FOREST SERVICE
REMOTE SENSING TIPS
RANGELAND MANAGEMENT

# Monitoring Rangeland Shrub Cover With High-Resolution Imagery and a Digital Dot Count Technique

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## Overview

*Estimates of shrub cover are typically made in the field using line-intercept methods. This study shows how high-resolution digital-camera imagery can provide similar cover estimates at reduced cost. A cost-effective technique using digital dot-grid overlap is also discussed in this report.*

## Rangeland Condition Assessments

Maintaining healthy, functional rangeland ecosystems poses a significant challenge for resource managers (figure 1). Effective management depends on a good understanding of the status-changing nature of range conditions. One important indicator of rangeland health is the condition of shrub cover (O'Brien and others 2003). Normally, managers rely on repeated field inventories to monitor rangeland shrub cover. However, because plot locations are widely distributed across the landscape, field inventory is difficult, time consuming, and costly.

**Figure 1**—A typical rangeland in Utah containing a healthy cover of shrub, forbs, and grasses.

## Remote Sensing Monitoring Technique

In response to this resource-management problem, the Remote Sensing Applications Center (RSAC) has developed an effective method of monitoring rangeland shrub cover. This approach combines high-resolution, digital aerial imagery (figure 2) with digital dot counting.

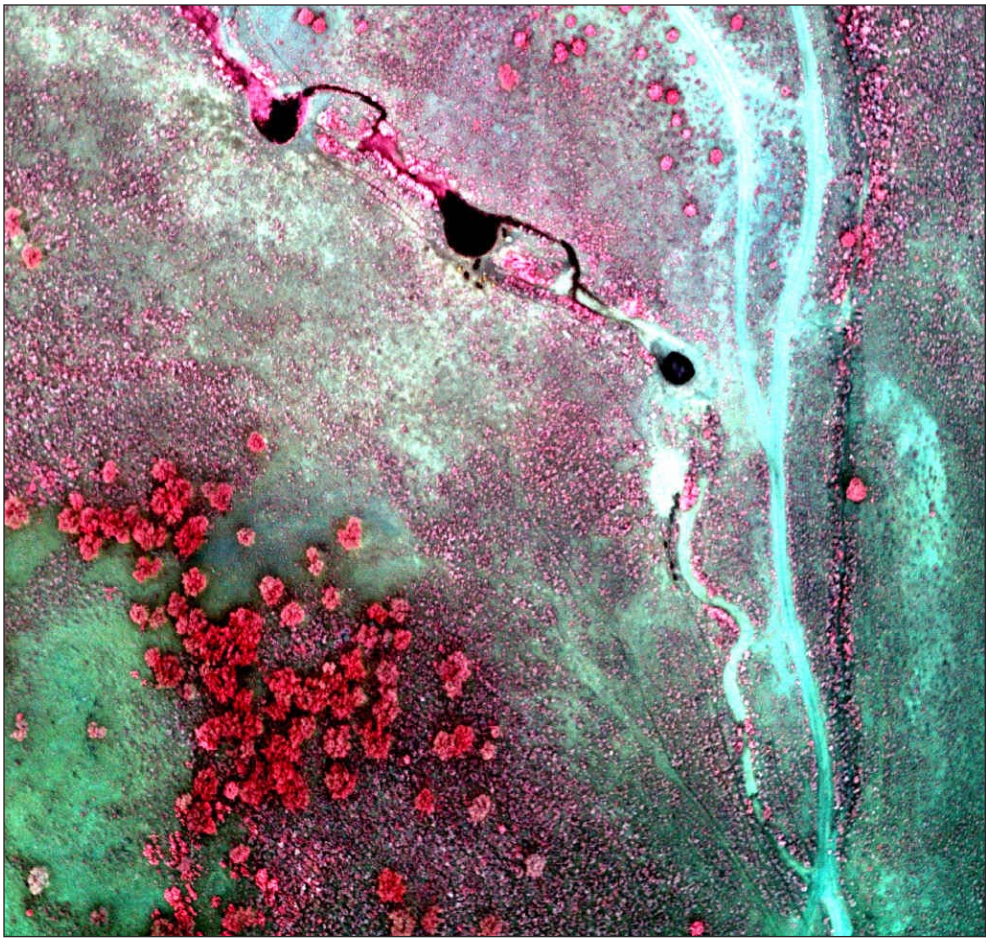

**Figure 2**—The same rangeland from the remote sensing perspective. The image width is about 900 feet.

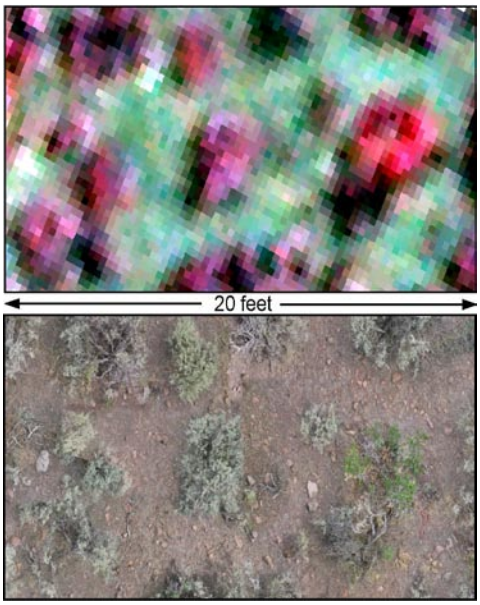


**Figure 3**—An extreme zoom-in with 3-inch-resolution, color-infrared, digital aerial imagery *(top)* shows that very small shrub crowns are resolved; *(bottom)* the same scene in the field.

### High-Resolution Imagery

High-resolution, digital aerial imagery comes directly from a digital camera. It may also be obtained by scanning ordinary photographs. It has a number of benefits.

