Coeur d'Alene Tribe GIS Unmanned Aerial System (UAS) Program: A 2018 Update

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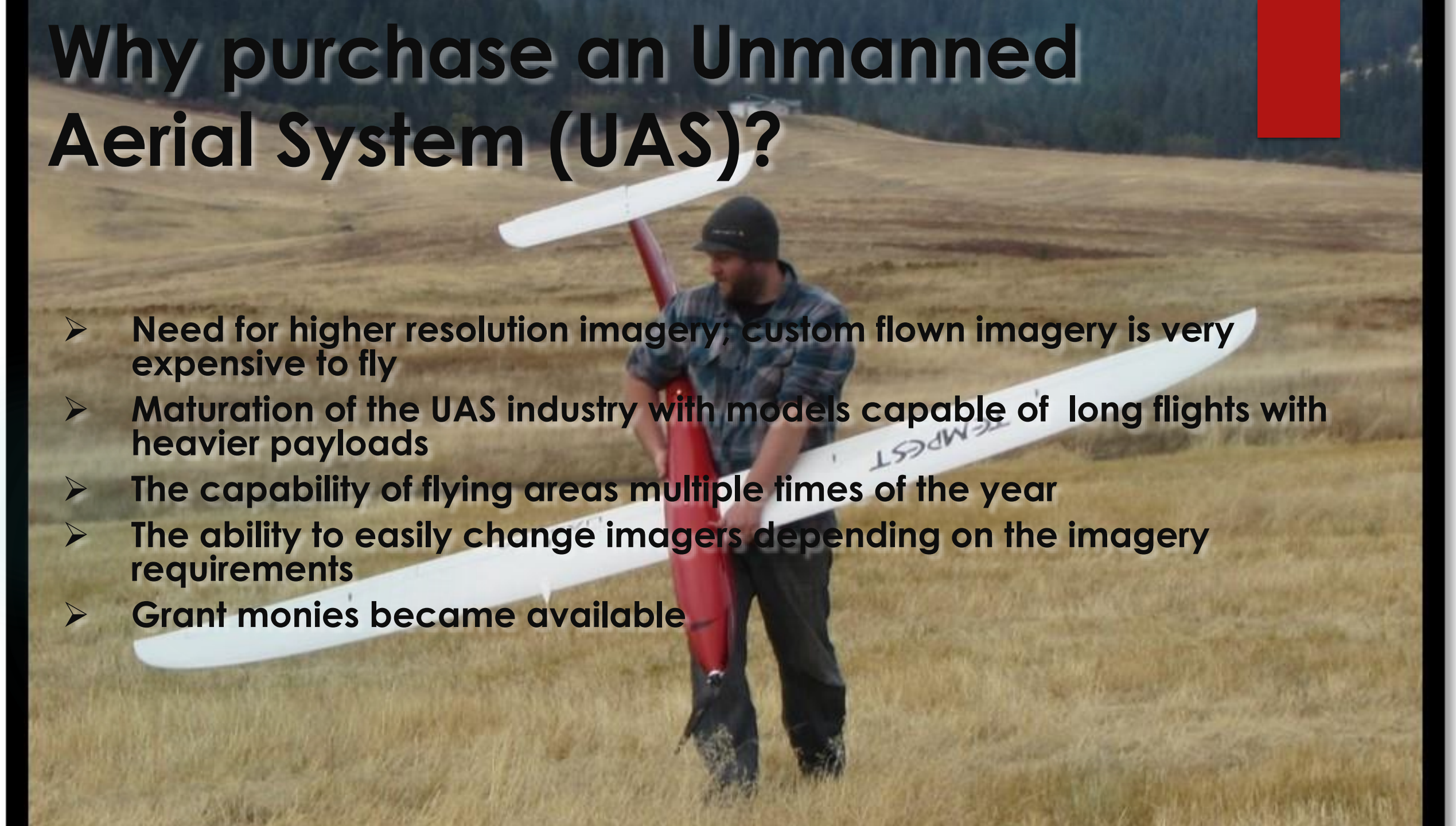
Coeur d'Alene Tribe GIS/UAS Staff:

Career Day at the local High School

- Top: James Twoteeth, Berne Jackson
  Bottom: Sabine Krier, Giovan Alcala

Why purchase an Unmanned Aerial System (UAS)?



