

Aerial Photo Inventory, Acquisition and Orthorectification Project for Little Bighorn NB and Grant-Kohrs NHS

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1. Introduction

In 2006 the Rocky Mountain Network I&M program entered into a cooperative agreement with the Wildlife Spatial Analysis Lab, University of Montana, to acquire and orthorectify historical areal photography. Baseline aerial photography in a digital and orthorectified format serves as an important foundation for addressing baseline conditions in all ROMN parks. At GRKO, knowing how the landscape has changed over the last century provides valuable insight into the cultural-natural landscape. At LIBI, this information will serve to help understand vegetation and fire dynamics, changes in the cultural and physical landscape, and will integrate closely with the vegetation map planned for the park. For all parks, historic photography is rich in information beyond VS monitoring and can be used by all park divisions, including interpretation and maintenance.

Objectives for the project included:

- Develop and inventory of historic aerial photography for GRKO and LIBI;
- Settle on (1) Number of time series (2) desired photo dates, (3) footprint, (4) imagery type (color or B/W) and scale of imagery that meets goals of the VS monitoring and is within budget.
- Acquire imagery – Focus will be on acquiring the most recent imagery first. Older imagery, particularly prior to the 1960s, is time-consuming because work must be coordinated with the National Archives.
- Orthorectify - Using the most recent 1-m DOQQs (NAIP 2005 imagery) as a reference, orthorectify imagery with a RMSE of no more than ± 14 meters (± 7 DOQQ error from reality ± 7 m) new image error from DOQQ)
- Mosaic – Imagery should be contrast balanced so that seams are invisible and linear feature match up.
- Document – Metadata for the source imagery and orthorectification process will be provided in FGDC-compliant xml format.

2. Data and Methods

Hardcopy images were obtained from the NPS Technical Information Center (GRKO, 1974; LIBI 1977), National Archives (LIBI 1954), and USGS EROS Data Center (LIBI 1991).

All were scanned at the following specifications:

Park - Image Date	Scan Resolution (dots per inch)	Image Resolution	Number of Images	Average Error (meters)
GRKO 1974	900	1:7,200	Twenty seven individual photos in 3 Flight lines	2.4 m
LIBI 1954	720	1:20,000	Forty individual photos in 5 flight lines	3.9m
LIBI 1977	900	1:10,800	Two individual photos in one flight line.	2.3m
LIBI 1991	21 Microns~1209dpi	1:40,000	39 individual photos in 5 flight lines	.55m

Table 1. Scanning and Accuracy Specifications

The highest resolution imagery (i.e., showing the most detail) is for GRKO at 1:7200. The 1991 imagery has the lowest resolution (1:40000) and consequently will show the least amount of detail.

Orthorectification was performed using Leica Photogrammetry suite. The first step in performing the orthorectification is building a block file. The block file contains all of the scanned aerial photos as well as ancillary information about them such as photo size and scale. If available the block file also contains all information about the camera used to take the photos, the number of flightlines, the number of photos per flightline and the direction of flight for each flightline.

Once the ancillary information is entered into the block file, the user begins by identifying all the fiducial marks for each photo. This provides necessary information on the interior geometry of the photos, i.e. how well the photo was scanned. After this the user begins to identify ground control points (GCPs). GCPs are features that are visible in the aerial photo, the reference image, and any overlapping aerial photos. The GCP's and fiducials are used to generate the equation used to reference the photos to ground locations. The minimum number of GCPs needed varies depending on the amount of ancillary information was available to enter into the block file, however nine GCP's per photo is average. Typically GCP's are collected until the accuracy, or Root Mean Square Error (RMSE), of the model is within acceptable parameters. This is typically $\frac{1}{2}$ of the size of a pixel or less. Once the calculated RMSE is within acceptable limits the

image rectification/resampling process is run. The resulting images are then mosaiced to produce the final single orthorectified image of the study area.

Once processed, images were compared to 1:40,000 NAIP (2005) Imagery for LIBI and High Resolution Homeland Security Imagery (2004) for GRKO.

More specific information on the processing steps and methods are found in the respective metadata files.

3. Results

A total of four final mosaics were completed. At GRKO, a single mosaic was completed for September 19, 1974 (Figure 1) - around the time of GRKO's establishment. This mosaic extends approximately 1km north and south of the park and a half kilometer to the east and west.