Resolution relates to the ground-resolving distance of an image. High-resolution imagery (about 6 inches or less) is needed to identify and measure small ground objects like shrub crowns (figure 3).

Aerial platforms are well suited for obtaining imagery over small, widely distributed plots. This imagery provides a consistent, permanent record of plot conditions over time. Digital imagery can be analyzed using efficient, computer-assisted interpretation. Cover estimates can be made from the imagery at any time, not just during the busy field season. High-resolution imagery can also capture data for up to 10 times as many plots per day than can be visited in the field.

## Digital Dot-Count Technique

Digital dot counts are the modern equivalent of traditional photo interpretation pioneered during the 1950s (figure 4). When compared to coincident field-based estimates of shrub cover (by line intercept), image-based estimates by digital dot count have these advantages:

- They match within about 10 percent per plot, on average.
- They match the average of all plots within about 2 percent.

Robust estimates of shrub cover can be made in about 25 to 45 minutes per plot. This time includes all the steps: preparing the imagery and dot grids, labeling the dots, and calculating percent cover.

Selecting the dots that intersect shrub crowns is a straightforward interpretive task (figure 5). It does not require extensive image-processing expertise. Standard corporate software can implement all the procedures.

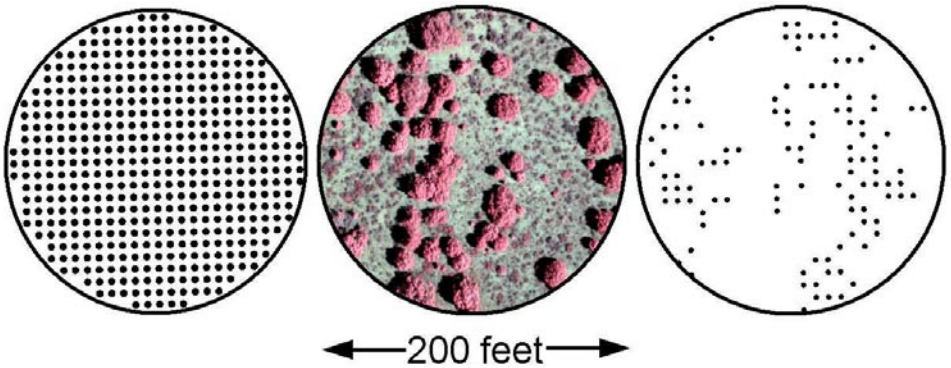


**Figure 4**—A digital dot grid *(left)*, which is interpreted over a plot image *(center)*, results in a count of dots intersecting shrub crowns *(right)*. Shrub dots ÷ total dots x 100 = percent shrub cover (in this case, 24 percent).

