Maximizing UAS for SAR Operations

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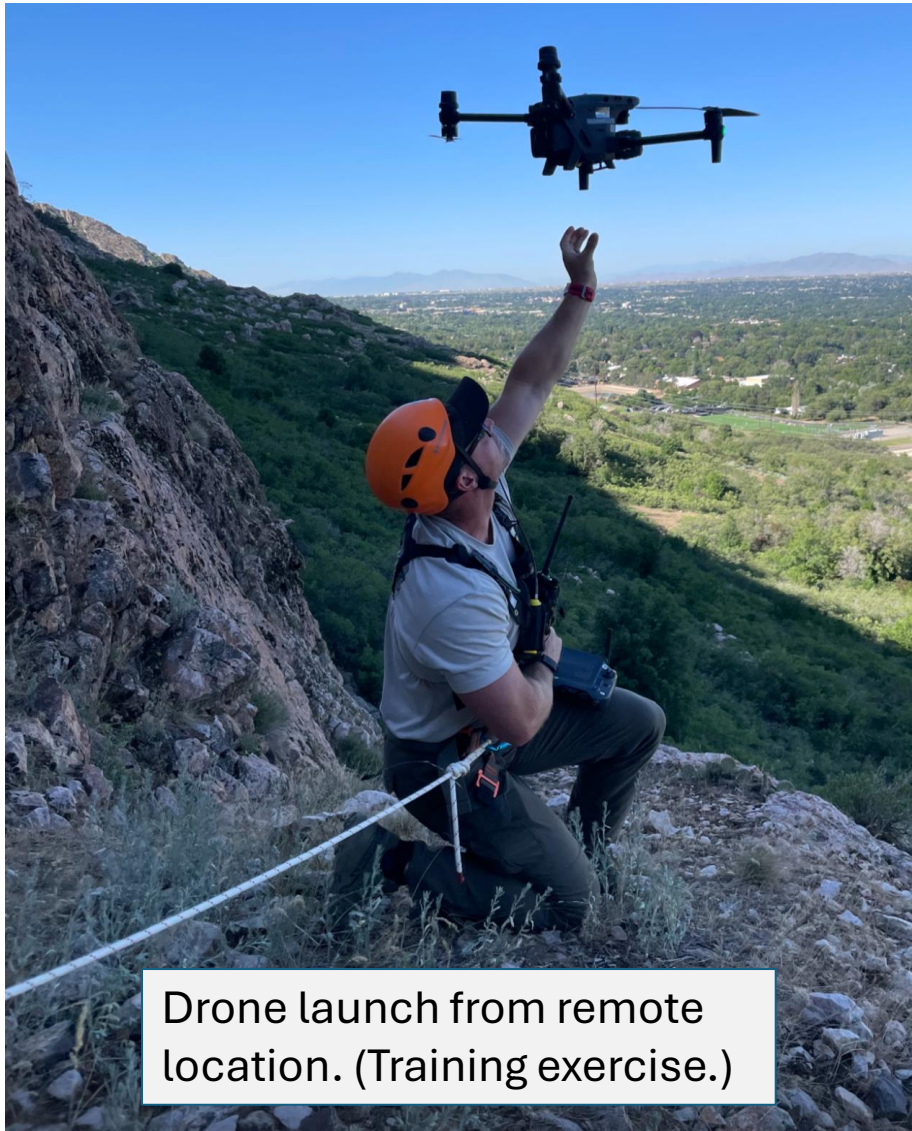
Class Objective

- Explore advanced strategies and tools to get the most out of UAS in ongoing SAR operations.

- Questions/Discussion:
  - Who is already using drones in their SAR team?
    - Please give us a brief overview of what you are doing and your future plans.
  - Who is already FAA Part 107 certified?
  - Who flies drones recreationally?
  - Who is seriously considering using UAS with their SAR team?
    - What is your status/progress?
  - Who is just curious about SAR drones and simply wants to know more?

Summary of Class #1: Starting Your Own UAS Program
Notes are online at the link given earlier: https://sohl.org

- Benefits and uses of UAS in SAR
- Federal regulations (FAA) on drone pilots (Part 107)
- UAS program planning and team buy-in
- Equipment choices
- Funding
- Example callout missions using drones



Drone launch from remote location. (Training exercise.)

