

BLM and sUAS Use in Natural Resource Management

Field Technologies in Natural
Resources and Fisheries Conference
November 19, 2015



Bureau of Land Management

The Bureau of Land Management (BLM) may best be described as a small agency with a big mission: To sustain the health, diversity, and productivity of America's public lands for the use and enjoyment of present and future generations. It administers more public land – over 245 million surface acres – than any other Federal agency in the United States. Most of this land is located in the 12 Western states, including Alaska. The BLM also manages 700 million acres of sub-surface mineral estate throughout the nation.



Bureau of Land Management Overview

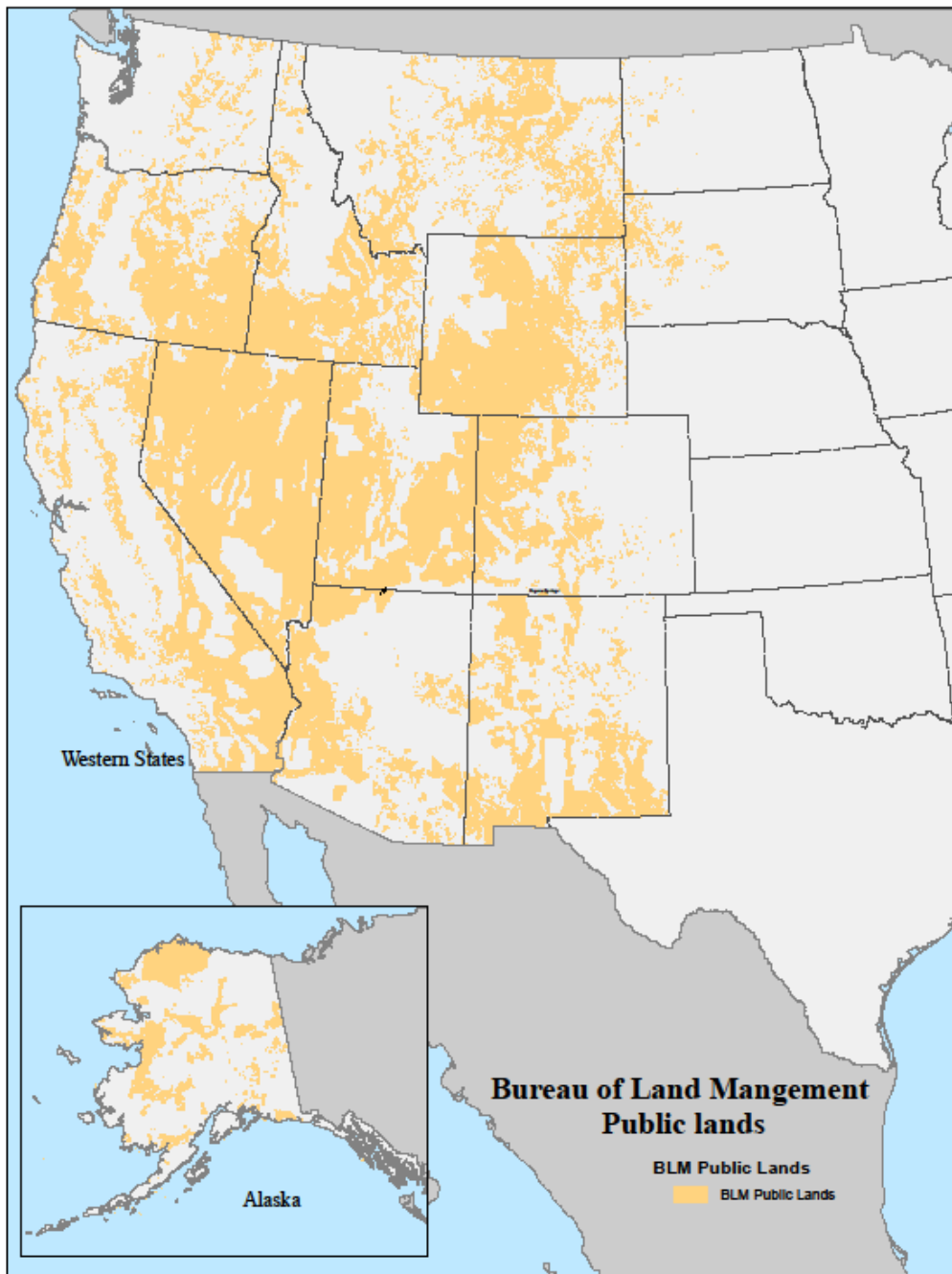
The BLM resides within the Department of the Interior (DOI) along with:

- National Park Service
- US Fish and Wildlife Service
- Bureau of Indian Affairs
- United States Geological Survey
- Bureau of Reclamation



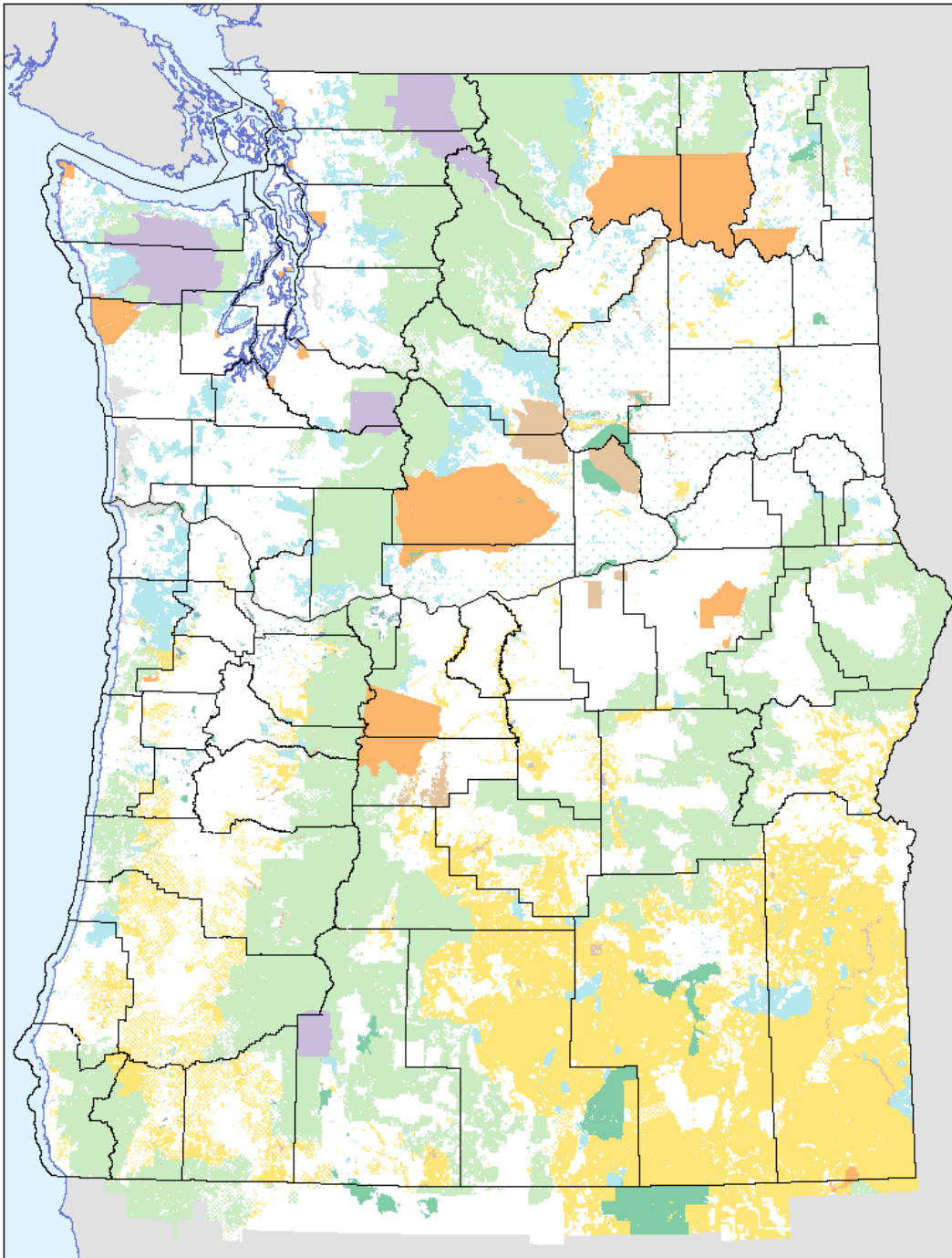
BLM Public Lands

The Bureau of Land Management's mission is to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.