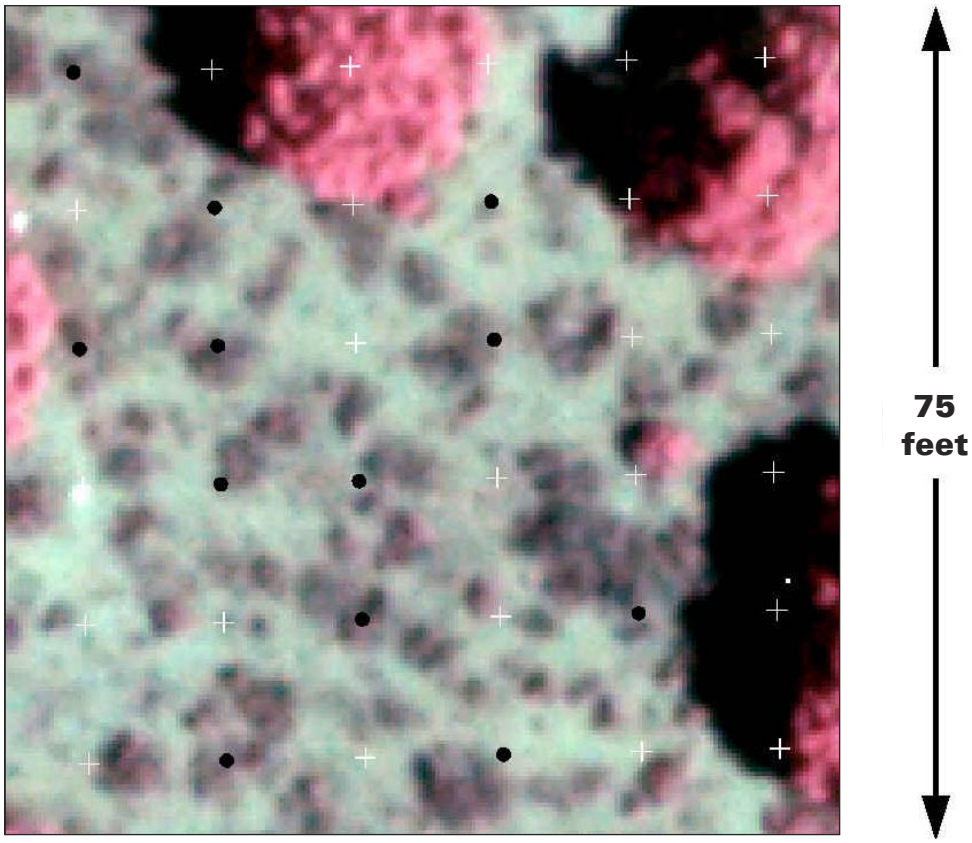


**Figure 5**—A mouse click selects every dot intersecting a shrub crown (shown here in black). The computer calculates shrub cover from the dot counts.

### Strategy 1: Conduct a Field Inventory at Reduced Cost

Remote sensing cannot replace the detailed information available from field inventory. When detailed inventories are required, field costs can be reduced by using the following strategy:

- Obtain imagery in concert with field inventory at time one.
- Obtain imagery at time two.
- Determine shrub-cover trends by comparing image-based estimates from the two times.
- Limit subsequent field inventory to plots that have undergone significant changes.

### Strategy 2: Monitor Shrub Cover in the Absence of Field Inventory

Budget limitations often preclude extensive field inventory. In the absence of field data, the condition of shrub cover can still be monitored using an image-based approach. This strategy involves two steps:

- Obtain imagery at time one and time two.
- Determine shrub-cover trends by comparing image-based estimates from the two times.

### Simple Design Strategies

Image-based estimates of shrub cover are similar, but not equal to, field-based ones. For example, image estimates may be higher than expected because they represent canopy cover (figure 6), rather than foliar cover. Image estimates may also be lower than expected. This is likely to occur with plots where high tree cover interferes with overhead observation of shrub crowns. Consequently, it is best to avoid comparing field and image estimates to determine shrub-cover trends. Consider alternative monitoring strategies, such as these:

## Cost/Benefit

Two things worth considering, associated with the remote sensing approach, are image acquisition costs and interpretation time.

Currently, high-resolution digital imagery is available for about $80 to $150 dollars per plot. These costs vary depending on the

