slopovers, and at 2300 hours or so, the MQ-1 allowed us to see better than the Division Supervisors on the ground whether we were going to catch it or not as we considered major late night manpower planning changes for the next day's Incident Action Plan," said Wilkins. "We could see the dozer and hand crews and we knew where up and downhill was as if it were daylight, we had a better big picture than those on the ground operating in the dark and smoke similar to Initial Attack mode."

Wilkins and other Incident Management Team members point to several instances of the effectiveness of the MQ-1. For example, the MQ-1 detected a spot fire ignited by a burnout operation early enough so that crews could quickly respond and contain it. The imagery that the MQ-1 provided allowed operators to obtain the approximate size and position (latitude/longitude) of the spot fire and to calculate the direction and distance from containment lines. Also, the MQ-1 reconnaissance of three hotspots detected by traditional nighttime infrared flights outside of containment lines confirmed one hotspot and revealed two hotspots to be false positives. This enabled the incident management team to allocate fire suppression assets more efficiently. In addition, the MQ-1 provided perimeter maps of divisions independent of traditional nighttime infrared flights.

"An unmanned aircraft like the MQ-1 probably isn't appropriate or needed on run-of-the-mill fires," said Wilkins. "But on an extraordinarily large, fast moving fire like the Rim Fire it's pretty handy when you have a concern about an area to be able to get a look at the fire and what it's doing on a more frequent basis than one nighttime infrared flight."

Wilkins and other Incident Commanders could be able to use "Unmanned Aircraft Systems" (UAS) more often when managing fires on National Forest System lands in the not – too-distant future. The U.S. Forest Service uses the term "UAS" because that is what is used by the Federal Aviation Administration (FAA), which has regulatory authority over the National Airspace System. Some branches of DoD, and others, call unmanned aircraft RPAs while the news media and members of the public often refer to them as "drones."

Collectively, a UAS consists of an aircraft platform, sensor and communication payloads, and the ground control segment. FAA policy identifies "Unmanned Aircraft (UA) as 'aircraft' flown by a 'pilot' regardless of where the pilot is located." U.S. Forest Service policy uses the

same definition. Like manned aircraft, satellites, and balloons, UAS can be equipped with different types of sensors to gather a wide variety of images and information. These include sensors that can provide near, real-time Full Motion video; radar and other sensing equipment that can create maps; and meteorological instruments that can obtain temperature, humidity, and wind direction and speed.

The U.S. Forest Service has been considering and evaluating UAS technologies for several years. The National Aeronautics and Space Administration (NASA) *Ikhana* UAS was used to map a number of prominent wildfires in 2007, 2008, and 2009. U.S. Forest Service fire management staff has identified many additional potential uses of UAS in managing wildfires and prescribed fires. These include wildfire detection; assessment of wildfire potential; prioritization of wildfires; monitoring of prescribed fires and wildfires being managed to achieve resource management objectives; monitoring wildfire behavior, rate and direction of spread, and flame length; identification of roads and other potential fire breaks, water sources, and potential fireline and helispot locations; measurement of temperature, wind direction and speed, and relative humidity; location of spot fires and values at risk ahead of fires; facilitation of radio and data communications between dispatch, the fireline, and the incident command post; acquisition of Electro-Optical/Infrared (EO/IR) [color camera] images; monitoring of air quality; and evaluation of the effectiveness of fire management actions.

The U.S. Forest Service is currently exploring the potential to use, and developing a program to manage the use of, UAS for fire management and other natural resource management purposes, such as forest and range management, research, and forest health protection. The agency has chartered an interdisciplinary UAS Advisory Group to address guidance and use of UAS within the U.S. Forest Service. The group is led by Bob Roth, Aviation Management Specialist with the U.S. Forest Service Missoula Technology and Development Center and is comprised of subject matter experts with backgrounds in aviation, safety, and natural resource management programs. It has been tasked with several actions, including conducting a thorough review of agency policy; making policy recommendations; completing a risk assessment; and developing a strategic plan. After the group has completed these tasks, U.S. Forest Service leadership will determine the utility of a UAS program for the agency.

“While UAS are a promising technology, it’s important to remember that several different types of aerial platforms can be equipped with sensors to gather and transmit data,” said

Roth. "Just as doctors need to diagnose patients before they prescribe treatments, we need to define our mission requirements and then determine whether UAS or other aerial platforms are best suited to meet them."