Summary of Class #2: Using UAS in SAR
Notes are online at the link given earlier: https://sohl.org

- Mission types and how drones are used
- Mission planning for drone ops
- Lost person behavior and search optimization
- Operational coordination with other teams
- Debrief and real mission examples

MRA Climb Team and drone operations together.
Image: Sheri Trbovich

How you will spend the next 90 minutes of your life . (Open to discussion & interests)

- Advanced Search Techniques
- UAS Mission Planning
- Crew Resource Management – Optimizing Effective Teamwork
- Airspace Deconfliction and Extended Operational Periods
- Special Situations and Agency Jurisdiction Issues
- Specialized Scenarios
- The Future is Now
- Actual Mission Experiences (presenters and audience both)
- Q&A, Wrap-Up, How to get more information.

Advanced Search Techniques

- Thermal camera optimization (day/night, hot rocks, and temperature considerations)
- Search team viewing large screens and coordinating with the mapping team
  - Can simply be a larger screen hard wired to the HDMI on the flight controller
- Computer-assisted object recognition: Loc8 and DJI

Advanced Search Techniques: Thermal Cam.

- Day/Night
  - Day: Can see through light foliage
  - Night: Thermal is your primary flight camera
- Thermal range
  - Narrow thermal display around body temp.
- Thermal pallet
  - Pink hot is handy (highlights 37° C)
  - B&W is usually best
- Thermal bogies
  - Hot rocks from the Sun
- Thermal camera warning
  - Can damage camera with the Sun