BLM OR/WA

The Bureau of Land Management administers more than 16 million acres of land in Oregon and Washington. Oregon and California (O&C) lands in Western Oregon contain forest lands and Public Domain lands contain mainly range lands.



What is an Unmanned Aircraft System?

- Defined as an aircraft system without a pilot onboard
- “Unmanned” systems are *not* unmanned - they require human operation and control
- BLM is focused on small UAS (<55 pounds)



Why are we using UAS Technologies?



Landsat 7 ETM+ (30m)



NAIP 2010 (1M)



UAS at 400ft (5cm)



UAS at 200ft (2.5cm)



Manned aircraft flights can be problematic due to weather, safety concerns, and operating costs

Satellite observations can be hindered by spatial resolution, weather conditions, and long data acquisition intervals

Field surveys can be expensive, logistically challenging and geographically limited

UAS provide fine-scale, cost-effective scientific geospatial products for resource monitoring



Why Small UAS?

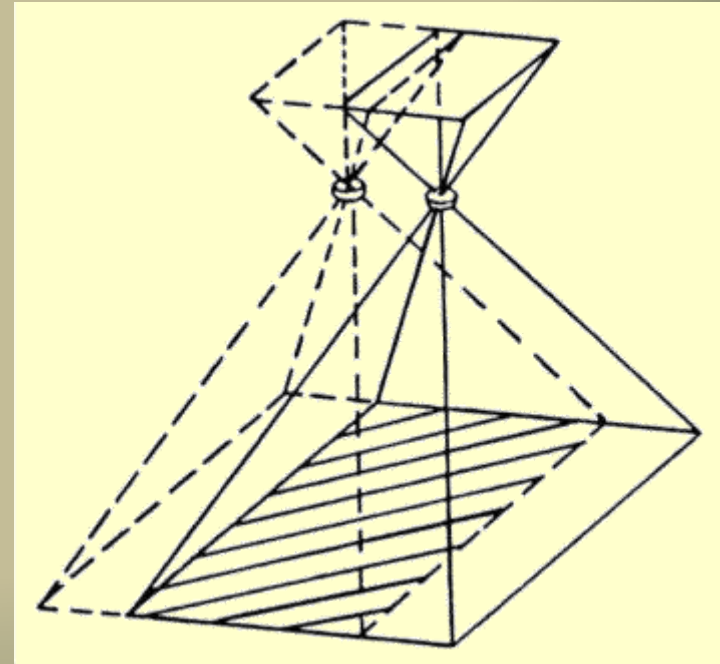
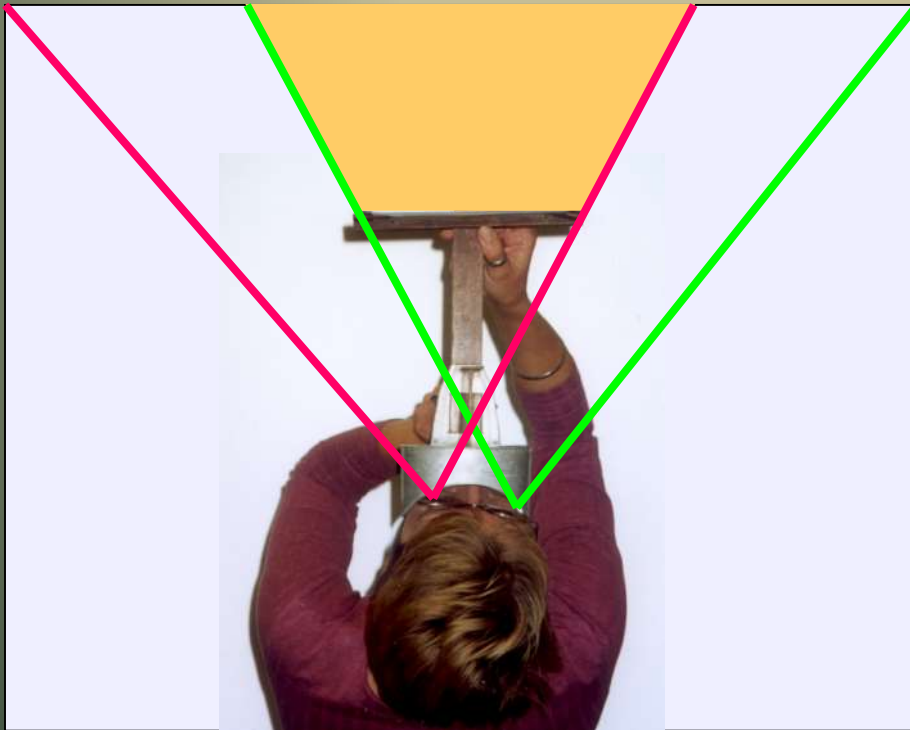
- The BLM is the leader in the Department of Interior in the use of emerging Unmanned Aircraft System (UAS) technologies for managing natural and cultural resources on public lands
- The BLM produces fine scale, high quality geospatial products for study areas using UAS acquired imagery to produce:
 - 3D Point Clouds (.las)
 - Ortho imagery
 - DEMs
 - Contours
- Depending on project specifics, UAS data acquisition has the potential to be more
 - Economical
 - Safer
 - Efficient
- Allows for resource management activities that could not otherwise be performed
 - Enhanced Observations
 - New Science
 - More Informed Decisions
 - Enhance/supplement/extend monitoring and documentation



What makes this work?

Photogrammetry

The art, science, and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring, and interpreting photographic images and patterns of electromagnetic radiant energy and other phenomena.



STEREO PHOTO OVERLAP AREA



“UAS” History in the BLM

1998 -1999 Low-Altitude Remote Controlled Airplanes

2000-2004 Aerial Camera Blimp System



Current U.S. Dept. of the Interior UAS Platforms

At this time, all current and retired aircraft are surplus from other government agencies

New Aircraft currently in use by BLM Falcon Unmanned Inter-operable system

Falcon



Bungee Launch / Parachute Recovery

Aircraft Weight – 11 pounds

Wing span – 96"

Length – 54"

Range – 3 miles

Endurance – 60 minutes

Payload – EO/IR

Digital Camera – up to 2 lb.

Sony α5100 , Ricoh GR, Canon S100

Falcon Hover



Vertical Launch and Recovery

Aircraft Weight – 7 pounds

Span – 48"

Range – 1 mile

Endurance – 20 minutes



Current U.S. Dept. of the Interior UAS Platforms

At this time, all current and retired aircraft are surplus from other government agencies

Aircraft currently in use by BLM

Honeywell – T-Hawk RQ-16



Aircraft Weight – 18 pounds
Range – 10 km
Endurance – 47 minutes
Fuel – 100LL Aviation
Payload – EO/IR
Digital Camera – up to 9 oz.
Ricoh GR, Canon S100

Other Aircraft in DOI UAS Fleet

Aerovironment Raven RQ-11A

- Aircraft Weight – 4.5 pounds
- Range – 10+ km
- Endurance – 90 minutes
- Fuel – Electric
- Payload – EO/IR
- Digital Camera –
Sony HDR-AS100V
Go Pro Hero 3

MLB Super Bat

- Aircraft Weight – 35 pounds
- Range – 9 km
- Endurance – 6+ hours
- Fuel – Unleaded
- Payload – EO/IR
- Digital Camera –
Canon T3i Rebel



Cameras/Sensors

- Cameras:

- Sony α5100 (has 1/4000 shutter speed and GPS)
- Ricoh GR (has 1/4000 shutter speed resulting in minimal image blur)
- Canon SX260HS & S100 – GPS enabled (RGB and Color IR)
- Nikon D750



