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Using a Drone with a Thermal Camera for Cattle Roundup

Abstract

In the Intermountain West, livestock are summered in mountain ranges and collected in the autumn and moved to lower ground for ease of closer monitoring during calving with less snow. Mountain grazing comes with challenges gathering cattle. Drone teams with thermal camera drones joined producers to collect cattle during the fall collection. Drones enabled producers to identify areas where horseback riders could be effectively utilized to gather cattle, thereby saving time and reducing the risk of injury to both the horse and rider in rough terrain, and locate animals that would otherwise be a loss of income. Search and rescue methods were used to search 600 acres in 1 hour, and technology limitations were identified.

Keywords: Cattle, thermal camera, drone

Introduction

Small, unmanned aircraft systems (sUAS or simply UAS), also known as drones, are being heavily implemented in multiple areas of agriculture, taking advantage of a wide range of application possibilities. A few examples include monitoring crop life, herding

and supervising cattle movement, and spraying weeds and crops. Livestock producers are now using drones to check fence lines, monitor calving, and conduct property water surveys (Bolanos, 2022). Producers have found that using drones helps them save time and effort by expediting tasks (Schelfhorst, 2022). Local producers requested research into the effectiveness of this technology in the high range during fall collection, which can last over a month.

In the Intermountain West, livestock are typically summered in mountain ranges nearby and collected each autumn to access lower pastures during the harsh winter months and ease closer monitoring during calving. Calving is conducted from late January to February in the winter range closer to home, where the cow and calf can be closely monitored with less snow. Grazing during the summer in the high range reduces grasses and fire hazards and allows the lowland to produce feed for cattle during the winter.

Using mountain ranges and pastures comes with its own set of challenges. Spring turnout of cattle on mountain ranges requires less time and effort than gathering cattle at the end of the fall season. During the fall, it’s a larger process to move the cattle back to holding pens and trailers, as the cattle have dispersed across the mountain and need to be re-gathered. Cows like to explore their environment, and they can get lost in the process; coupled with the harsh landscape (Photo 1), it becomes more difficult to find and gather the entire herd (Bailey et al., 2021). This roundup may take a few trips up and down the mountains, riding the range on horses, or using all-terrain vehicles (ATVs).

Photo 1. *Western Mountain Range for Summer Cattle Grazing*

Integrating drones to aid in cattle recovery and movement is an effective way to overcome some of these cattle-specific challenges. Cattle can be quickly located by deploying a drone that easily navigates across the mountainside or within ravines. This allows the livestock producer to conveniently identify areas to focus horseback riders' efforts to gather cattle. Using drones not only saves time and money but also reduces the risk of injury to the horse and rider in the rough terrain of western mountain ranges.

Materials and Methods

Utah State University (USU) Extension and the Aggie Drone Academy conducted several projects at 4 locations using drones to locate lost cattle using a thermal sensor drone. The first 2 locations were in October and December of 2024. Two additional locations were added in September 2025. All drones used were an Autel EVO II Dual 640T V3 Thermal Sensor Drone. The drone is equipped with a 50MP Camera, 640x512 at 30fps, a 13 mm lens, 16x digital zoom, and 10 temperature measurement modes. The highest altitude above ground level was under 400 feet, per FAA regulations; however, about 1,800 feet above the take-off point of the drone, all the while following terrain to establish the regulated height. The gimbal angle of the camera was about -

55°. Visual scans were performed using thermal camera images. The maximum distance from the take-off point was 2,500 feet during the day. Night flights utilized the flashing beacon that increased the distance to 3,500 feet. All collections were selected from producer requests to locate missing cattle. All flights were manual flights with no programming due to the changing elevation of the landscape.

Research

At the first location, a team with two thermal drones joined cattle producers on the first day of collection to collect preliminary findings and feasibility. This drone team was equipped with two drones, a side-by-side ATV (Photo 2), and handheld radios. The livestock producers had approximately three teams of horseback riders. The drone team and one producer reached the location at 8:00 a.m. and deployed two thermal camera drones to different search areas. The drone team would deploy one drone with one visual observer, keeping the operation compliant with FAA Part 107 regulations and flying approximately 300-400 feet above ground level (AGL). The team also limited its AGL to 400 feet from takeoff, which limited its search ability.

Photo 2. *Side-By-Side on Mountain Ridge Carrying Drone Cases*

Two small groups of cattle were located, one in a grove of pine trees (Photo 3) and a second in an aspen grove (Photo 4). The first attempt was successful in locating cattle. The drone team then moved farther up the mountain at the request of the producer,

waiting for horseback riders to ride to the highest point of the range to herd cattle down the mountain.