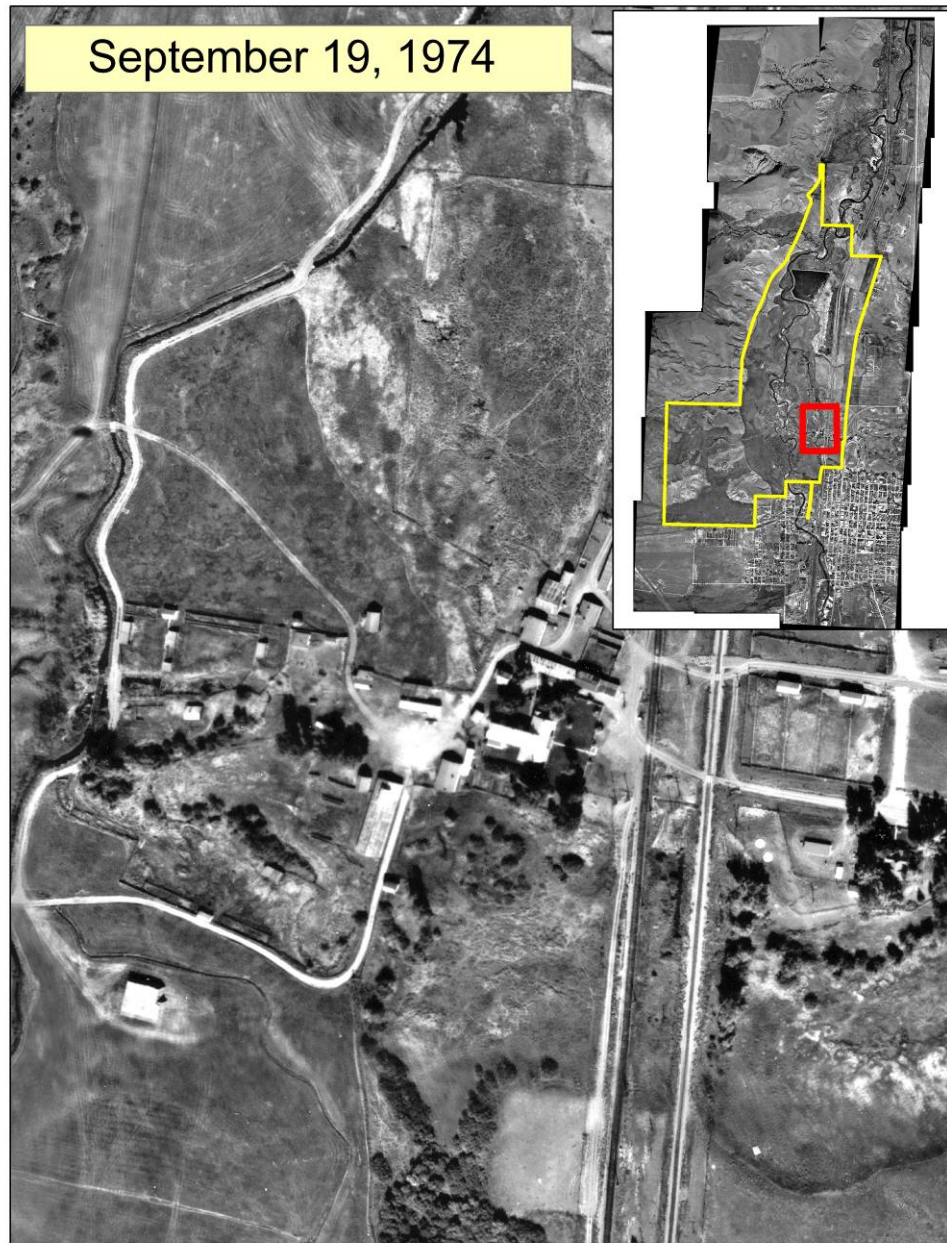


Figure 1. Mosaic Image for Grant-Kohrs Ranch NHS, September 19, 1974.

Three mosaics were completed for LIBI.

The first, dated July 30, 1954, represents the earliest available imagery that is of the entire park and of sufficient resolution (Figure 2). The footprint extends approximately 2.5 kilometers on each side of the park.