- Video:

- Onboard Natural Color/EO
- Onboard Thermal IR (FLIR)
- GoPro Hero 2 & 3 - 1080P, 4K HD camera (Cannot be used for stills due to rolling shutter and high data compression)
- Sony ActionCam (HDR AS100V) – GPS enabled



Camera Comparison



Canon S100 on RQ-16C T-Hawk

- 1/2000 Shutter (Max)
- 12 MP
- ~\$300
- GPS-enabled



Ricoh GR on RQ-16C T-Hawk

- 1/4000 Shutter (Max)
- 16 MP
- ~\$700

Policies: How the BLM Operates in the United States National Airspace

- Certificate of Waiver or Authorization (COA):
 - Authorization issued by the Federal Aviation Administration.
- Memorandum of Agreement (MOA):
 - Signed Dec. 24, 2013 between the FAA and DOI-OAS
 - Information Bulletin No. 14-04
 - under 400' (1200' through 2015 amendment)
 - line of sight
 - at least 5 miles from an airport
- Dept. of the Interior - UAS Operational Procedures (OPM) No. 13-11:
 - DOI-OAS outline procedures of how to operate UAS in the NAS
<http://www.doi.gov/aviation/library/upload/OPM-11.pdf>
- BLM – BLM National Aviation Plan:
<http://www.blm.gov/style/medialib/blm/nifc/av.Par.81745.File.dat/NAP.pdf>



Policies: How the BLM Operates in the United States National Airspace

Spectrum:

- Currently on military frequencies
- Future: On civilian government frequencies or encrypted public freq.

Range or private owner approvals:

- Dept. of the Interior guidelines ask that we get the range (refuge, park management agency) and/or private land owner approvals

Airworthiness:

- Annual check of the systems by DOI-OAS for individual aircraft airworthiness

NOTAMs & Notices:

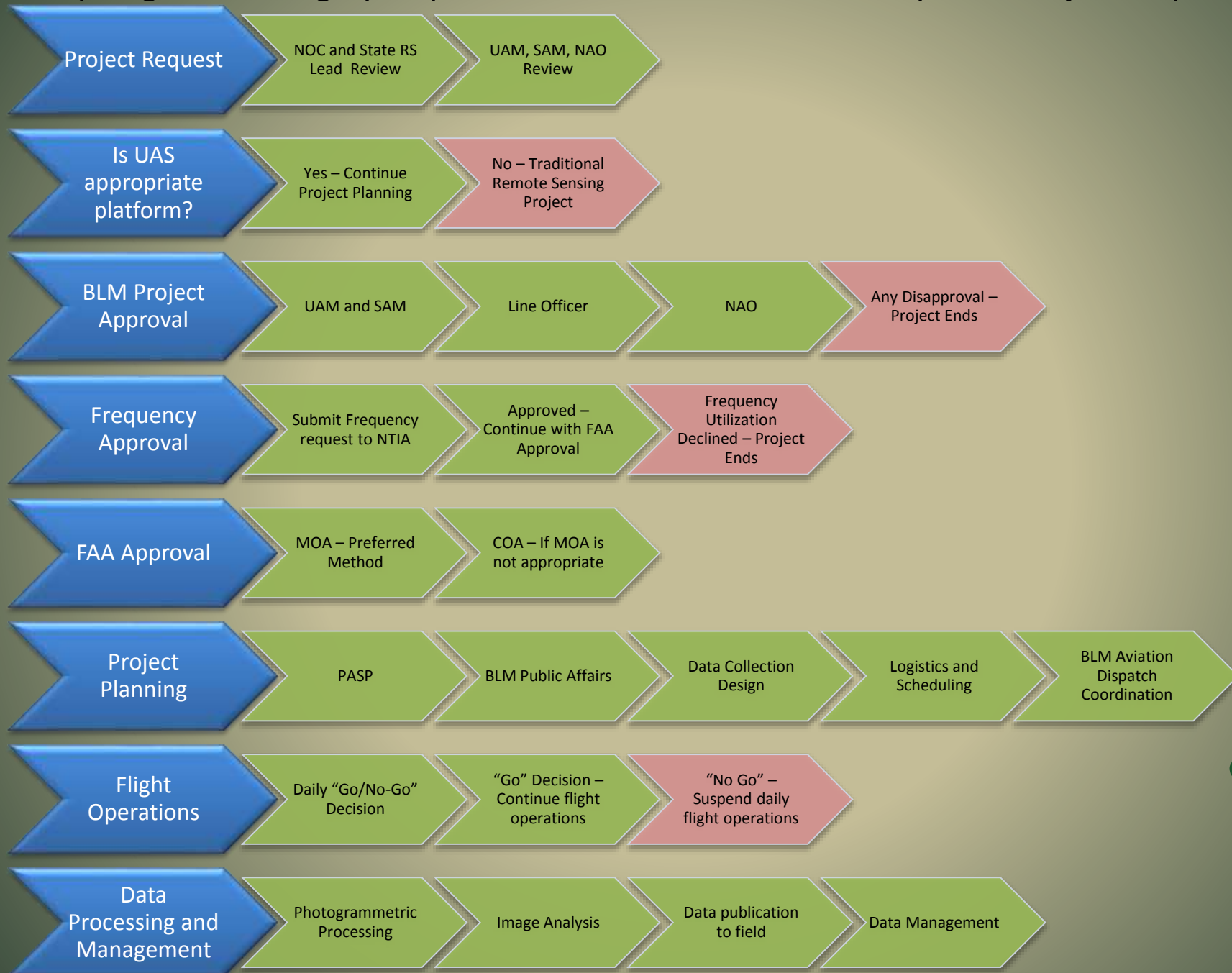
- Must issue a Notice to Airmen at least 48 hrs. in advance (COA or MOA)
- Contact the nearest Air Traffic Control Tower and Military Base if necessary

UAS Operators

- Currency – have flown or been on a simulator in the past 90 days
- Proficiency – must be checked by an OAS instructor once a year
- Class 2 Medical – good for one year as issued by FAA approved physician



Very Large Scale Imagery Request Process – Unmanned Aerial Systems Project Request



UAS Potential Projects

Oregon/Washington Project Ideas:

- Fire
 - Prescribed fire mapping
 - Documentation, scouting, salvage
- Forestry
 - Change detection
- Habitat
 - Meadow Restoration
 - Site Management Plans
 - In-stream Habitat
 - Vegetation mapping
- Wildlife
 - Nest location and monitoring for Golden and Bald Eagles, Peregrine Falcon, Marbled Murrelet
 - Wild horse, deer, cattle count/inventory
 - Red Tree Vole monitoring
 - Thermal location of Bald Eagle winter roosts and Sage-grouse leks
 - Spawning survey
- Riparian
 - River mapping
 - Restoration monitoring
 - Stream temperature
- Public Affairs / Outreach
 - Recreation Site
 - Wilderness
- Archaeology/Cultural



UAS Project Request



- Project Information including:

- Background
- Objectives
- Justification and Advantages
- Location
- Date
- Time Sensitivity

Currently The project request is a Microsoft Word template.

Plans are to convert to a Geocortex Web Application in CY 2015

UAS Snake River and Teton River Proposal

Project Title: 2014 UAS Upper Snake (FO) River Corridors Survey

Background:

The Snake River and Teton River offer some of the best fishing and recreational opportunities in the West. Hundreds of thousands of people visit each year to enjoy what the area has to offer. The Upper Snake Field Office is tasked with preserving the integrity of these river systems through careful management. Invasive species are a concern and control is a top priority for the field office. Riparian systems such as these are fragile and invasive species pose a significant risk to their stability. Due to the wide variety of vegetation and remoteness of the rivers, it is possible for new infestations to grow unnoticed. Aerial imagery could aid in future treatment plans for invasive species managed under the Early Detection & Rapid Response strategy.