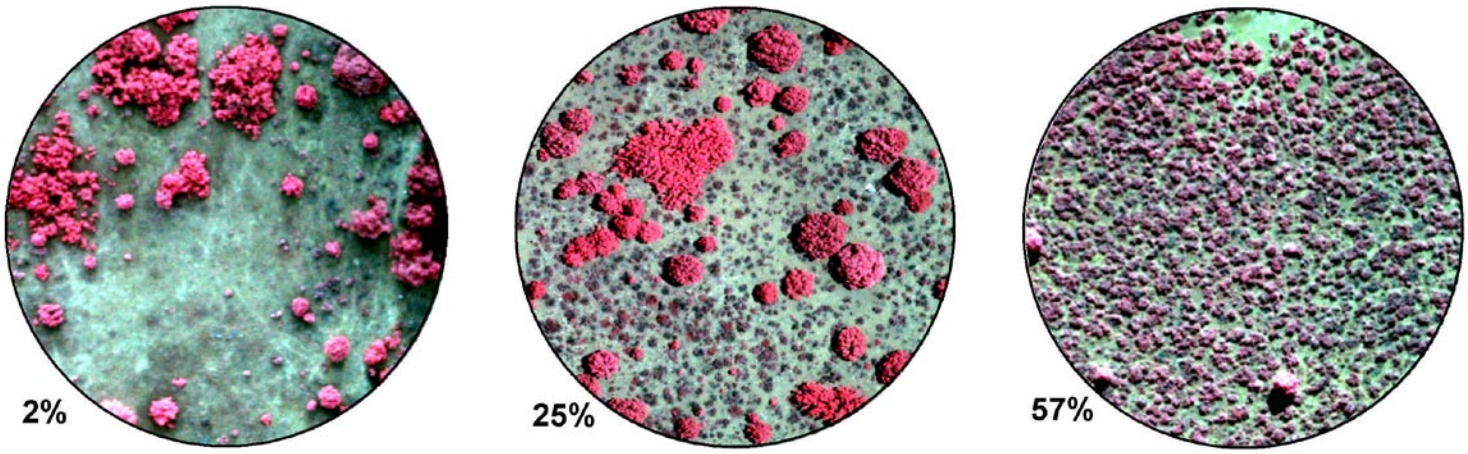


**Figure 6**—High-resolution, digital aerial imagery captures canopy (as opposed to foliar) cover. Image-based estimates of shrub cover using a digital dot grid are shown for three 200-foot-diameter plots.

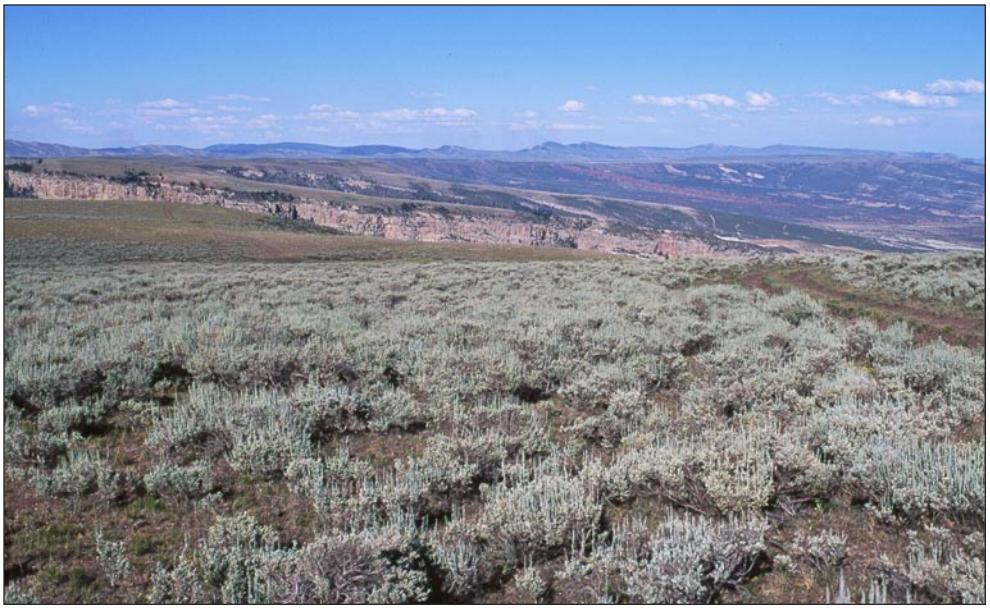

**Figure 7**—A Utah rangeland.

number and spatial distribution of the plots. Recent acquisition of imagery for 1,200 plots cost about $110 per plot, or $132,000 dollars. The imagery was retrieved from about 100,000 square miles of territory at a rate of 25 plots per day.

Current digital dot-count techniques allow a reasonably proficient technician to interpret shrub cover for about 8 to 10 plots per day. At this rate, 1,200 plots can be interpreted in about 20 to 25 person weeks. A modest up-front investment in software or training can increase staff efficiency and limit errors.

## Conclusions

RSAC is actively engaged in developing and supporting these remote sensing technologies. Because of their robust, quantitative, and accessible nature, these and related approaches are becoming increasingly used for inventory and resource management. In the near future, those interested in this approach can expect these improvements:

- Documentation in the form of a user's guide.
- Tighter integration with Geographic Information System using an enhanced digital-dot-counting interface.
- Increased availability of options for direct acquisition of digital aerial imagery.

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