- Need for higher resolution imagery; custom flown imagery is very expensive to fly
- Maturation of the UAS industry with models capable of long flights with heavier payloads
- The capability of flying areas multiple times of the year
- The ability to easily change imagers depending on the imagery requirements
- Grant monies became available

Selection criteria considered

- The ability to fly as many acres as possible per flight and still stay within the FAA line-of-sight contact rule.
- Large payload
- Rotary-style ("quad-copter") UAS's had very limited flight times (around 15 minutes).
- Fixed-wing UAS's typically have only a single motor and often have large wing-spans making them very energy efficient in the air. These types of UAS's can remain aloft for 1 to 5 hours increasing their acreage coverage dramatically. The larger of these can also carry more payload increasing the versatility of the aircraft.

The **UASUSA Tempest** was the finalist in the Tribe's selection process. It had a wingspan of 9 feet and could carry about 7 pounds for about an hour on a single battery. This gave the capability of acquiring imagery on close to 500 acres per flight gathering both RGB and near-infrared imagery simultaneously.

Acquisition of the Aero Systems West X-8

- During Coeur d'Alene Tribe GIS's flight training with their Tempest conducted by Aero Systems West (ASW) in Morgan Hill, California, the Tribal GIS Program realized that using the **Tempest** for training was not the best use of its time. ASW offered to sell one of its relatively inexpensive used foam UAS's, the **X-8**, to the Tribe to use as a trainer. It uses the same autopilot and flight software as the **Tempest**. So operationally, it is very similar to the **Tempest**. In the event of a "hard landing," its foam airframe is inexpensive to replace (available at Walmart!). By swapping the internal components, it can quickly be back in service.
- The Tribal GIS Program uses it to improve their fly-by-wire (autopilot stabilized mode) skills, in particular, manual landing procedures, a vital maneuver in some circumstances.

Training

- So what all does it take to get flying and to capture the data the Tribe was looking for?
- Tribal GIS Program staff did not have a background in Remote Control (RC) aircraft flying, thus, they had to have training using the **Mission Planner** software used by the Tempest autopilot. This tells the autopilot how the UAS will take off, land and grid collection areas. They had to learn how to conduct maintenance on the UAS and all related equipment.
- Also, they needed instruction on pre-flight, launch, recovery, manual flight operations and emergency procedures. This was provided by **Aero Systems West** at their training facility in Morgan Hill, California. Beginning with flights using the **X-8** to learn the basic procedures, they moved on to actual flight missions with their **Tempest**. Within a two day period, they became confident with flying the Tempest using it's autopilot and the Mission Planner software.

EPA Grant and Acquisition of Hyperspectral Sensor

- In September of 2017, the Tribal GIS Program was awarded an EPA Environmental Network Exchange grant. The goal is to research, evaluate and map the many wetlands, streams and lakes of the Reservation area and the impact of heavy-metals, a by-product of the mining industries in the Silver Valley. Also, a better method of mapping Eurasian milfoil beneath the surface of Lake Coeur d'Alene was needed.
- With the help of this grant they were able to purchase a third UAS, a **DJI Matrice M600 Pro**. It is a rotary-style model which is able to take-off, land and to fly in tighter spaces like forest stands and over water. It was equipped with a **Headwall Nano-Hyperspec** hyperspectral sensor with a spectral range of 400—1000nm and 270 bands.

Hyperspectral Data Collection

- Remote sensing techniques have the ability to identify soil properties for both environmental and agricultural purposes. Hyperspectral sensor data has been used for over a decade to help researchers detect chemicals and heavy metals. For future decision-making, targeted cleanup and on-going maintenance and rehabilitation efforts in Tribal wetland areas, the hyperspectral sensor attached to the **DJI M600** UAS can scan large sections to determine where runoff starts and where contaminated areas are located.
- The hyperspectral sensor collects vast amounts of images per flight. This would quickly fill the Tribe's current storage capabilities. To meet the demand of the incoming sensor data, a higher storage capacity server and tape libraries were acquired.

