Unmanned Aircraft Systems (UAS) Activities in Earth Sciences

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Department of the Interior (DOI) manages more than one-fifth of U.S. land
Sources of Remote Sensing Data

- Landsat 8 (30 meter)
- NAIP 2010 (1 meter)
- UAS at 400 ft (5 cm)
- UAS at 200 ft (2.5 cm)
What is the UAS Strategy

DOI’s UAS program strategy is tailored to the mission, funding, personnel, and infrastructure levels of the Department and is summarized as:

- **Focus on small UAS** (sUAS), which are more aligned with DOI’s decentralized mission execution strategy and more supportable by the Department’s funding, personnel and infrastructure levels.

- **Leverage available excess sUAS** to minimize procurement, training, and support costs.

- **Establish partnerships** with Federal departments who possess UAS capabilities beyond DOI’s to support DOI missions that require more extensive UAS capabilities.

- **Conduct operational tests and evaluations** of various UAS technologies to support the development of long-range UAS requirements and strategy for the DOI UAS activities.

- **Based on the requirements and strategy developed above**, procure (buy or contract) for UAS capabilities that cannot be met either through excess DOD sUAS or those available through partnerships with other Federal agencies.
USGS National UAS Project Office

Supports the technology transfer of UAS capabilities to enhance the informed decision making across the Department

- Established in 2008
- Collaborates on operational test and evaluation missions with other DOI bureaus and Office of Aviation Services (OAS)
- Evaluates emerging technologies
- Develops new products and capabilities
- USGS UAS Roadmap 2014

http://uas.usgs.gov/
# UAS Applications

## Public Safety
- Abandoned Mine Lands Survey
- Coal Seam Fire Detection
- Wildfire Incident Support
- Monitor Volcanic Activity
- Monitor Landslides
- Flood Mapping
- Law Enforcement Support

## Wildlife Management
- Migratory Birds (Sandhill Cranes, Trumpeter Swans)
- Pygmy Rabbit Landscape Habitat
- Grizzly Bear Monitoring
- Elk Population Survey
- Sea Turtles
- Sage Grouse Inventory

## Inspections-Mapping
- Fence, Pipeline, Power lines
- Mine Reclamation
- Vegetation - Invasive Surveys
- Archeological Site Surveys
- Environmental Survey - Palmyra Atoll
- Damage Assessments
- Easement Verification
- Volumetric Calculations

## Research
- Assess Impacts of Dam Removal
- Hydrographic Survey
- Fire Science Research
- Monitor Forest & Rangeland Health
- River Bank Erosion Studies
- Geologic Resource Mapping
- Sensor & Imaging Processing
Sandhill Crane Population Estimates
Monte Vista, Colorado

Developing methods to estimate Sandhill Crane abundance for natural resource management.

Execution of this UAS mission cost $2,645, compared to similar fixed wing manned aircraft surveys that cost $4,310 up to $35,000 if contracted privately.
Monitoring sediment volumes eroded from the reservoir and deposited downstream, where the mobile sediment can potentially affect salmon habitat.
Boundary/Fenceline Inspections
Haleakala National Park, Maui

Infrastructure inspections maintaining 65 miles of fence line to exclude pigs, axis deer, predatory mammals, and invertebrate threats to the native resources.
Mine Inspections
West Virginia

Mine permit inspections monitoring a range of topics: water quality, hazardous conditions, terrain topology, wildlife habitats, erosion, check dams, and post mining land use.
Pleistocene Trackway Mapping
White Sands National Monument, NM

Photogrammetric documentation using a UAS to aerial survey extremely fragile fossilized footprints from the late Ice Age
Pleistocene Trackway Mapping
White Sands National Monument, NM

Close-range Photogrammetry

- Fossil track from WHSA
- Data used to generate 3D-print

Story, et al 2015
Monitoring erosion rates of the Missouri River over a 7 mile stretch near Lower Brule. Stretches of the river have seen high rate of bank loss of up to 8 feet per year.
Debeque Landslide
Debeque, Colorado

Temporal series of Landslide models monitoring geomorphic processes.

June 2013

October 2013
Debeque Landslide
Debeque, Colorado

Point cloud comparison and calculations (using Cloud Compare)

Green indicates possible movement
Archie Carr National Wildlife Refuge – Nesting Sea Turtle Tracks

Burgess, et al 2015
Geospatial Data Products

Color Infrared - NDVI

Point Cloud Generation

Elevation Models

Feature Extraction

KML – 3D Modeling

Orthophotography

Volumetric Measurements

Contour Generation
Tangible benefits

- **Science:** UAS are far less disruptive to the environment and can carry high tech sensors, enabling UAS to gather repeatable, scientifically valid observations.
- **Safety:** DOI missions often expose personnel to significant safety hazards. From 1937 to 2000, 66% of all field biologist fatalities in DOI were aviation-related.
- **Savings:** The cost to operate sUAS is about 10 percent of the cost to operate manned aircraft.

Future

- **Legal/Regulatory:** FAA (sUAS rule, BLOS ops), State and Federal legislation
- **Technology:** Aircraft improvements (batteries), new & smaller sensors, processing software and ability to handle large data volumes
- **Applications:** More and varied, commercial services, collaborations, new integrated data products with other remote sensing and in situ data sets

**Summary**

UAS will be a standard piece of field equipment for scientists