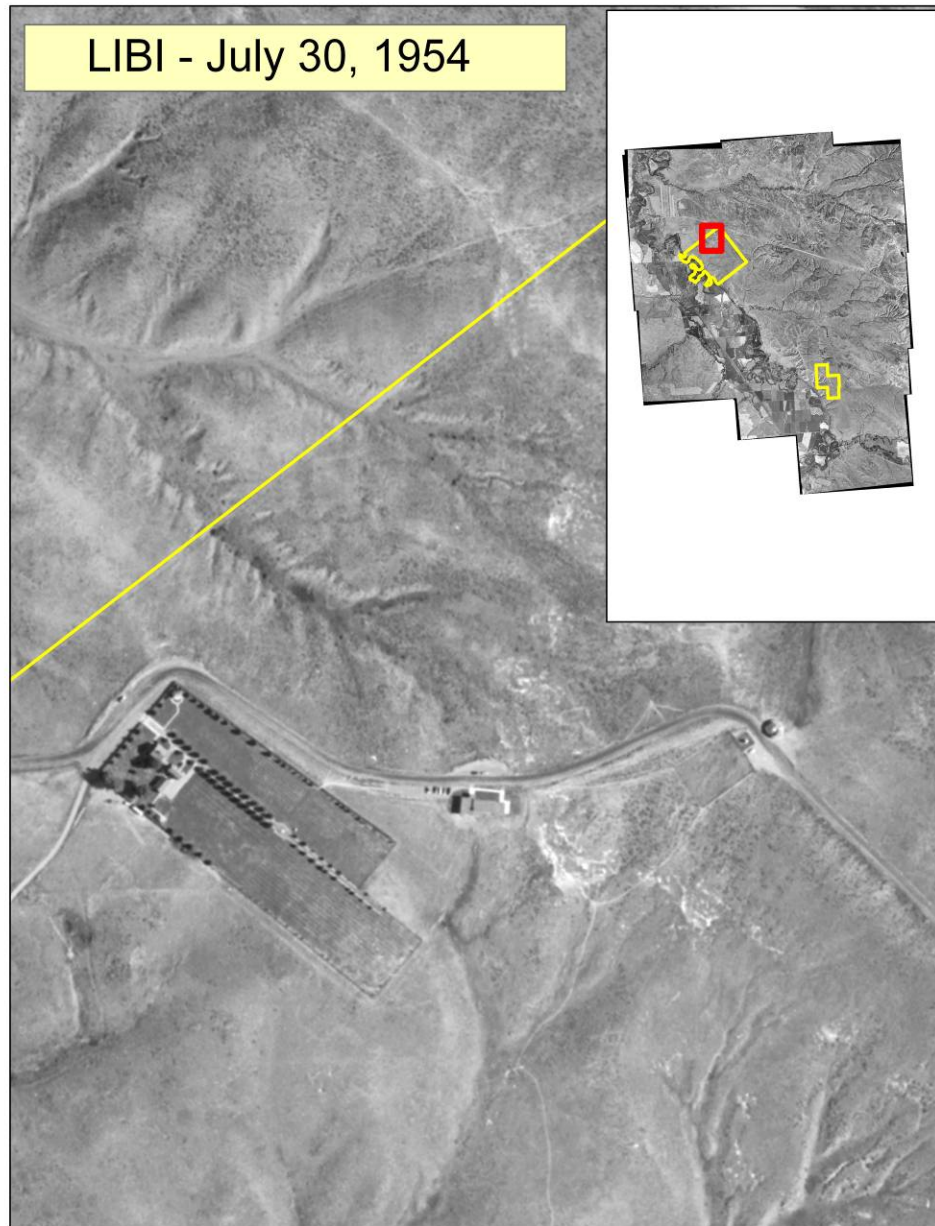


Figure 2. Mosaic Image for Little Bighorn National Battlefield, July 30, 1954.

The second mosaic for LIBI includes photos taken on June 26, 1977 (Figure 3). This is the best imagery available prior to the large fires in the early 1980s. Unfortunately, a complete seamless mosaic of images in-between park segments was not possible and each mosaic is limited to the park boundaries and a limited buffer.



Figure 3. Mosaic Image for Little Bighorn National Battlefield, June 26, 1977.