Regardless of whether the U.S. Forest Service decides to operate UAS itself, the agency needs a program, policies, and procedures to govern use of UAS on National Forest System lands because cooperators, such as state agencies or U.S. Department of the Interior agencies, will likely use them in the future during wildfires and other interagency events. New U.S. Forest Service policy that went into effect stipulates that aircraft and pilot approval for cooperator UAS will adhere to existing cooperator aircraft and pilot approval policy in Forest Service Manual (FSM) 5712.4 and 5713.43. The new policy also specifies that UAS are to be considered the same as manned aircraft, in terms of acquisition, approval and carding of pilots and aircraft, inspections, maintenance, avionics, training and operations and that all FSM and Forest Service Handbook direction regarding aircraft also applies to UAS. This includes the requirement for approval from the U.S. Forest Service Director of Fire and Aviation Management for acquisition (purchase, contract, and/or lease) of UAS. In addition, the new policy mandates that use of other agency UAS which have approved Certificates of Authorization requires prior approval from the U.S. Forest Service Washington Office Assistant Director for Aviation.

Using UAS has the potential to enhance the cost effectiveness, safety, quality, and timeliness of many data gathering and image acquisition missions associated with fire management on National Forest System lands by reducing the time and risks associated with accessing remote areas with limited roads and trails and hazards, such as snags; by providing the capability to cover large landscapes and acquire large amounts of data and images at appropriate intervals and scale; by providing the capability to gather data and images for long periods of time; and by providing the capability to acquire data and images in difficult aviation conditions such as smoke, night, low light, and dust.

UAS appear to have the most promise to achieve safety and cost benefits when used to perform long duration missions in environments with limited visibility, due to nighttime or smoke, and characterized by challenging flying conditions such as high winds and thermal updrafts. This often describes the wildfire environment. Currently, traditional infrared flights that provide a comprehensive aerial view of a fire are conducted once every 24 hours at night. UAS may afford fire managers flexibility to acquire a real-time aerial view of a fire at any scale

and at any time of day or night. For example, an Incident Commander could ask for immediate deployment of a UAS when tactical intelligence on fire behavior is urgently needed and the UAS could potentially provide continual observations for long durations of time.

The U.S. Forest Service has reviewed data compiled by the military, Department of Homeland Security, and other agencies that use UAS regarding the safety and cost effectiveness of these aircraft compared to other types of aerial platforms such as manned aircraft, satellites, and balloons. The U.S. Forest Service has also gathered a limited amount of data by participating in missions conducted by UAS such as the NASA *Ikanha* and the MQ-1. However, the U.S. Forest Service needs to acquire more data while UAS are conducting natural resource management missions in National Forest System environments to determine if they are safer or more cost effective than other types of aerial platforms. To do that, the agency must determine the missions that UAS will conduct; select appropriate UAS to conduct them; conduct missions in the National Forest System environment; and gather and analyze data.

The UAS Advisory Group could begin conducting test missions as early as summer, 2014. One of the key goals of the test missions will be to determine performance requirements of UAS for conducting fire management and other natural resource management missions. There are many different types of UAS and each has performance limitations in terms of the speeds and altitudes at which they can fly. The U.S. Forest Service is generally considering using small (16 foot or less wingspan) UAS. Performance requirements are driven by the type of data that needs to be gathered. If the area of interest is relatively small, say one acre, a UAS could hover over it or a slower flying UAS could be used. If the area of interest is relatively large, say one thousand acres, and data needs to be collected in a limited window of time, a faster UAS that can fly at higher altitudes may be required. However, altitude affects the resolution of the data that are acquired. The higher a UAS flies, the better the optics that are required. Better optics typically weigh more and require a bigger aircraft. A solid understanding of the performance capabilities and limitations of different types of UAS is critical to enabling the U.S. Forest Service to use these aircraft effectively to accomplish fire management and other natural resource management missions.