Photo 3. *Drone Thermal Image Showing Six Cattle in a Pine Grove (left) and the*

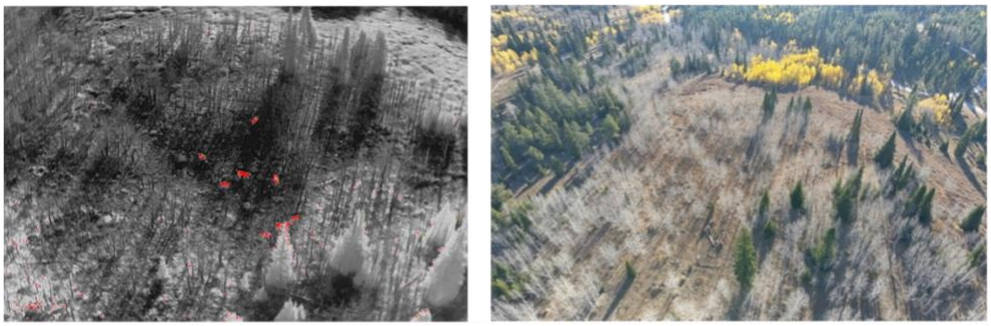

Photo 4. *Drone Thermal Image Showing Eight Livestock Animals in an Aspen Grove (left) and the Same Location Depicted Without a Thermal*

The livestock producer knew the landscape from experience and knew several extremely difficult locations for horseback riders to access. The team checked for cattle in those hard-to-access areas using the drone. These areas were quickly checked using the thermal drones (approximately 15 minutes of flight time) and found to have no cattle.

A drone flew over an approximately 2-acre area of dense brush and timber on the north side of a small ridge in less than 10 minutes, and no cattle were found. Unknowingly, horseback riders also searched the same area and did not find any cattle, confirming the drone search results. When asked how long it took to search that same area, they indicated roughly 65–75 minutes. The drone only required 15% of the time to search the same area (Photo 5). The drone team checked and excluded areas that were difficult to

ride and saved the producer approximately 1 day. It was determined that applying search and rescue methods would increase the success of locating cattle, and limitations were identified. The search and rescue methods will be addressed in the discussion section, and limitations in the results section.

Photo 5. *A Drone Scanned This Bloomington Lake, Idaho, Area in 15% of the Time Required to Search the Area on*

The second location used in testing the drone implementation had been impacted by fire and floods, which made the normal routes back to the lower pastures unpassable. The team rode on horseback for a mile to reach the search area. The drone team was deployed with an Autel Evo II Dual 640T V3 drone to search for 40 cow-calf pairs. This team implemented search and rescue techniques to increase success. The total area covered during this flight mission alone was approximately 1,500 acres (counting vertical and horizontal coverage).

In less than 30 minutes, and covering an area of about 600 acres, a single cow with a calf was found. The team then searched the nearby mountains to eliminate other possible areas for other cattle (Photo 6).

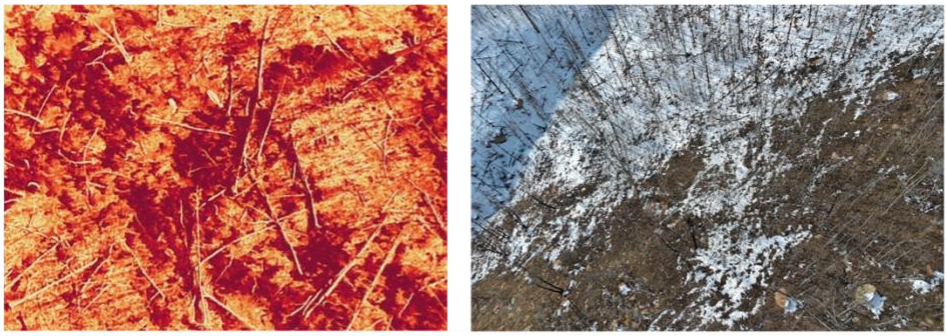

Photo 6. *Drone Thermal Image (Using Glowblow Color Pallet Scan) Showing a Cow and Calf Stuck in Huntington Canyon, December 2024 (left) and a Nonthermal Comparison (right)* Photo: Shalyn Drake

The livestock producer knew the landscape and the different locations where the cows would normally gather. The rough terrain and impassable areas due to recent floods made it almost impossible to approach the areas, even on horseback. By using the drone and its thermal capability, the team was able to search these areas with just a short walk of about 100 yards.