Project Objectives:

- This project would test the ability of mapping woody invasive species along both the Snake River and Teton River riparian systems. The emphasis of the mapping test will be to determine the extent and ability to map infestations of salt cedar (*Tamarix ramosissima*), and Russian olive (*Elaeagnus angustifolia*).
- Objectives are to test techniques and capabilities of the T-Hawk unmanned aerial system (UAS) mapping at various altitudes.
- With success, additional aerial surveys would be planned to discover the full extent of both these woody invasive species along the rivers.

Justifications and Advantages:

- Traditional ground surveys to identify infestations are labor intensive and costs of performing these surveys continue to rise.
- Use of an UAS could provide much quicker and cost effective mapping procedures. It would also allow the size of new infestations to be gathered faster, allowing a quicker response and plan for treatment.
- Lance Brady has offered to conduct the UAS mission free of charge. Only the travel costs for him and his assistant(s) would be incurred.

Project Locations:

- Snake River corridor from Swan Valley to Heise Hot Springs
- Teton River, north Rexburg

Estimated Project Date:

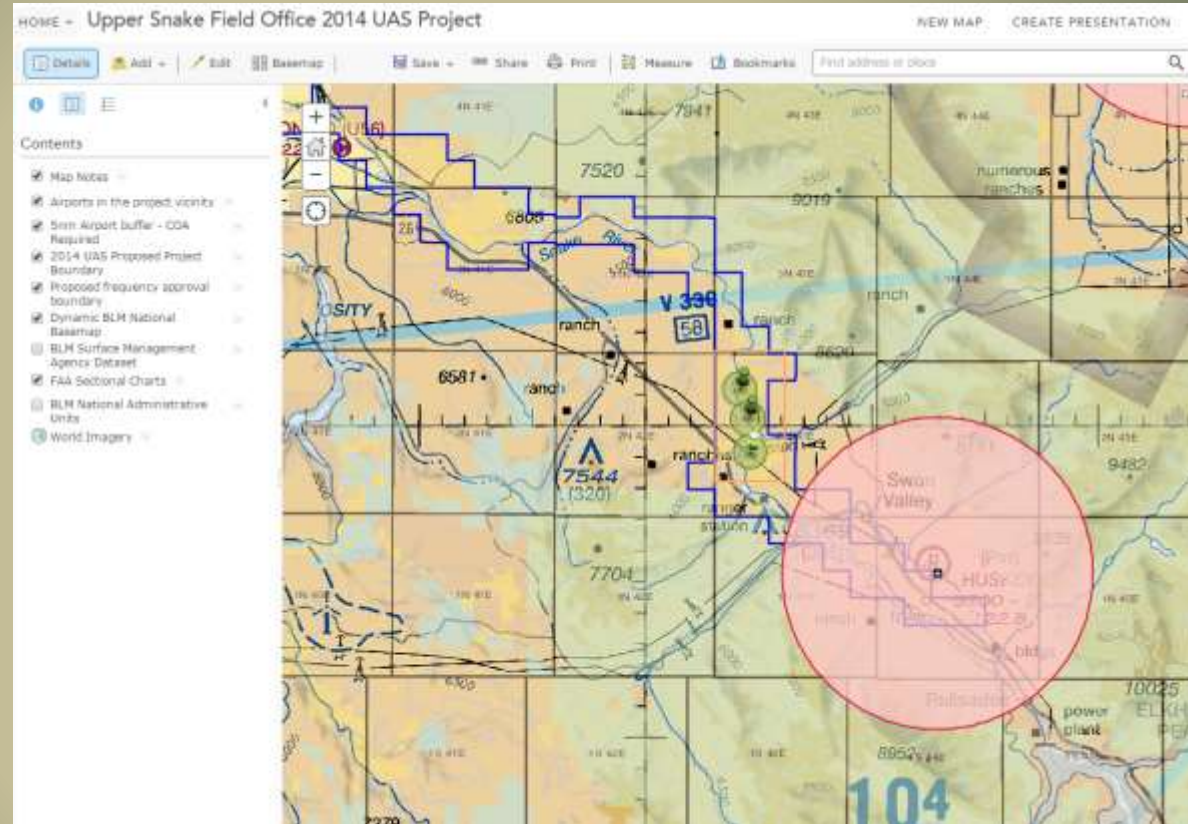
Mid-Late summer

Time Sensitivity:

The Upper Snake FO is looking to map infestations while the plants are in bloom, near mid to late summer

UAS Project Feasibility Analysis

- Schedule
- Airspace
- Elevation
- Terrain
- Aircraft Performance
- Project size
- Surface Ownership



COA or MOA?

Memorandum of Agreement MOA

- “File and Fly”
- 48 hour notice and NOTAM are only requirements
- Scientific, Wildlife, SAR
- Class G Airspace
- >5NM from civil airports/heliports
- 1200’ AGL and below
- <55 pounds
- Visual line of sight
- DOI lands, or notification of land owners
- No ops over populated areas
- Certain limits in Mode C veil
- Night ops approved w/conditions

Memorandum of Agreement between the U.S. Department of the Interior and the Federal Aviation Administration Regarding Operation of Small Unmanned Aircraft Systems in Class G Airspace

A. Introduction: This Memorandum of Agreement (MOA) between the U.S. Department of the Interior (DOI) and the Federal Aviation Administration (FAA) sets forth provisions that will allow DOI-operated small Unmanned Aircraft Systems (sUAS) increased access to Class G airspace for public aircraft operations in accordance with applicable laws and government agency policy.

B. Scope: The policies, procedures and operations prescribed in this MOA apply to DOI sUAS operations involving scientific applications, wildlife surveys and Search and Rescue (SAR) efforts within Class G airspace at or below 400 ft AGL, authorized through Certificate of Waiver or Authorization (COA) via Notification procedures.

C. Authority: Title 49 of the United States Code (49 USC) § 106 provides the authority to the FAA to set aviation safety standards and regulate aviation operations in the National Airspace System (NAS). Title 49 USC provides the authority for government agencies to conduct public aircraft operations in the national airspace subject to certain limitations § 40125.

D. UAS Airworthiness Certification: The DOI assumes responsibility that the sUAS it will operate under this MOA are airworthy and in condition for safe operation based on the manufacturer’s specifications, technical manuals and maintenance recommendations for the aircraft, control station, and associated support equipment. Where appropriate for unmanned aircraft, the aviation standards aircraft detailed in DOI Department Manuals 351 DM, Flight Operations Standards and Procedures and 352 DM, Aviation Safety shall be applied. More specific guidance is contained in DOI Operational Procedures Memorandum (OPM) No.11, DOI Use of Unmanned Aircraft Systems, and OAS Instruction 5400-202. All DOI UAS will be inspected for airworthiness and kit condition by OAS designated aircraft inspectors at the same interval as DOI manned aircraft.

E. UAS Pilot/Crewmember Qualification: The pilot in command (PIC) and flight crewmembers, including visual observers, of DOI sUAS shall be qualified in accordance with the requirements listed in the FAA UAS Operational Approval Notice N8900.227. sUAS pilots and observers are required to have an appropriate current medical exam in accordance with DOI OPM No. 11 and will be subject to annual flight evaluations administered by DOI Office of Aviation Services designated pilot inspectors. These qualifications must meet or exceed requirements listed in the FAA UAS Operational Approval 8900.227.

F. Spectrum and Associated Documents: DOI will be responsible in ensuring that the appropriate frequency spectrum approvals are obtained in advance of any sUAS operation.



COA or MOA?

Certificate of Waiver or Authorization

COA


- Lengthy Process – 60 Working days
- Usually requires licensed pilot to be PIC
- Additional notification and reporting requirements

The screenshot shows a web browser window with the URL <https://loeaaa.faa.gov/oeaaa/COAMyAssignments.jsp?getThese=Draft#>. The page header includes the Federal Aviation Administration logo and a navigation menu with items: COA Cases, Notifications, COA Reports, Tools, Data, Reports, Options, Help, and Log Out. The main content area contains instructions: "Click the button below to enter a New UAS COA Case" and "Note: A draft UAS COA case will be created and saved upon clicking the 'Enter UAS COA Case' button." Below this is a button labeled "ENTER NEW UAS COA CASE". An "OR" separator follows, with the instruction "Click the button below to renew Existing UAS COA Case" and a button labeled "RENEW EXISTING UAS COA CASE". Another "OR" separator follows, with the instruction "Select a UAS COA Draft to edit." At the bottom, a table header shows "COA Cases - Draft" and a status bar indicates "10 Records found, displaying all Records."