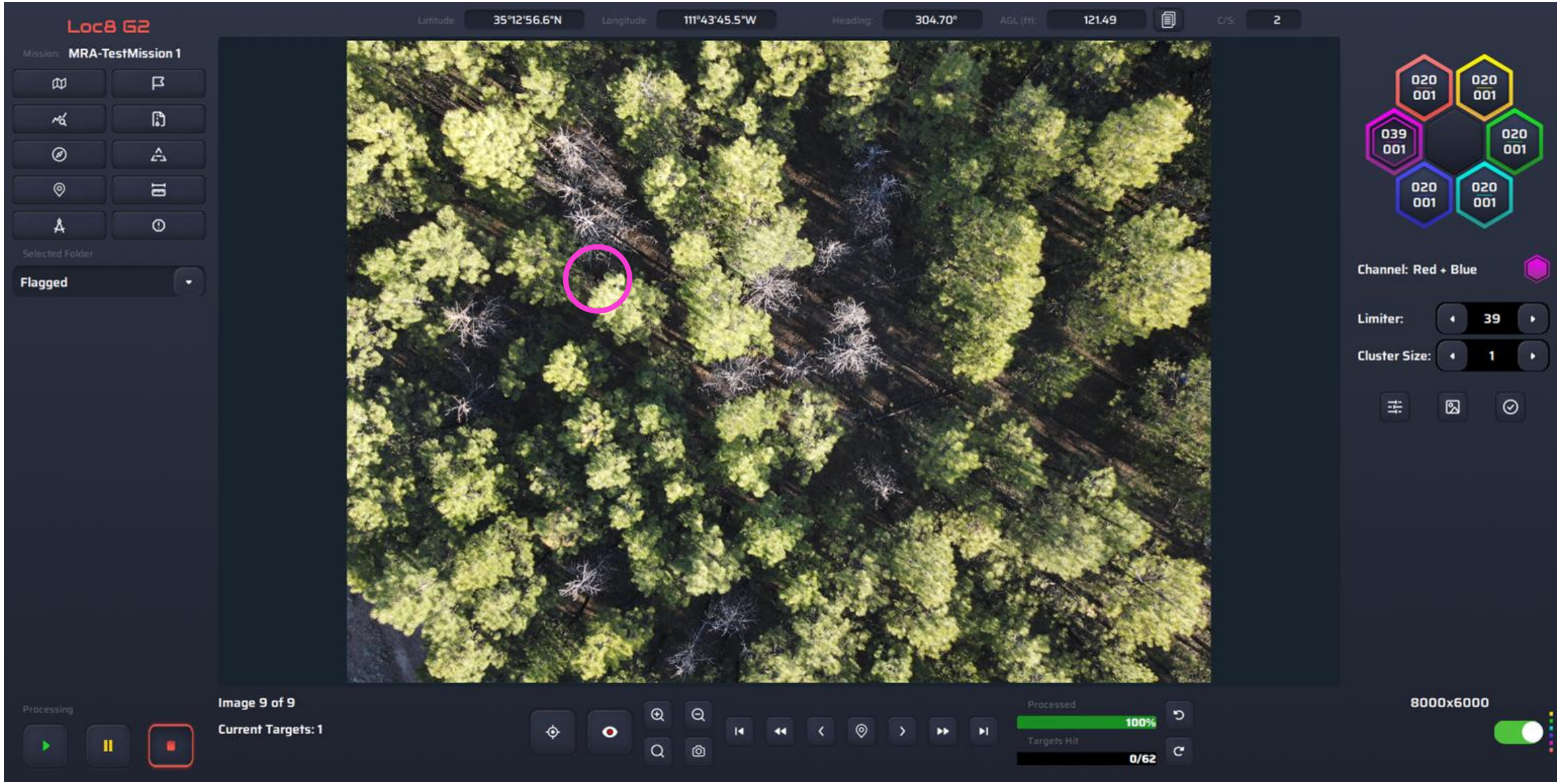
Advanced Search Techniques: Search Team

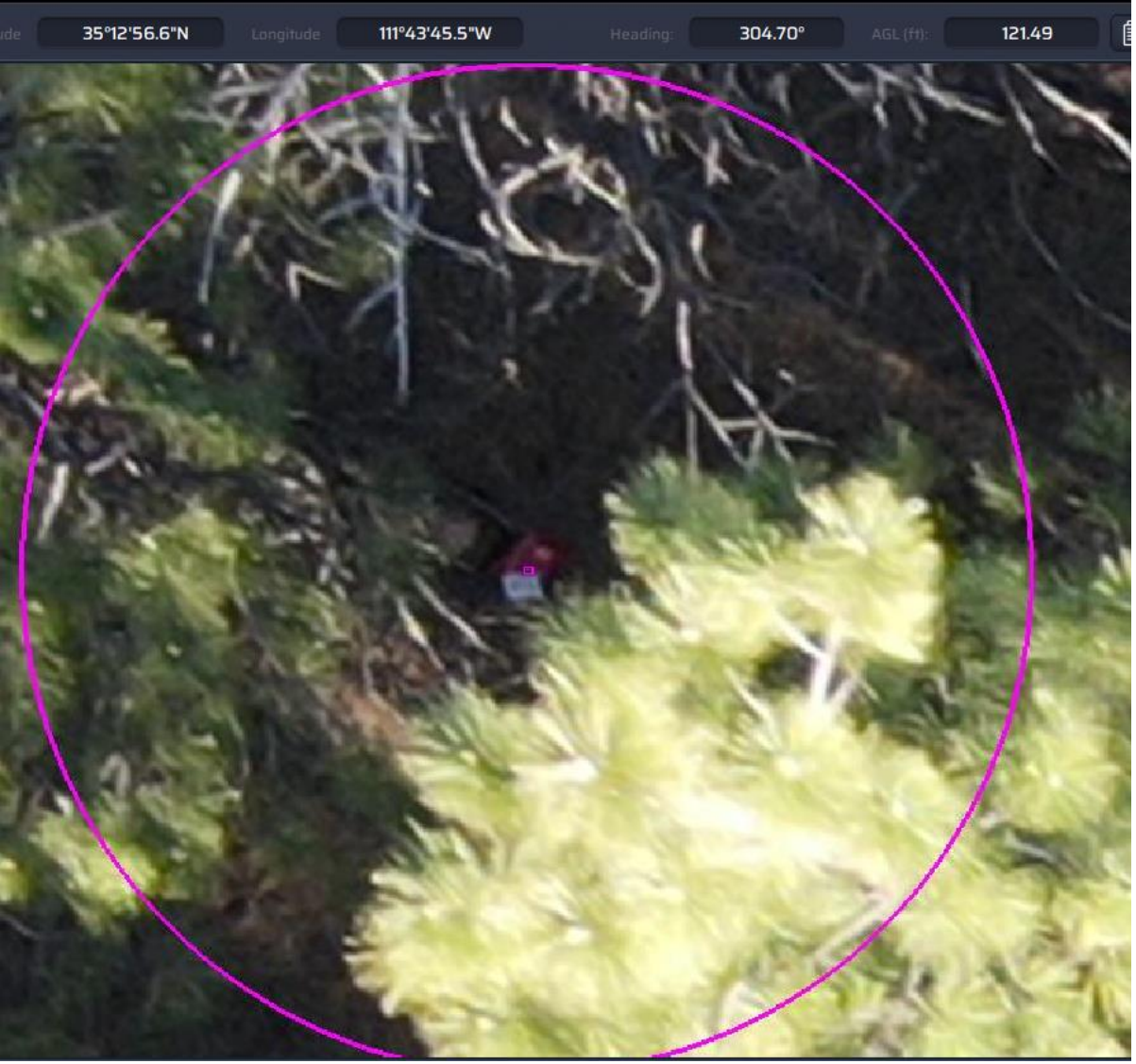
- Looking over your shoulder
  - Second set of eyes
  - Reduces pilot load
- Large screen monitor
  - Huge asset!
  - Full advantage of HD video
  - Searchers search; Pilot flies
  - Multiple people can search
- Easy addition
  - HDMI cable or WiFi
  - Monitor on table, in truck, whatever