During the 2025 season, the drone team was asked to locate 30 head of cattle missing after a forest fire near Afton, Wyoming. Producers had been riding for days with little to no success. The producers also rented airplanes to spot cows. Locals contacted Utah State University Extension to help locate the missing cattle and present this new technology to producers. The drone team conducted its first nighttime cattle locating. The drone team found it easier to fly further distances in up to 3,500 feet from takeoff. The team located 2 cows and 2 elk that night in under 2 hours, searching 2 square miles. The area where the cows were located had previously been searched by horseback. The location was reported to the producer the next day and retrieved. The next morning, an additional 7 cows were located within 2 hours in another location further from the night search location. The total area searched was 1 square mile of dense pine trees.

The drone team returned to Bloomington Lake, Idaho, in September of 2025. The aspens had much of their foliage still on the trees when compared to the previous year (Photo 7). This did limit the ability to see cattle within the foliage. The drone team had better knowledge of the area and was able to locate and exclude areas that did not

need to be ridden by horse. The ability to communicate with the riders, where the cattle were also increased. The search methods were further explored, and one additional limitation was noted. The day of the search, the air temperature at 10:15 am was 65.7°F. The highest air temperature for the day was recorded was 77°F at 3:38 pm. These cooler temperatures that year made it possible to have longer favorable searching conditions. In one day, 81 of 144 cows were located in the first day, with an additional 30 the next day.

Photo 7. Drone images from the 2005 Bloomington Lake collections, thermal image using the Glow blow filter, Locating 4 cows. Notice more

Results

The first obstacle common to all drone usage areas is how long the drone can stay in the air. Most batteries would last approximately 25 minutes, depending on altitude and wind conditions, on a clear, calm day. The number of maneuvers also influences the amount of battery used per flight. The first team brought 10 batteries with them, which allowed approximately 4 hours of flight time. This day took between 7–8 hours to gather up the cattle. The drones were not used 100% of the time in the air, but having a power bank or the ability to charge batteries on a speed charger would be a great addition to a similar operation.

In addition, the teams found that fall winds coming up from the valley caused the drones to use up more power by fighting the higher wind shear. This, in turn, reduced flight time. In December, the battery life was decreased to about 15 minutes due to

temperatures lower than 30 °F. Fortunately, the cold area covered also meant that the thermal readings helped find animals' heat more quickly. However, the cold also meant that the animals didn't move as much, which made it harder to identify them because movement is one technique for finding identifiable heat signatures of lost animals.

Other limitations were identified with the thermal imaging as ambient environmental temperatures increased to exceed or match the thermal image of the cattle. As the daytime temperature increased into the low 90s (Fahrenheit), imaging quality decreased. Around 11:00 a.m., it became difficult to tell the difference between a rock that was 98 °F and a cow that was 101 °F (Photo 8). The 2025 Bloomington Lake search found that south-facing slopes are difficult due to early warming of the area compared to the north side or even the valleys.

Photo 8. *Thermal (left) and Color Photo (right) of Cattle at 11:45 a.m. In the Open Area, Where It Was Becoming Difficult to Identify Cattle from Other Hot Spots*

However, by using the thermal camera's forward-looking infrared (FLIR) feature, real-time temperature readings confirmed the slight difference in temperatures. Even though it was easier and more effective to see cattle in the cooler morning, finding stationary cows near large rocks or outcroppings required more effort. The most effective thermal setting after the temperature rises is called *gradient fire*. Movement detection was the key to finding animals. The teams also found that evergreen trees gave off heat signatures in both locations, making it difficult to confirm cattle sightings.

The last limitation was a communication problem between the livestock producer and the drone team. Even though the producer was accompanying the drone team, and they spoke directly, there was still a lack of knowledge of drone capabilities and terms used by drone pilots, which caused delays in finding cattle.

A proven method to reduce communication problems is to develop a basic plan that outlines the overall objective and divides up responsibilities between all involved in the operation. By using a map of the area and marking water holes and normal gathering areas, the drone team wouldn't have to wonder where to fly next. Although communication was established through handheld radios, a set plan would have been helpful to coordinate efforts among the lead cattle producer, the producer's team, and the drone team. Using known and practiced search and rescue patterns with drones would be an effective use of resources in locating individual missing livestock at the end of the season.

Cost

While working with producers to locate cattle. We found that the Wyoming producer paid $200 an hour to locate cattle by airplane. This cost would include the cost of preparation, travel to the site, and landing. This would not allow for much time for searching. The total cost to purchase an Autel thermal Camera drone, 2 extra batteries, speed charger, large battery pack, Part 107 certificate with possible training, and drone registration would be roughly $6,000. This would allow the producer to have unlimited flights. With the current cost of Beef cattle, a producer would need to find 3-4 cows that would normally be a loss of revenue to break even on his investment.