Project Aviation Safety Plan

- Responsible aviation manager (UAM, SAM, Etc.) drafts the PASP and circulates for signatures
- Outlines aviation safety aspects for the project
- Required for every project prior to submission of COA or MOA notification
- All project participants are briefed on the PASP and sign off prior to project start

 EMDD	MONTANA / DAKOTAS B.L.M. EASTERN MT/DAK DISTRICT PROJECT AVIATION SAFETY PLAN (P.A.S.P.)		1) Project Summary 2) Review & Approval 3) Directions & Notes 4) Project Overview 5) Project Personnel 6) Project Information 7) Airports/Landing Zones 8) Flight Following/Tracking 9) Radio Frequencies 10) Passenger/Cargo Manifest 11) Airspace 12) Special Instructions 13) Risk Management 14) PASP Attachments
	01 ► PROJECT SUMMARY		
PROJECT NAME: Powder River Basin UAS Monitoring Project			
PROJECT ACTIVITY: Use of Unmanned Aerial Systems (UAS) with camera/infrared imagery recording devices to monitor/locate coal seams and other criteria necessary for area rehabilitation.			
HOSTING UNIT: MT/DAK BLM, Eastern MT/DAK District (EMDD), Miles City Field Office (MCFO). This document is a collaboration of the Soils as well as Fire & Aviation divisions.			
PROJECT LOCATION: The UAS project area is located on BLM land (MT/DAK BLM-EMDD) in the Powder River Basin of southern Powder River County near the MT/WY state line.			
ANTICIPATED PROJECT DATES: Spring, 2013 until completed (tentative through Winter 2018); PASP can be active for 5 years w/additions as needed;		Reoccurring Flights Held Periodically: <input checked="" type="checkbox"/>	
FINAL RISK ASSESSMENT: Low Complexity: <input type="checkbox"/> Moderate Complexity: <input checked="" type="checkbox"/> High Complexity: <input type="checkbox"/>			
02 ► REVIEW & APPROVAL			
SIGNATURE	PRINTED / TYPED NAME	DATE OF SIGNATURE	
P.A.S.P. PREPARED By:	District / Unit Aviation Manager (UAM):	Month / Day / Year:	
P.A.S.P. REVIEWED By:		Month / Day / Year:	
P.A.S.P. REVIEWED By:		Month / Day / Year:	
P.A.S.P. REVIEWED* By:		Month / Day / Year:	
* BLM State Aviation Manager is required to review plans of high complexity only (optional for lower complexity).			
P.A.S.P. APPROVED By:	Field Office Manager (FOM):	Month / Day / Year:	
Approval Notes ►	The agency approves this Project Aviation Safety Plan (PASP) with the following assumptions: > The Pilot in Command (PIC), supplemental pilots, mission operators, mission observers, project crewmembers, and ancillary personnel will: a) have obtained required training, schooling, ratings, certification, approvals, medical exams, and currency requirements; b) provide documentation proving said certifications; c) ensure risk mitigation/contingency plans and procedures are approved and activated which address emergency recovery or flight termination of the UAS in the event of a systems failure (i.e. lost link points [LLP]; divert/contingency points [DCP]; flight termination points [FTP]; etc.); d) coordinate and obtain clearances with Denver and Salt Lake City Air Route Traffic Control Centers (ARTCC's); e) adhere to all policies, authorizations, and agency direction; f) complete all data reporting, including UAS incidents/mishaps as applicable; etc.		



Project Logistics

Project Logistics completed the week prior to flight operations:

- Travel approvals and arrangements
- Equipment preparation and testing prior to departure
- Shipping of UAS equipment if necessary
- Camera preparation



Public Relations

- Field Office PIO are engaged and the local Line Officer determines the appropriate PIO outreach
- Media inquiries handled by local office staff
- Internal information – BLM Daily, etc.



Flight Operations

- Go/No-Go decision made each day based on environmental conditions
- Shortest phase of a UAS project
- Usually 3-4 days on site at the project
- 2 UAS operators are the minimum for a small project, but 3 is more typical



Field Data Check

- Data collection is checked in the field for completeness after each flight
- Photoscan run on laptops in the field on “Low” setting only to verify alignment and coverage
- Complete data processing occurs later in the office
- Any necessary GPS/Survey Grade ground control and scale measurements are taken in the field the same day as flight operations occur



UAS Applications

- Field data collection (AIM)
- Rangeland health
- Vegetation monitoring
- Habitat monitoring
- Fuels projects
- Fire rehab
- Noxious weeds
- Wildlife surveys
- Stream channel morphology
- Archaeological site inventories
- Recreation use and inventories
- Transportation planning/OHV management
- Hazardous Materials
- Trespass / ROW compliance



Typical Project Size

- Projects are scheduled for 1 week, with 3 flight days (Tuesday-Thursday) and travel days Monday and Friday
- The T-Hawk is capable of imaging up to a few hundred acres per day at approximately 1 cm spatial resolution
- Generally approximately 15 flights can be completed in 3 days, each collecting 750-1000 images
- Plan on 500+ Gb of data