Advanced Search Techniques: Computers

- Loc8 and RDT https://www.usri.ca/
  - Loc8 is visual camera analysis
  - RDT = Radiometric Data Toolset
  - Post processing, not live
  - Expensive but very powerful
  - Big learning curve
- EagleEyes https://www.eagleeyessearch.com/
  - Realtime computerized search
  - Expensive subscription
- DJI: New real time search AI with terrain following

Loc8 example, can you see the search clue?

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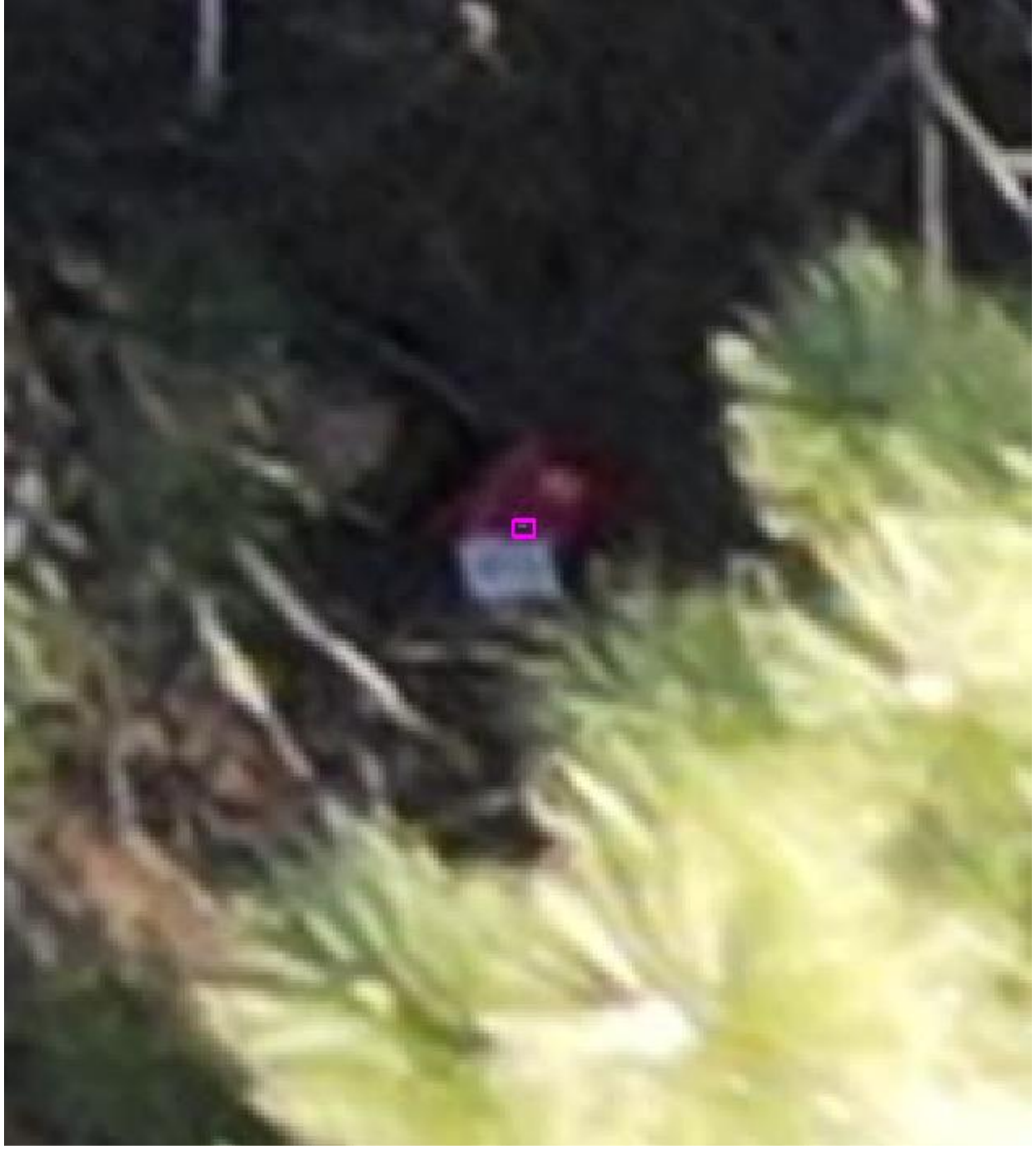
111°43'45.5"W
Heading:
304.70°
AGL (ft):
121.49