Processing the Data

- Tribal GIS Program staff would love to just go out and fly every day – weather permitting – and obtain imagery. Nevertheless, they need to be able to process all that imagery and have a usable end product.
- They did research and discussed the different available image processing software packages with others who had experience. Using a free trial version of **Pix4D** showed a very capable software option, but it seemed overly difficult to learn, so they decided on **Drone2Map**, an **ESRI** software product that was more easy to learn and use. It seemed natural since they already used many other **ESRI** products like **ArcGIS Desktop**, **Server**, **Portal** and several field apps. Processing with **Drone2Map** is quite easy once the flight logs have been obtained to assign coordinates to the images.
- They learned that you need a very powerful computer to process the many images from a flight. It takes a lot of time; 580 acres of RGB imagery took the most capable workstation the Tribe had over 24 hours. The program may have difficulty with some flights' imagery, but **ESRI** support can walk you through those issues. **Drone2Map** will show 2D and 3D views of the finished data, and end-products such as mosaicked ortho-imagery, NDVI, Digital Surface Models (DSM) and Digital Elevation Models (DEM). The final full **Drone2Map** report shows everything about the data and how to perfect data collection procedures.

What the Tribal GIS UAS Program Can Do

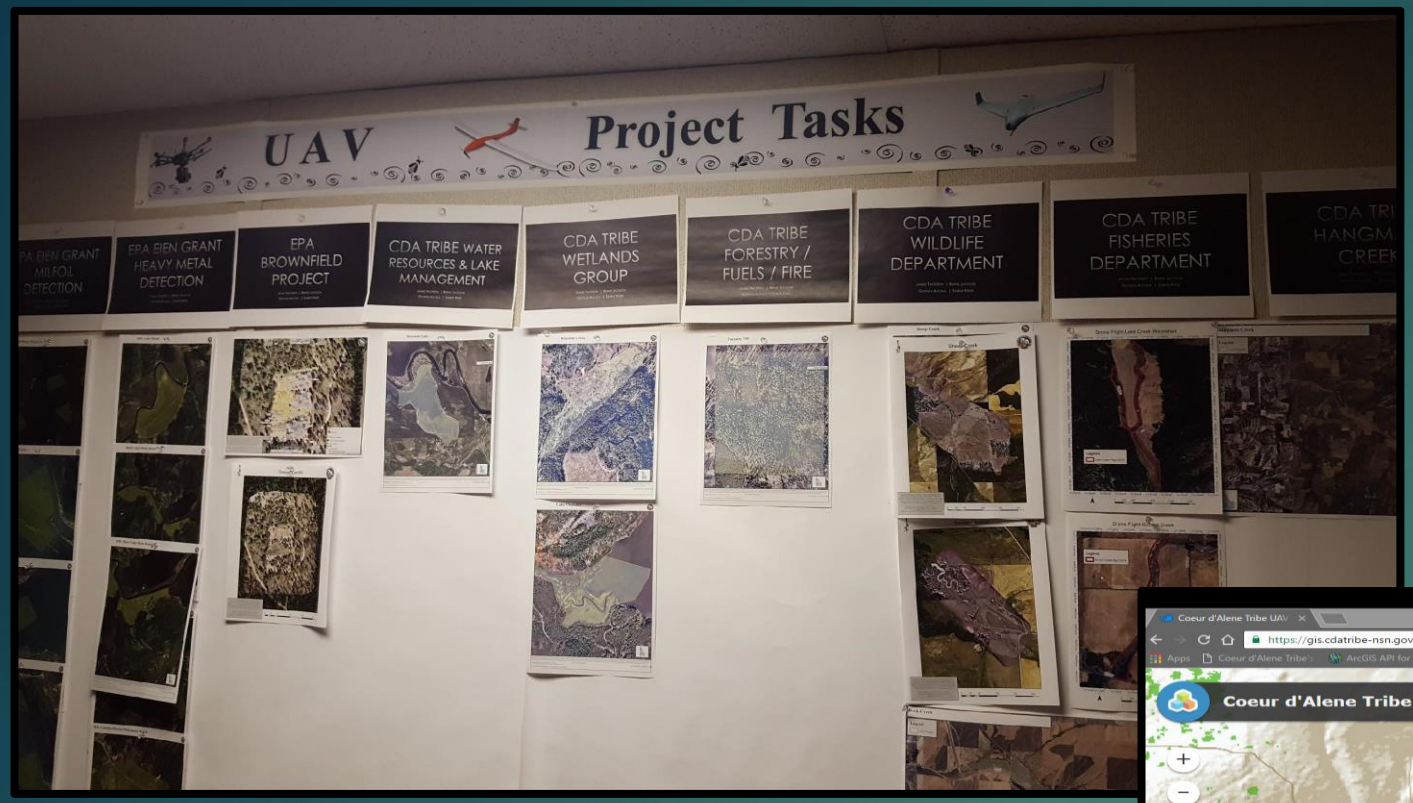
Current Capabilities

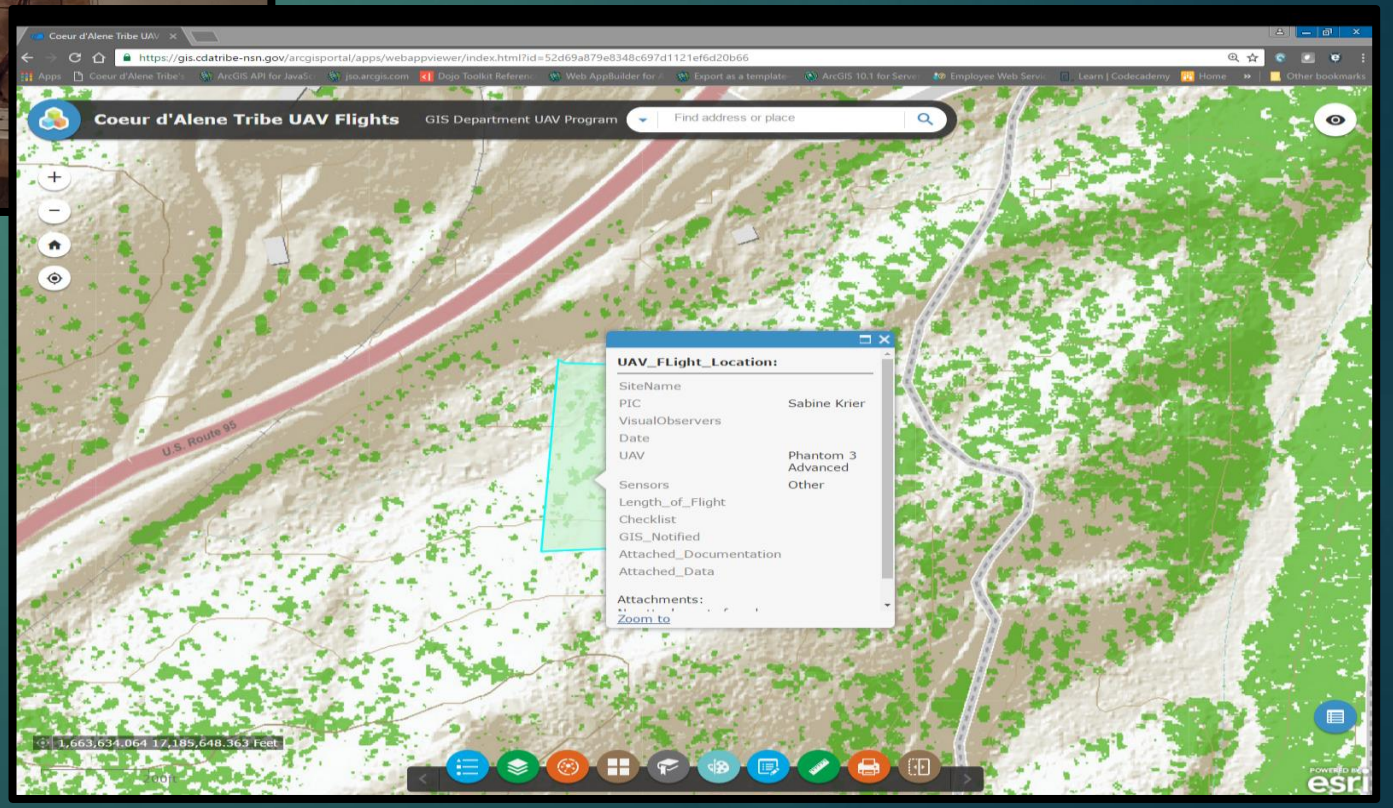
- Fly as often as needed
- Determine study areas
- Forestry or crop monitoring multiple times of the year
- Archaeology
- Stream/River bank
  - Restoration (Hangman Creek)
  - Erosion over time (St. Joe River)
- Timber management
  - Health (beetle or other tree disease)
  - Stand examine (sample plots)
  - Tree counts
  - Fire safety (fuel loads)
- Agriculture
  - Crop health (disease)
  - Harvest yield prediction vs. what makes it to the elevators (compare)
  - Pest control
  - Fertilizer optimization
  - Improve efficiency to farm marginal areas
- Misc
  - Aerial videography of events and Tribal operations