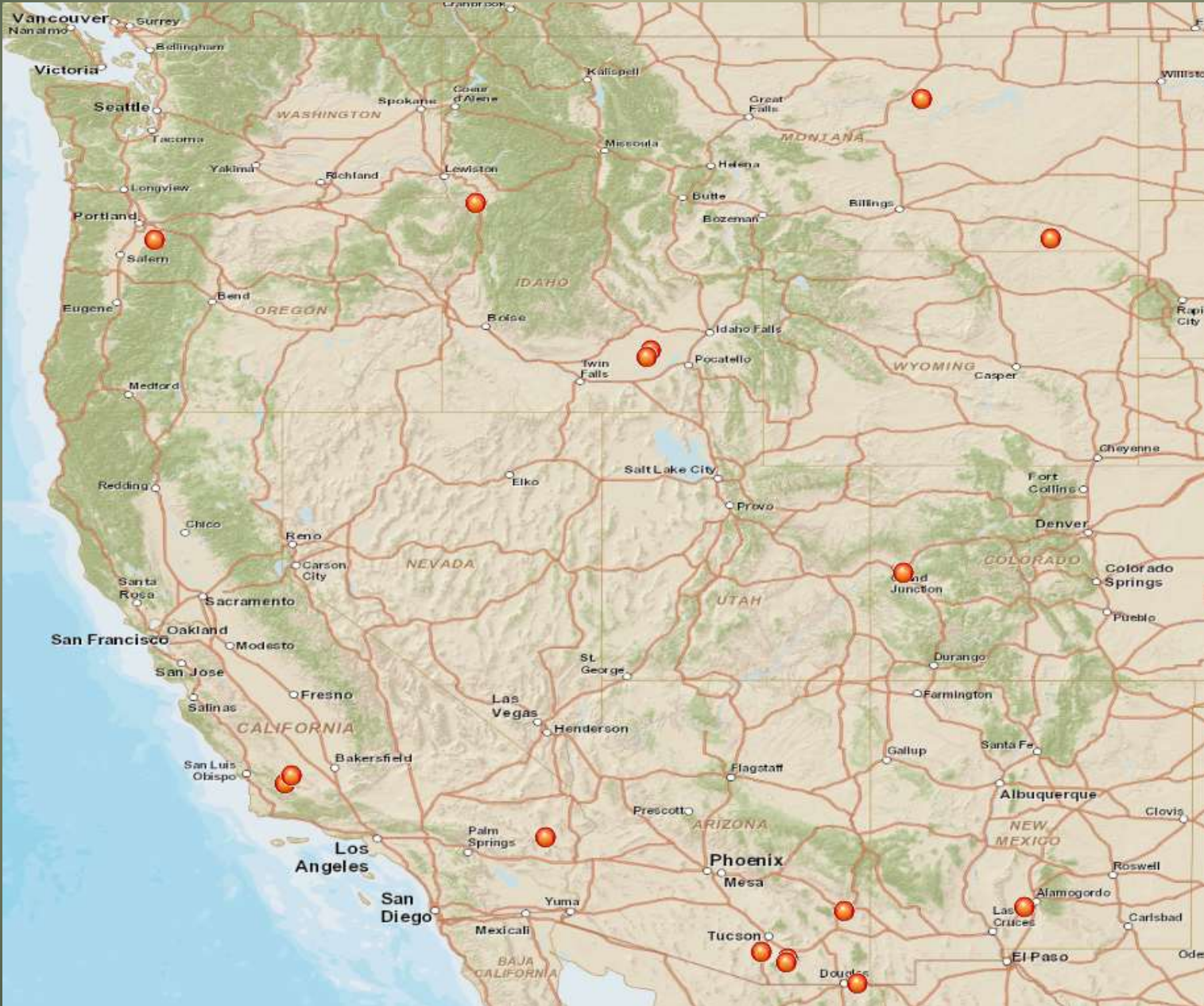


NOC UAS Projects on BLM Lands

- **FY 2012**
 - Rush Skeletonweed mapping – Upper Snake, Idaho
 - Vegetation Mapping – Safford, Arizona
 - Riparian mapping – Safford, Arizona
 - Fence line survey – Safford, Arizona
- **FY 2013**
 - Rush Skeletonweed mapping – Upper Snake, Idaho
 - AML Site Volumetric Calculations – Tucson, Arizona
 - Flood damage assessment - Miles City, Montana
- **FY 2014**
 - Cultural Site Mapping – Cottonwood, Idaho
 - Wildlife Survey (Sage Grouse) – Kremmling, CA (USGS partnership on BLM land)
 - Landslide Monitoring – Grand Junction , Colorado (Mesa County Sheriff partnership USGS on BLM land)
 - Mine site mapping/Volumetrics - Grand Junction , Colorado (Mesa County Sheriff partnership on BLM land)
 - Paleontological Site Mapping – White Sand, New Mexico (National Park Service partnership)
 - Tree Orchard Mapping – Salem, Oregon
- **FY 2015**
 - Vegetation Survey – Tucson, AZ
 - Riparian Mapping – Safford, AZ
 - Dam Breach imaging – Safford, AZ
 - Cultural Site – Needles, CA
 - Vegetation/Geological Survey – Bakersfield, CA
 - Cultural Site Mapping – Malta, Mt
 - Sage-grouse Habitat Mesic Mapping – Spokane , WA

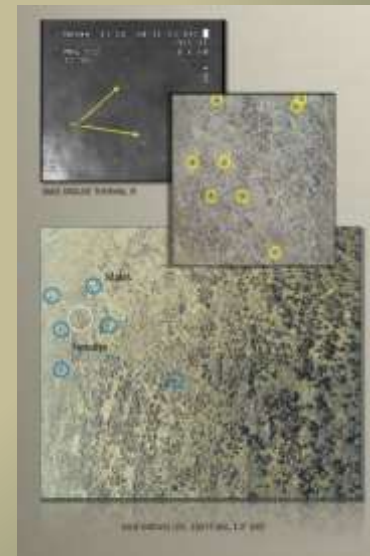


BLM UAS Projects



NOC UAS Project Support

- **FY 2011**
 - Monte Vista Sandhill Crane (USFWS, USGS) – Alamosa, CO
- **FY 2012**
 - Elwha Dam Removal Project #1(BOR, NPS, USGS)– Port Angeles, WA
 - Coal Basin Mine Reclamation(OSM, USGS) – Pitkin County, CO
 - Elwha Dam Removal Project #2(BOR, NPS, USGS)– Port Angeles, WA
 - Mine Compliance Inspection (OSM) – Logan, WV
 - Monte Vista Sand Hill Crane (USFWS, USGS) – Alamosa, CO
- **FY 2013**
 - Sage Grouse Lek inventory (USGS, Colorado Wildlife, BLM) – Kremmling, CO
 - Front Range Climate Study project #1 (USGS) – Evergreen, CO
 - Front Range Climate Study project #2 (USGS) – Evergreen, CO
 - Mine Compliance Inspection (OSM) – Logan, WV
 - Monte Vista Sand Hill Crane (USFWS, USGS) – Alamosa, CO
 - Kern Pikley NWR waterfowl survey (USFWS, USGS) – Tulare, CA
- **FY 2014**
 - DeBeque Landslide (USGS, Colorado Geologic, BLM) – Grand Junction, CO
 - Elk Survey (Washington State University, USGS) – Bellingham, WA
 - Chimineas Ranch Elk and Veg survey (USGS, BLM, ASU) – Bakersfield, CA
 - Pelican survey (USFWS, USGS) – Mobridge, SD
 - Klamath Riparian Youth Project (USGS, BIA) – Klamath Falls, OR
 - Mine Compliance Inspection (OSM) – Pineville, KY
 - Mine Compliance Inspection (OSM) – Logan, WV
 - Topock Marsh Riparian (USGS, USFWS) – Needles, CA
 - Las Cienegas Riparian (USGS, BLM, TNC) – Tucson, AZ
- **FY 2015**
 - Carrizo Plain Veg survey (USGS, California NR, BLM) – Bakersfield, CA
 - Pyramid Lake Pelican Survey (USGS, USFWS, BIA) – Reno, NV