In addition to determining performance requirements, there are several key issues that must be addressed before the U.S. Forest Service will be able to use UAS in fire management. The first is the need to obtain a “Certificate of Authorization” from the FAA. A Certificate of

Authorization is required for all Federal, state, and local government agencies to conduct UAS operations in the National Airspace System. The FAA currently issues Certificates of Authorization to public entities to fly UAS in specific, limited areas and it takes a significant amount of time to obtain a Certificate of Authorization. This is a challenge for an agency like the U.S. Forest Service that manages 193 million acres of land located throughout the U.S., especially for wildfire management missions where specific locations can't be identified ahead of time.

It was relatively fast and simple to deploy the MQ-1 to the Rim Fire because the California Air National Guard has been using RPAs for years. Streamlined programs, policies, and procedures developed by the California Air National Guard governing the use of the MQ-1 enabled the military organization to obtain an Emergency "Certificate of Authorization" to fly the MQ-1 on the Rim Fire from the Federal Aviation Administration within 48 hours.

The FAA can consider an emergency Certificate of Authorization when: 1) A situation exists that is defined as a condition of distress or urgency where there is, or that has, the extreme possibility of loss of life, and 2) The proponent has determined that manned flight operations cannot be conducted efficiently; and 3) The proposed UAS is operating under a current approved Certificate of Authorization for a different purpose or location.

The U.S. Forest Service has worked closely with the FAA UAS Integration Office (AFS-80) to ensure that agency needs and mission requirements are understood. Congress has mandated the FAA to issue new regulations on UAS by September 30, 2015 which may make it easier and faster for agencies like the U.S. Forest Service to obtain permission to operate UAS.

Another issue that must also be addressed before UAS can be used effectively in fire management on National Forest System lands is availability of spectrum. UAS require radio frequencies with a high data rate and a large range to transmit infrared, video, communications, and other data over long distances which would be required to use UAS in fire management. These types of frequencies are very limited and are in high demand by other U.S. Forest Service programs as well as private businesses, such as television stations and cell phone providers, and consequently can be difficult to obtain. In addition, frequencies have to be approved for use and deconflicted in an area by the National Telecommunications and Information Administration before they can be used, which can take a significant amount of time.

In the wildfire environment, the integration of UAS with manned aircraft, such as helicopters, airtankers, air attack, and aerial supervision modules must be carefully considered to ensure that all can operate safely.

Finally, training will be required for U.S. Forest Service staff and Incident Management Team members to interpret the data that is collected by UAS, as well as to operate UAS if the agency determines that is appropriate. Training courses to interpret data provided by UAS range in length from one day to six months and consequently could require investment of a significant amount of personnel time and funding.

If U.S. Forest Service leadership decides to implement a UAS program that includes use of these aircraft for management of wildfires and prescribed fires on National Forest System lands, there will likely be a significant "on the job" learning curve for agency personnel and Incident Management Team members regardless of whether the UAS are operated by U.S. Forest Service staff, private vendors, or military personnel. On the Rim Fire, Incident Management Team members conducted an After Action Review and identified several areas that need improvement if and when UAS are used in fire management in the future. For example, Incident Management Team members noted that Temporary Flight Restriction (TFR) requests made to the FAA through Air Operations must reflect the need for sufficient air space horizontally and vertically to accommodate UAS operations at altitudes between 12,500 feet to 18,000 feet to allow the aircraft to fly above or below clouds to obtain imagery. Incident Management Team members also identified the need to determine whether Operations or Plans should order UAS and plan and assign missions. They concluded that while Operations often has immediate and important missions, using UAS in Plans with strong coordination with Operations may make more efficient use of the asset and complement other infrared acquisition that is already a part of Plan's responsibilities.

Use of military RPAs, such as the MQ-1, on wildfires on National Forest System lands will likely be limited due to cost. While the cost of operating the MQ-1 on the Rim Fire, which exceeded $100,000, is a small percentage of the total cost of more than $100 million to suppress the Rim Fire, and was likely offset by savings incurred as a result of more timely and efficient suppression operations, the number of fires with values at risk that justify that level of expenditure are limited.

Developing a U.S. Forest Service UAS program, policies, and procedures will take time to ensure that the aircraft are flown safely and effectively. At this time, nobody knows exactly when, where, or how UAS will be used in fire management or other natural resource management programs. However, as UAS technology continues to become more widely available and less expensive, and regulatory requirements continue to become less cumbersome, it's hard to imagine that the aircraft won't play a significant role in fire management in the future.