Long Term Plans

- Animal tracking (thermal)
- Lake and stream temperature monitoring (thermal)
- Fire management (thermal)
- Higher-precision stream bank studies (LiDAR)
- Forest canopy studies (LiDAR)

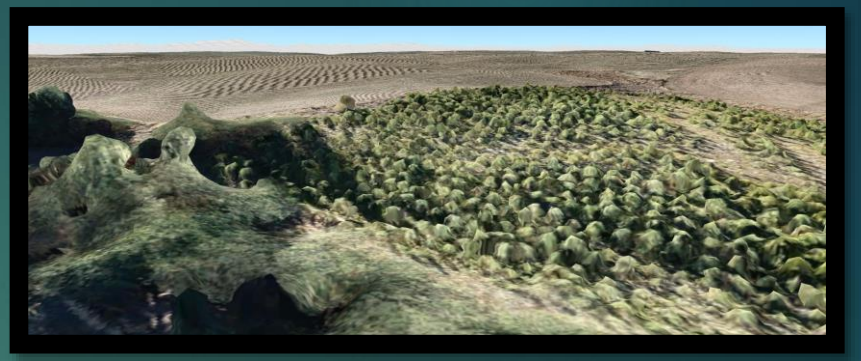
Planning


UAV Project Tasks
EPA BIEN GRANT HEAVY METAL DETECTION
EPA BROWNFIELD PROJECT
CDA TRIBE WATER RESOURCES & LAKE MANAGEMENT
CDA TRIBE WETLANDS GROUP
CDA TRIBE FORESTRY / FUELS / FIRE
CDA TRIBE WILDLIFE DEPARTMENT
CDA TRIBE FISHERIES DEPARTMENT

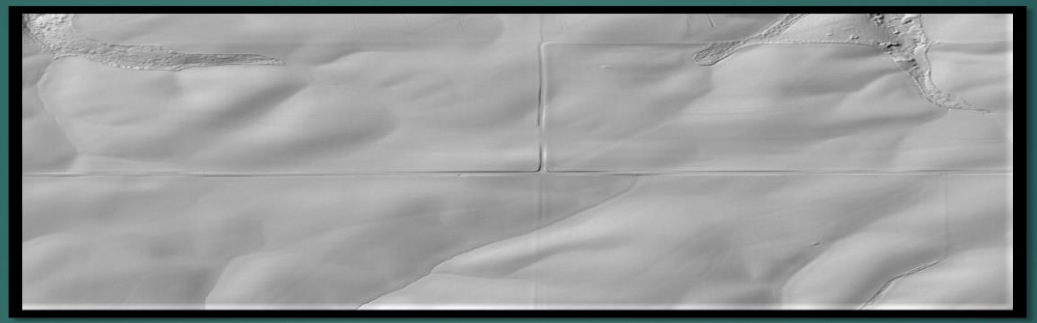

Coeur d'Alene Tribe UAV Flights
GIS Department UAV Program
Find address or place
U.S. Route 95
UAV_FLight_Location:
SiteName
PIC
Sabine Krier
VisualObservers
Date
UAV
Phantom 3 Advanced
Sensors
Other
Length_of_Flight
Checklist
GIS_Notified
Attached_Documentation
Attached_Data
Attachments:
Zoom to
1,663,634.064 17,185,648.363 Feet
esri