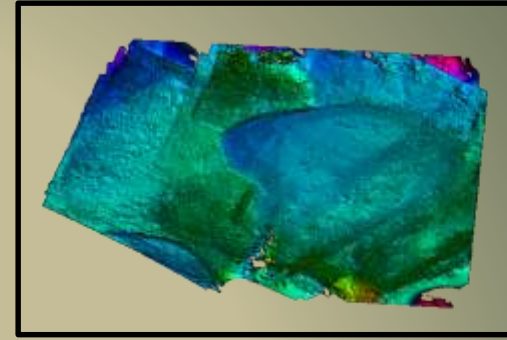
Geospatial Data Products



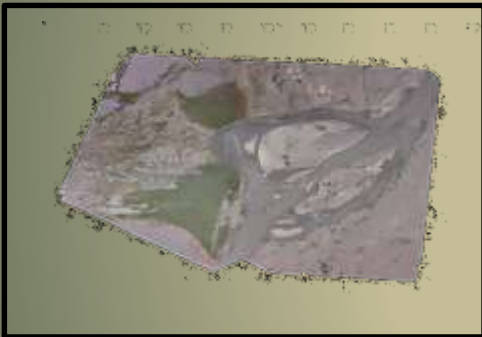
FULL-MOTION VIDEO



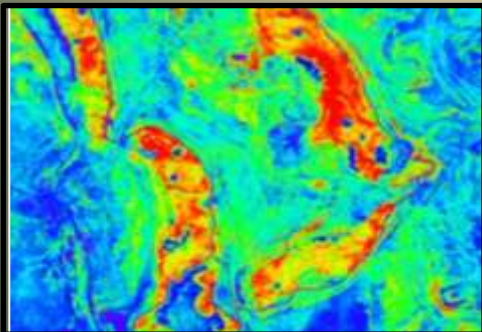
3-D POINT CLOUD DATA



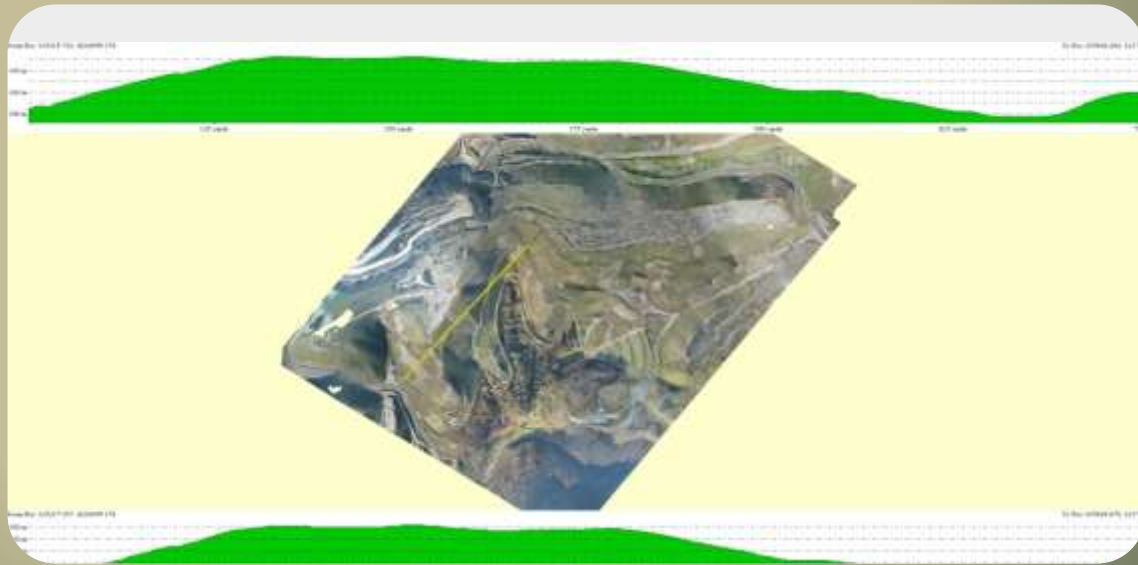
ELEVATION MODELS



UHR ORTHOIMAGERY



SPECTRAL INDICES (NDVI)



Gravel Pit Volumetric

Grand Junction, Co

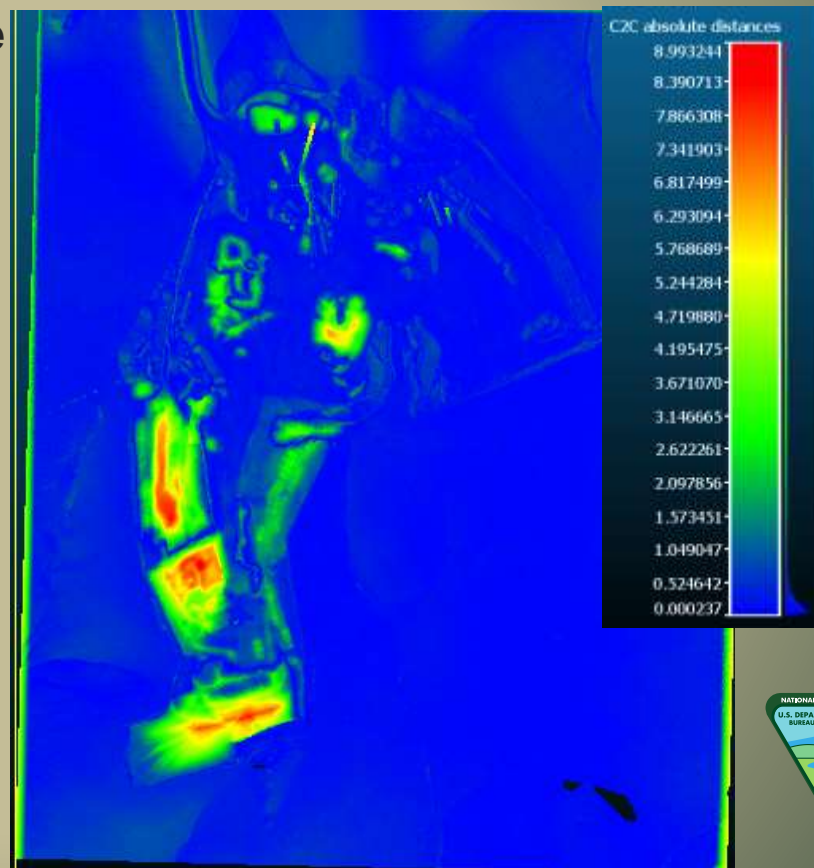
- Cooperative, multi-project effort (BLM, Mesa County Sheriff's Department)
- Included gravel pit volumetric change estimation, landslide monitoring and dinosaur quarry mapping
- Cost-effective effort which supported gravel pit compliance inspection
 - Traditional Aerial Mapping: \$10,000
 - UAS Mission: \$120



DEM Hillshade



Orthophotography



Volumetric Change (meters)

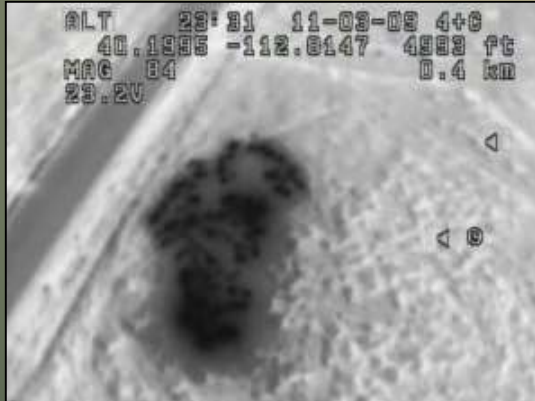


Wildfire – Prescribed Burn

UAS Training - Dugway Proving Grounds, Utah



Electro-Optical Video of Prescribed Burn



Infrared Video of Prescribed Burn



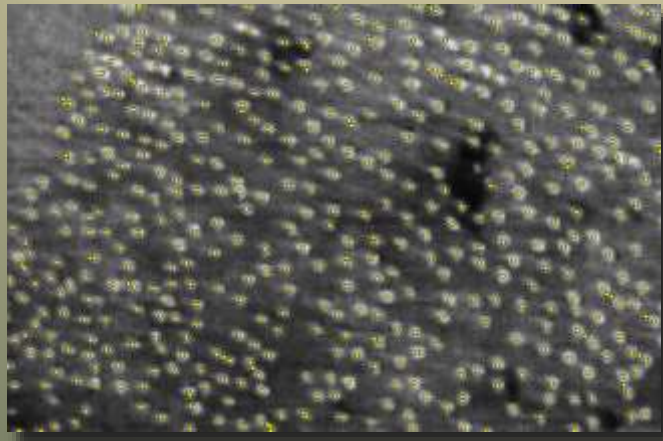
Sandhill Crane Population Estimates

Monte Vista, Colorado – First UAS Mission in NAS

March 2011



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.



Debeque Landslide

Debeque, Colorado



June 2013

Temporal series of Landslide models monitoring geomorphic processes.