Resolution is key!

- All search “tools” (eyes or software) need something big enough to see.
- Resolution = actual ground spacing between two pixels
- Resolution depends on
  - Altitude
  - Number of pixels
  - Zoom settings/focal length
  - Image quality
  - Lighting
  - Video feed real time from the drone
- Still images have better resolution than video

Crew Resource Management (CRM): Optimizing Effective Teamwork

- Training and SOPs
- Team positions, roles, and responsibilities
- Culture of continuous learning – AARs are an important part of this
- Some teams have a standardized review form

Crew Resource Management (CRM)

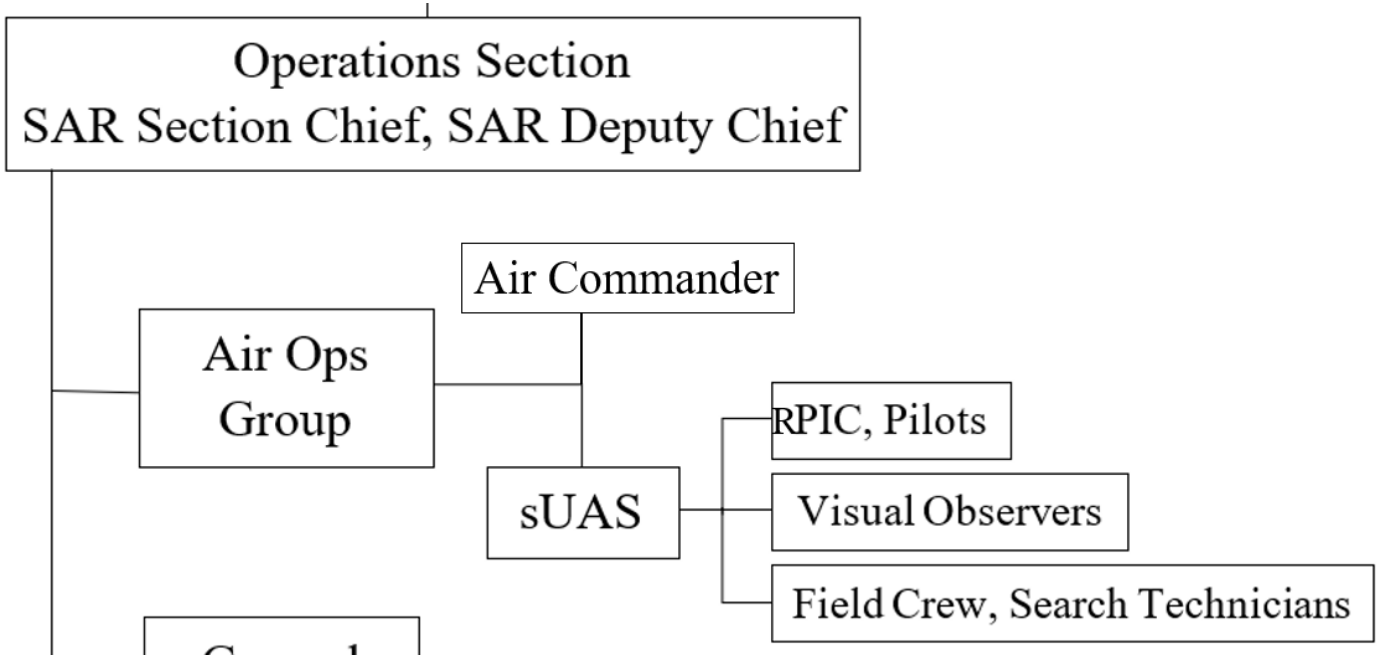
- Aviation’s standard approach to team management.
- Foster’s effective teamwork
- Continual training and awareness is key
- Encourage two-way communication between leaders and crew
  - Crew members must know that their opinions and concerns are valued.
- Clearly defined roles and responsibilities
- Delegate flying to less skilled pilot while chief pilot solves problems
- Follow SOPs