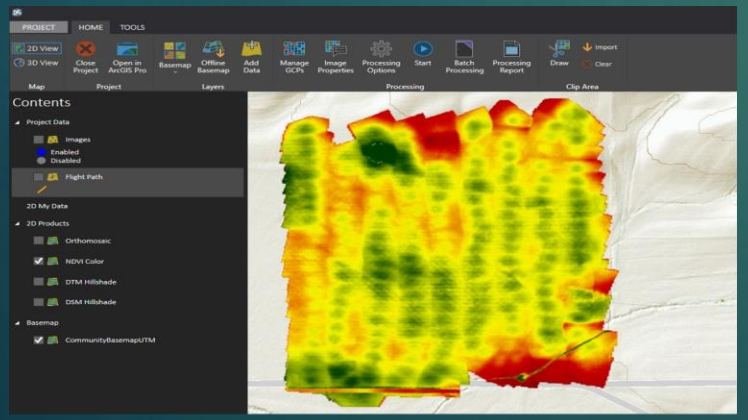
Tempest Launch

3D Imagery captured with the Tempest

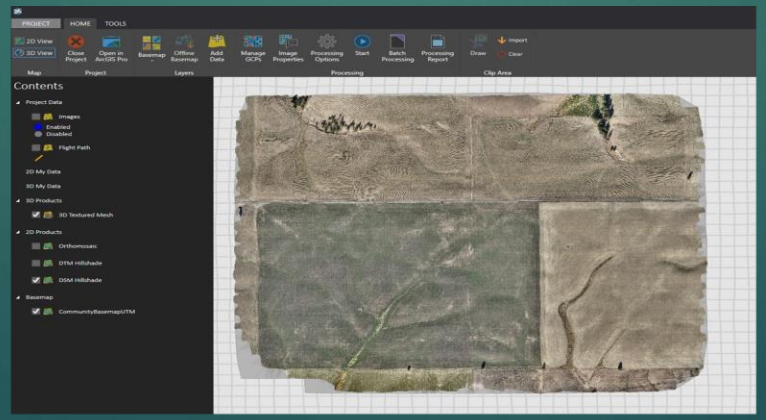


Hill shade produced from a DEM captured with the Tempest's Sony A6000 RGB sensor

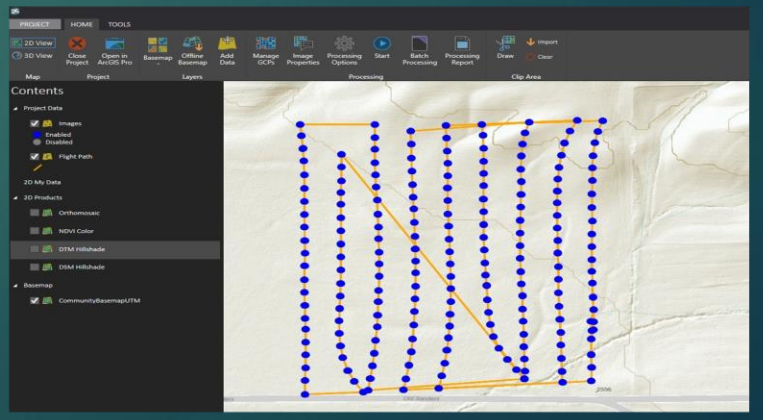




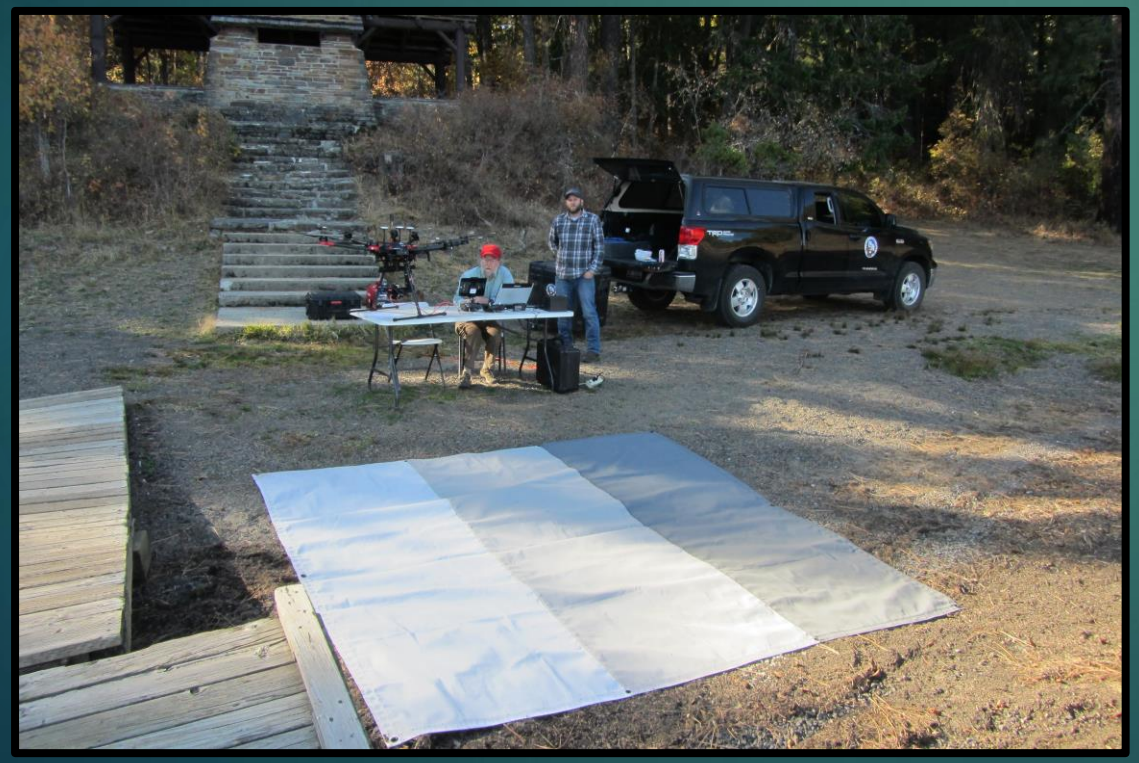
NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)



ORTHO IMAGERY @



Flight Path and Capture Points




SAMSUNG
MENU
Dst: 544 m | Alt: 87.4 m | Spd: 7.1 m/s

Lessons Learned and Words of Advice

- You must be committed to creating a UAS program and have the need for the product it can produce. It's not about the "flying;" it's about data acquisition. Be patient. This will be a long and arduous process. And needless to say, it will be *very expensive*.
- Selection of a vendor is difficult. Many of these companies are young and going through growing pains of their own. Many companies out there selling UAS's can be gone next year or even next week. Vet them thoroughly. Choose carefully. An on-site visit can tell you a lot about a company. Ask for a list of other customers you can contact.
- If you are going to be flying different sensors, make sure they can easily be swapped in and out with minimal tools and rewiring. Some have a modular compartment where the different sensors just plug in and out.
- Flight times claimed by the vendors are highly inflated.