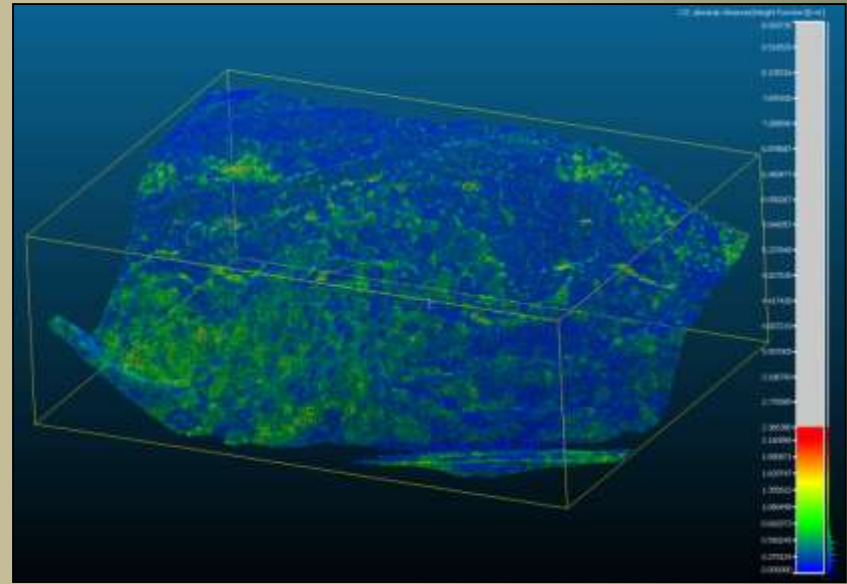
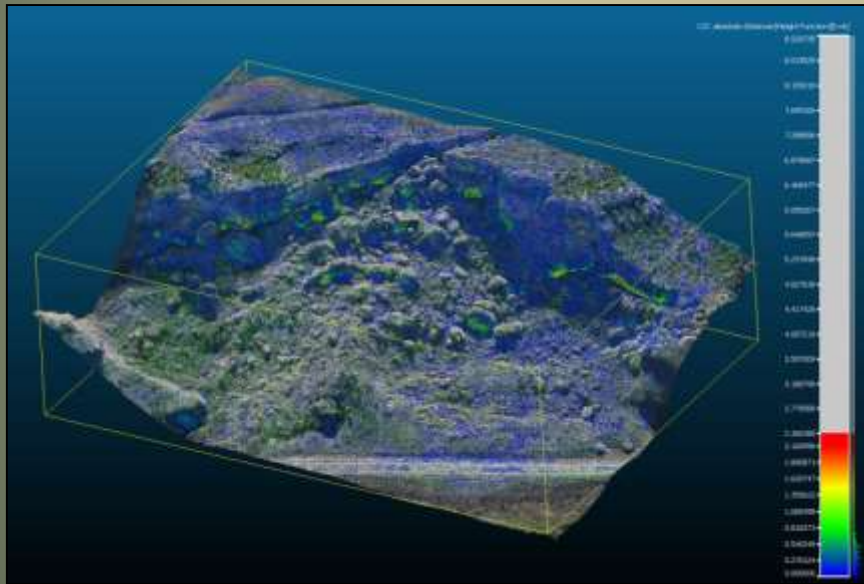
October 2013



Debeque Landslide

Debeque, Colorado

Point cloud comparison and calculations (using Cloud Compare)
Green indicates possible movement



Rush Skeletonweed

Idaho Falls, Idaho - 2012



NAVBAR 16:36 08-14-12 4+C
 43.0856 -113.1487 5229 ft
 MAG 217 0.4 km
 23.0V



Project Objectives:

- Invasive vegetation mapping: Rush Skeletonweed
- Building UAS Program experience
- First BLM project flown in National Airspace

- **Aircraft:** RQ-11A Raven
- **Camera:** Stock Raven EO Video pointed NADIR
- **Conclusion:** Stock raven video camera is not adequate quality for photogrammetric image processing

Mapping in the San Simon

Safford, AZ - 2012



Project Objectives

- Vegetation mapping
 - Fence line survey
 - Infrastructure mapping
 - Riparian area mapping
 - Building UAS program experience
- **Aircraft:** RQ-11A Raven
 - **Camera:** GoPro Hero 2
 - **Conclusion:** GoPro has adequate resolution, but rolling shutter and data compression are not acceptable for photogrammetric data processing

Dogtown Mine

Tuscon, Arizona



- **Project Objectives:**
 - Volumetric calculation of mine materials
 - Mapping of Abandoned Mineland Site
- **Aircraft:** RQ-16C T-Hawk
- **Camera:** Canon S100
- **Conclusions:**
 - Project was successful for calculating volume of material
 - S100 has too slow of shutter speed resulting in image blur
 - Survey Grade GPS ground control is required for adequate precision for calculating volumes

HX Dam Breach

Safford, Arizona



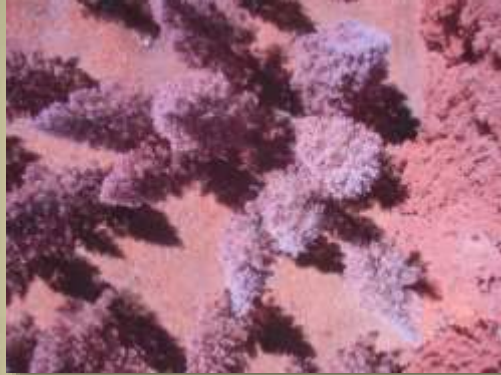
1 foot contours generated from UAS derived DSM overlaid on sUAS Imagery

Assisted the Arizona State Office and the Safford Field Office with imagery and derived data products to documents and measure the impacts of the 2014 HX Dam failure. It is suspected that a 5.2 magnitude earthquake compromised the dam structure on June 28, 2014.



Horning Seed Orchard

Portland, Or



Canon sx260 IR camera Douglas Fir



IR Orthophoto Douglas Fir



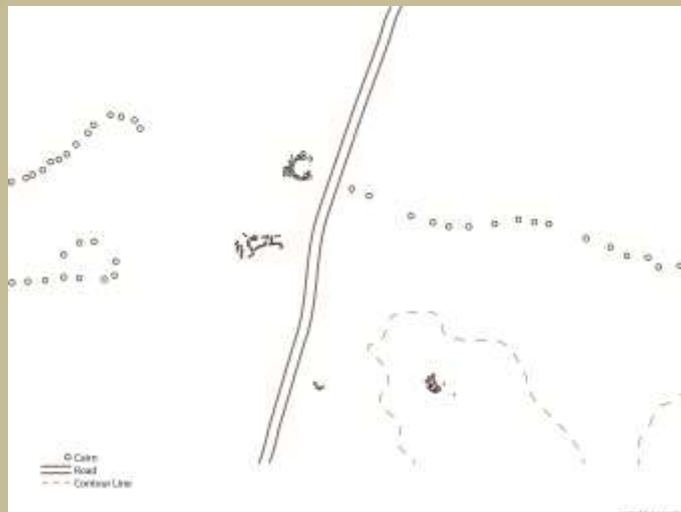
Canon s100 camera Douglas Fir



Color Orthophoto Douglas Fir



Cultural Site Survey



The sites are dominated by the presence of a buffalo kill location, prehistoric drive lines, ground figure (both anthropomorphic and zoomorphic), habitation sites and medicine wheels.

In the Summer of 2015 the BLM was able to conduct a prescribed burn over the cultural site to remove vegetation which allowed for image acquisition with little vegetation present revealing cultural artifacts. To date an all-encompassing map of these locations did not exist due to extreme difficulties in mapping these large scale and complex locations from the ground. Aerial inventory and recordation allows for better management and protection of these unique national Register of Historic Places (NRHP) eligible properties.



Swanson Lakes Mesic Vegetation

Creston, WA



Greater Sage-grouse and Sharp-tailed Grouse utilize the mesic habitat in the area for rearing young during the summer.

In the Summer of 2015 the BLM used the SuperBat aircraft to capture imagery over 9 square miles of habitat. At a flying height of 800 feet above ground, we attained about 8 cm resolution. We plan to combine the high resolution color imagery with infrared information from satellite to compute the NDVI for vegetation classification.



Remote Sensing as Field Data:



- UAS imagery can be used to produce cover estimates similar to plot level data collected in the field
- Stereo imagery facilitates accurate cover interpretation, and height measurements
- Allows access to difficult to reach, potentially unsafe areas
- A complement to field data - NOT a substitute
- Extends the field season

% Sagebrush Cover =
Sagebrush "hits" (over all transects)
total # of transect points
% Sagebrush = $58/150 = 38.67\%$

Software Used for a Typical UAS Project

- Project Request– ArcGIS for Desktop, Portal for ArcGIS
- Project Evaluation – ArcGIS for Desktop, ArcGIS for Aviation
- Project Preparation – ArcGIS for Desktop, ArcGIS Server
- Field Deployment – Agisoft Photoscan, ArcGIS Server, Avenza PDF Reader (iOS), Portal for ArcGIS, Geocortex, ArcGIS for Desktop
- Data Processing – Agisoft Photoscan, Cloud Compare, ArcGIS for Desktop, Erdas, ENVI, Feature Analyst, Stereo Analyst, 3D Analyst, ArcGIS Pro, ArcScene
- Data Publication – ArcGIS Server, Portal for ArcGIS, Geocortex, ArcGIS for Desktop



Questions?

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