The third completed mosaic was for June 15, 1991 (Figure 4). This represents the first available quality imagery following the major burns of early 1980s. This image generally extends between 2 and 6 kilometers on either side of the park boundary.

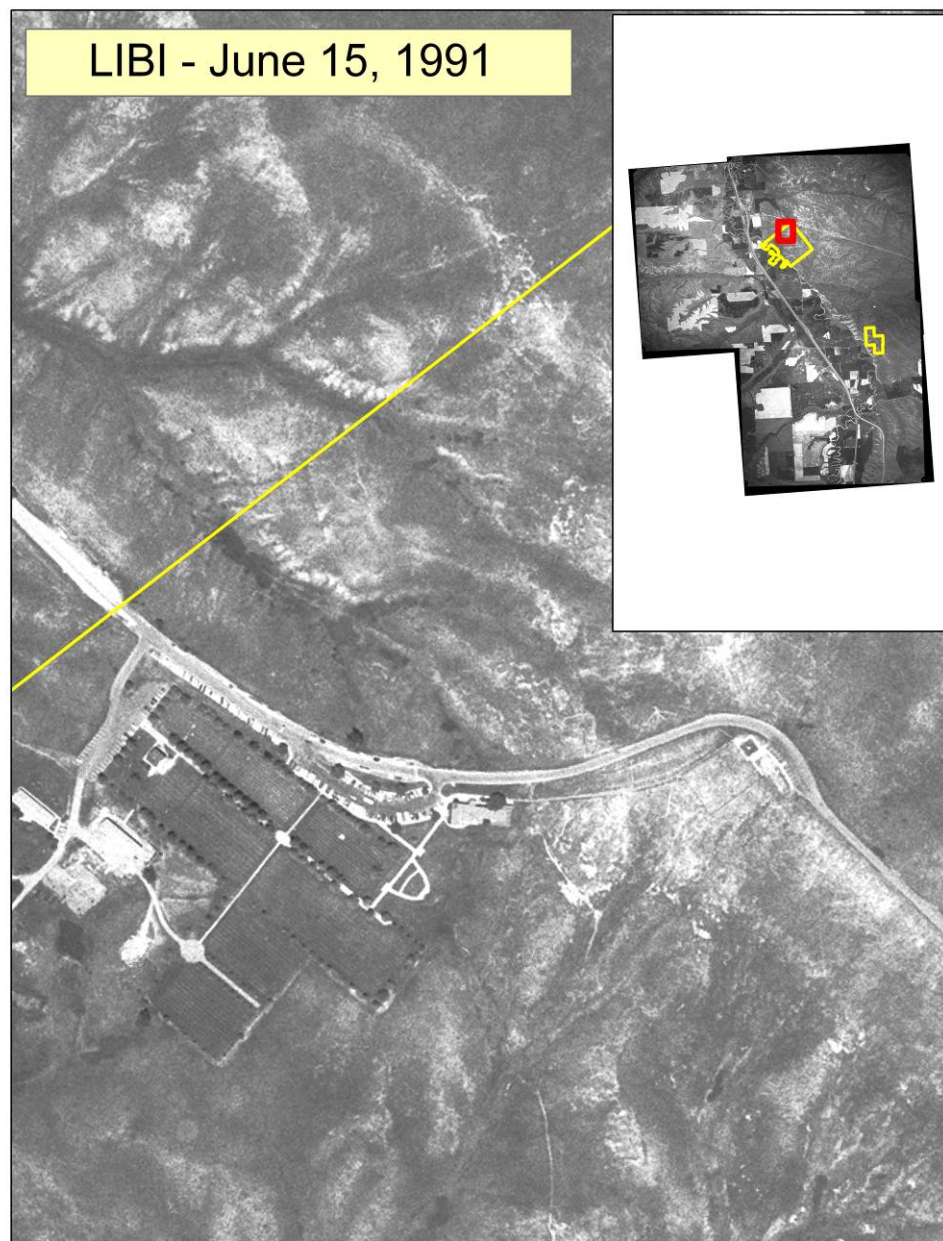


Figure 4. Mosaic Image for Little Bighorn National Battlefield, June 15, 1991.

A fourth mosaic, which only covers the Reno-Benteen portion of the park, was taken on September 4, 1991 (Figure 5). This image shows the extent of the fire that occurred that summer.