Discussion

Common search and rescue flight patterns used by public services, the Civil Air Patrol (Civil Air Patrol, 2019), and with drones. The first most-used flight pattern for large areas is a **parallel search** pattern with the camera gimbal set at nadir (straight-down, -90°)

and flying at very low speeds (Figure 1). However, the drone team found that a gimble setting between -50° to -65° was the most common setting they used.

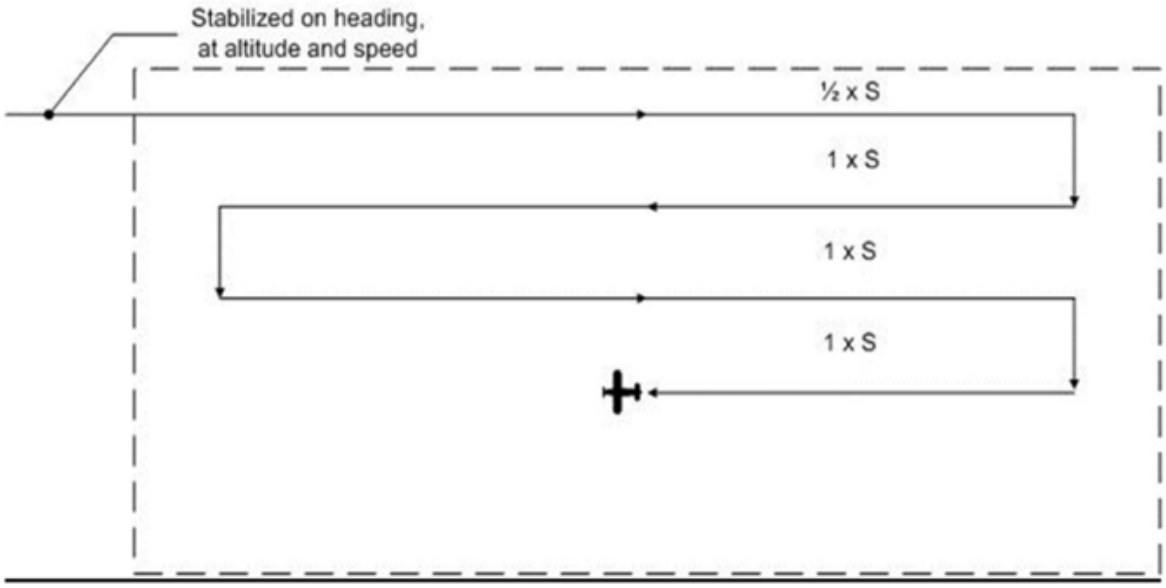

Figure 1. ***Parallel Search*** *Used by Civil Air Patrol* (Civil Air Patrol, 2019)

The team would need at least one pilot, one dual controller to watch the screen in thermal camera mode, and one visual observer. Another common large-area search pattern is a **sector search**, which uses similar gimbal and speed settings but begins each sector (triangle) at the same spot and moves outward from there (Figure 2). We used this pattern to search the sides of mountains or ravines while centrally located in a valley. We used the parallel search within those sectors.