- Make sure you get actual flight training on your UAS, even if you have to pay for it outside the cost of the UAS. Every UAS is unique and flight procedures can be very different. You may (likely) have to travel to their facility to do this training.
- Everything from take-off to landing is handled by the autopilot on a UAS used for image acquisition. However, it is a good idea to be able to fly them manually in the "stabilized" mode for emergency procedures and landings.
- Crashes are inevitable and UAS's break. Get over it. Don't forget to insure your bird for replacement value! Have a plan for recovering from a ground/obstacle "encounter," and get back flying!

Our Vision

- Three years ago, there was a dream of a UAS Program. Now there are three UAS's, several sensors for various imagery bands, dozens of flights with data capture and image processing completed and a lot of flying stories!
- Coeur d'Alene Tribe's GIS/UAS Program would like to cover as much of the Coeur d'Alene Reservation as possible, assisting the other departments like Natural Resources, Planning, Lake and Land Managements with their research, analyses and management.
- We plan to share our knowledge and experience with other tribes, and hope to inspire our youth to choose a career in this exciting and important field.

http://georunner28.maps.arcgis.com/apps/Cascade/index.html?appid=e8977298c03b4050b7e90bba6984a16f

https://youtu.be/mGSrmu75UME

The Road Ahead

- ***THERMAL SENSOR***
  - *Evaluating environmental effects on lake, rivers and creeks*
- ***LIDAR SENSOR***
  - *Focused elevation calculations*
- ***UNDERWATER UAV***