CRM: Training & SOPs

- Training
  - Flight practice with just UAS team
  - Mission training with full SAR team
  - Constructive criticism is key
- Standard Operating Procedures
  - MRA has a boilerplate SOP document
  - Sample organizational chart is included
  - All team roles and responsibilities defined
  - Checklists are valuable for each aircraft

CRM: Team Members

- Refer to the MRA UAS SOPs
- Team positions, roles, responsibilities must be clearly understood and defined
- A larger org chart allows you to expand



CRM: Culture of Continuous Learning

- Analyze and learn from mistakes
- After Action Reports or documentation is important
  - Every team member submits an AAR after each mission
  - Some California teams use a form to fill out (see next slide)
- Adjust policies based on real experience
- Crashes will happen—learn from them!

One of Sohl's experimental drone builds that didn't work so well.

Example AAR form. This one is used by some teams in California.

TEAM DEBRIEFING
AERIAL RECONNAISSANCE

1. INCIDENT NAME	2. OP PERIOD	3. TEAM NUMBER ASSIGNMENT # (ATTACHED)

4. AIRCRAFT TYPE(S) PILOT IN CHARGE PILOT AT CONTROLS (IF DIFFERENT) VISUAL OBSERVER

5. ASSIGNMENT SUMMARY

6. FLIGHT PROFILES

LOCATION	ELEVATION (AGL)	DURATION	DESCRIBE FLIGHT, SEARCH EFFORT, OTHER NOTES
LOCATION	ELEVATION (AGL)	DURATION	DESCRIBE FLIGHT, SEARCH EFFORT, OTHER NOTES
LOCATION	ELEVATION (AGL)	DURATION	DESCRIBE FLIGHT, SEARCH EFFORT, OTHER NOTES
LOCATION	ELEVATION (AGL)	DURATION	DESCRIBE FLIGHT, SEARCH EFFORT, OTHER NOTES

7. DESCRIBE PORTIONS YOU WERE UNABLE TO SEARCH

8. DESCRIBE ANY CLUES / HOW ARE FLIGHT TRACKS-VIDEO-PHOTO STORED OR SHARED

9. DESCRIBE ANY HAZARDS OR PROBLEMS ENCOUNTERED

Large Operations: Airspace Deconfliction

- Coordinating multiple drones: RPIC and/or Air Commander
- Airspace Deconfliction
  - Separate drone airspace
    - Horizontally geographically
    - Vertically above sea level (Not AGL)
    - Vertical separation needs a DMZ buffer
  - Define departure and approach routes
  - Never trust helicopter pilots

Large Operations: Drone Cycling

- Air Commander position is helpful
- Cycle drones for continual ground team support
- Put 2nd drone on-station before returning 1st drone
- Especially important when providing lighting
- For IC situational awareness, just return the first drone before deploying the second drone
- Support team stops searching and prepares batteries during return flight
- Pilots can discuss plans during battery swap and/or before return flight is initiated.