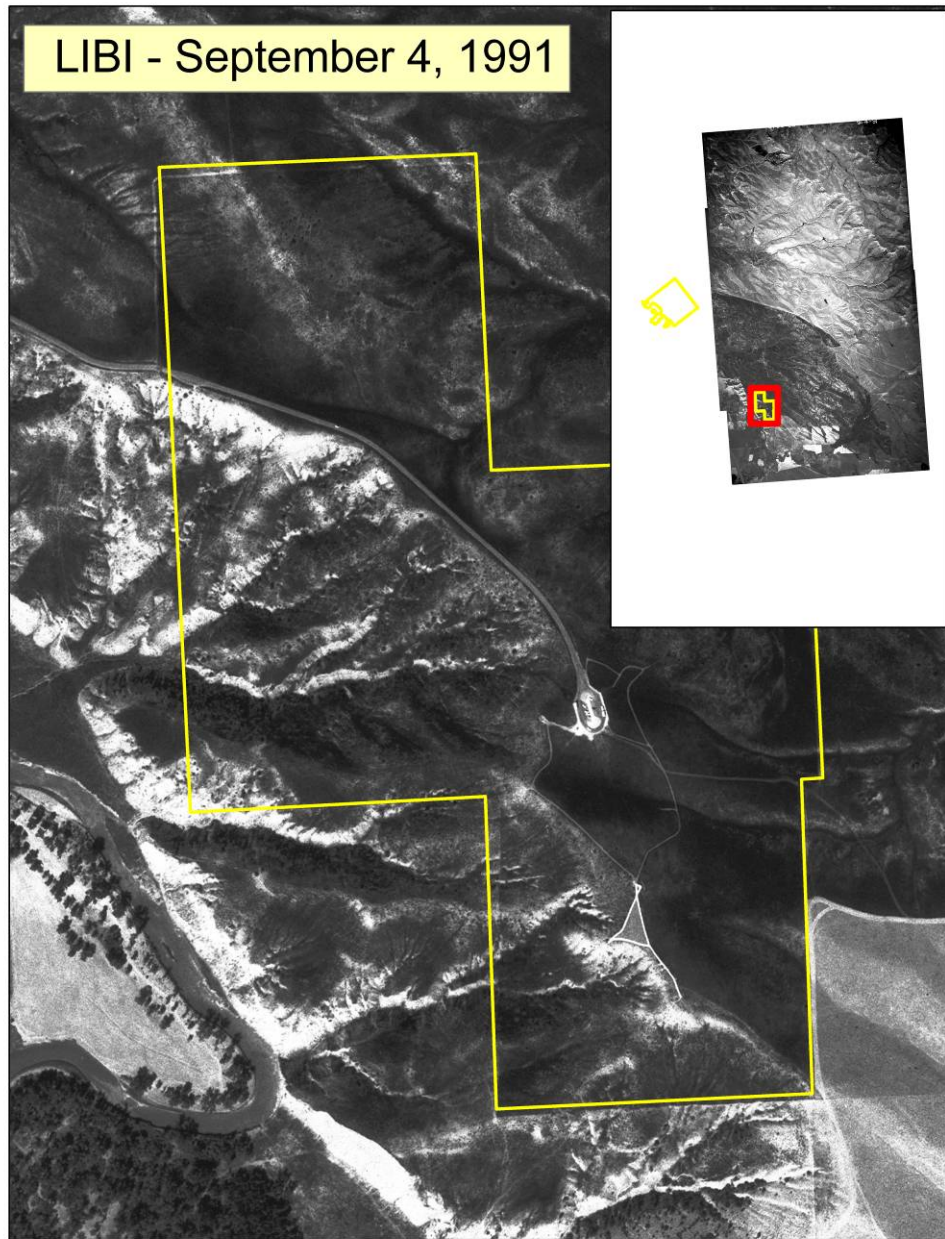


Figure 5. Mosaic Image for Little Bighorn National Battlefield, September 4, 1991.

4. Conclusion

This report concludes the project, which was delivered to the NPS on September 30, 2007. All metadata for these images have been posted to the NPS Data Store [<http://science.nature.nps.gov/hrdata/>] and copies of the images have been mailed to the respective parks. Due to the image size, copies of the images themselves were not

posted to the NPS Data Store but are available on request from the Rocky Mountain Network Data Manager.