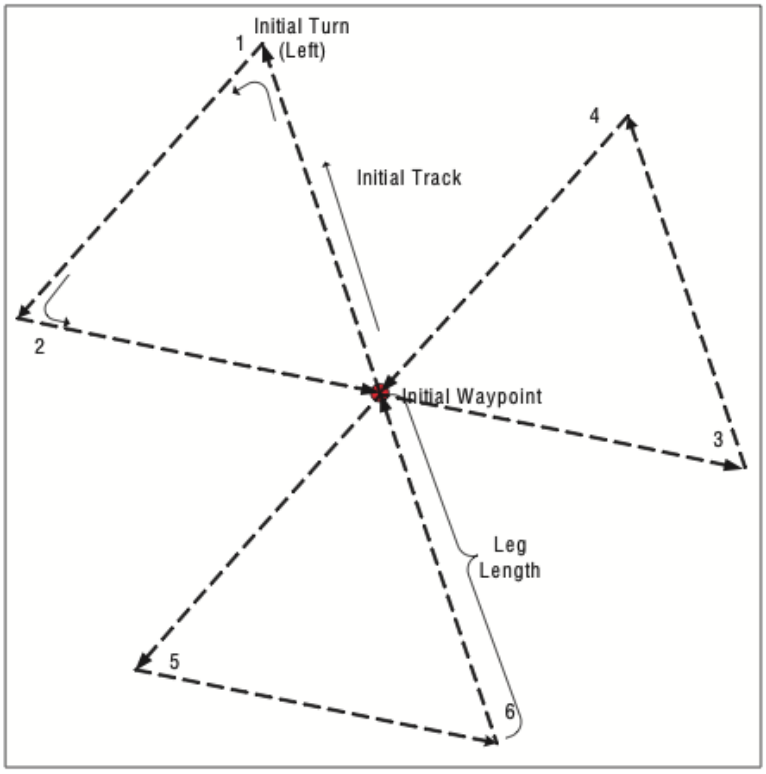

Figure 2. ***Sector Search*** *Used by Civil Air Patrol* (Civil Air Patrol, 2019)

When “Hot Spots” were found, we would use the **expanding square search** (Figure 3). This allowed us to get a better visual of the “Hot Spot” and allowed us to watch for movement or see around foliage. The quadrotor drone allowed us to make a circle, keeping the hot spot centered. If the cow was identified, then we moved to an expanding circle technique, which allowed us to find other cattle in the same area. In this type of pattern, a gimbal setting closer to -70° would be appropriate in canvassing the area, and speed could also potentially increase slightly from the previous patterns.

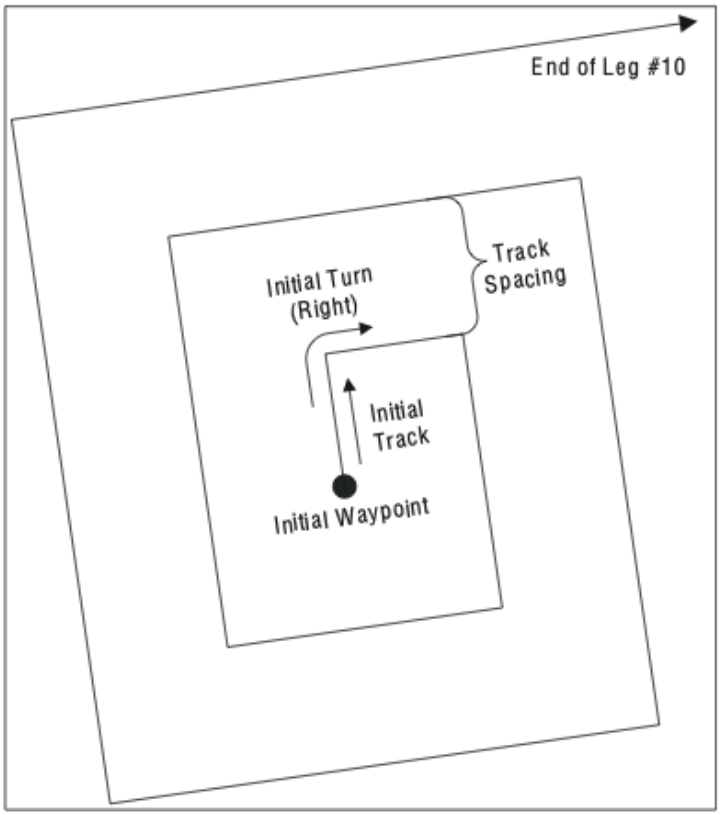

Figure 3. ***Expanding Square Search*** *Used by Civil Air Patrol* (Civil Air Patrol, 2019)

The final pattern teams could use is a **constant orbit** around the area, allowing those traveling on horse to “eyeball” the location via the drone. It’s a way to communicate where to go.

Manual flight skills are essential in each of these patterns, as well as a full team to keep the drone in visual line of sight and to utilize visual observers, both components per FAA Part 107 operations and limitations.

Time of day is also a key element of the search; the further the ambient temperature is from the item searched, the easier it will show on the thermal camera. When searching for cattle, mornings are more productive than midday when ambient temperatures may be warm in the summer.

Conclusion

Using drones with thermal sensors can be an effective tool in finding and collecting livestock from the summer mountain ranges in the West. Drones can complete searches in much less time than required on horseback in demonstrated areas. Using

drones reduces the workload of the rider and horse, saving time and energy and reducing the risk of injury (Thomas, 2022). With proper training and certification, livestock producers can use drones for locating cattle. The return on investment for buying a thermal drone can be validated by finding missing cattle that would otherwise be a loss of revenue or the cost of working hours for ranch hands searching day after day for an additional month to locate all the cattle.

Photo Credit

Justin Clawson provided all images unless otherwise noted.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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