Large Operations: Simultaneous Missions

- One drone provides patient illumination
- Second drone searches for ingress/egress route options

- One drone stays with first subject
- Second drone continues search for other subjects

- Air Commander coordinates flight ops and isolates pilots from distractions and incident command (sterile cockpit)

Large Operations: Batteries

- Spare batteries are essential to a successful mission
- Helpful having common batteries between aircraft
- Ground support technicians monitor continual battery charging
- If doing remote operations having a vehicle is helpful (snowcat, ATV, etc.) can charge batteries from ACC plug on vehicle

Large Operations: Pilot and Crew Issues

- Pilots must dress stupidly warm! This is not an aerobic activity!
  - Having a warm place between flights is awesome
- Cold hands need good touch gloves or fingerless gloves
- Long missions require cycling through pilots to avoid mistakes
- Search crews get tired of staring at monitors
- Distractions are common, isolate the pilots/crew from everyone else
  - “See anything?” “Have you found them yet?” “Where are you?”

Special Situations and Agency Jurisdiction Issues

- What is a COA and where can it be useful?
- Coordinating with the AHJ, LE, FAA, Parks, Military Airspace, etc.

Special Scenarios: Avalanches

- Several teams are working on avalanche beacon searches from drones.
- Use drone gimbal camera to view both the beacon and the terrain
- Beacon must be far enough away from drone to eliminate RF interference
- Preliminary tests are very promising, routinely finding the target beacon signal in under 90 seconds
- Mitigation not likely: FAA bans flights with explosives; Teluride Ski Resort did a trial program (w/ COA) but abandoned it

Special Scenarios: Avalanches

- RECCO did some experimentation with a drone flying the antenna but seems to have paused development of that project.
- Can use the drone to search for hazards such as hang fire from cornices or other feeder canyons containing unstable snow
- Use drone to sweep for clues (gloves, hands, equipment, etc.)
- Use drone to determine safe ingress/egress routes

RECCO on drone, development seems to have stopped in 2016.
Image from Facebook.

Special Scenarios: Water

- Can rapidly sweep brushy riverbanks from the river’s point of view
- Best to fly low and close
  - Hard to see a body through water
  - Thermal cameras don’t work
  - Watch for hazards (esp. trees)
  - Surface winds can be tricky
- Floods: Can rapidly clear an area
- Mudslides: Can search like avalanches

Special Scenarios: Payload Delivery

- Highly dependent on the aircraft
- Reduces battery flight time
- Both after-market and OEM options
- Payloads:
  - Radio for patient
  - Food/water
  - Space blanket
  - First aid
  - Entire litter and climbing gear

Special Scenarios: Mission Flight & Mapping

- We rarely use any of this.
- In the time required to create the mission we can just fly it manually.
- We already have maps and aerial imagery of our areas.
- Probably useful for extended searches
  - Especially when coupled with Loc8 or similar
- Setting up mission flights for Powder Mountain ski patrol for daily closing sweeps looking for guests.

DJI Pilot App, Mission Flight
Image from Run Li, DJI

The Future is Now

- Integration with mapping platforms such as SARTopo
- Internet integration with FlightHub2, DroneSense, etc.
  - Keeps the AHJ informed!
  - Additional eyes searching the video feed
- StarLink

Live Demo of FlightHub2 or DroneSense

- Advantages and disadvantages of each interface.
- Live discussion and possible demo.

Actual Mission Experiences (Presenters and audience both!)

- Breakdown of a complex SAR mission
- Highlight drone roles and decision trees

Q&A and Wrap-Up. How to learn more.

- Thoughts?
- What do you plan to do with this information?
- How can we help you?
- You can reach out to us at:
  - Captain Kyle Nordfors: uas@mra.org
  - Dr. John Sohl: jsohl@weber.edu
  - Sgt. Brenden Berry: b_berry@marinsheriff.org

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