

Glacier National Park Scientist Refines Low-Cost Resource Mapping Alternative

Editor's Note: The Flathead River Basin Riparian Study Team, under the direction of Dr. R. Gerald Wright, CPSU leader at the University of Idaho, is in the final year of an 18-month study, funded by EPA through the Flathead River Basin Environmental Impact Study, to inventory riparian communities and investigate specific impacts within the River corridor. Carl H. Key, biological technician at Glacier NP, in

*January 1982 completed a resource map series for the project, using the method he describes below. Key now is completing a Landsat project for the Park and working to develop a digital resource information system. A full color Landsat picture of a 75-square mile area of Glacier NP and a description of the technique's applications appears on page 7, October issue, **Science** 82.*

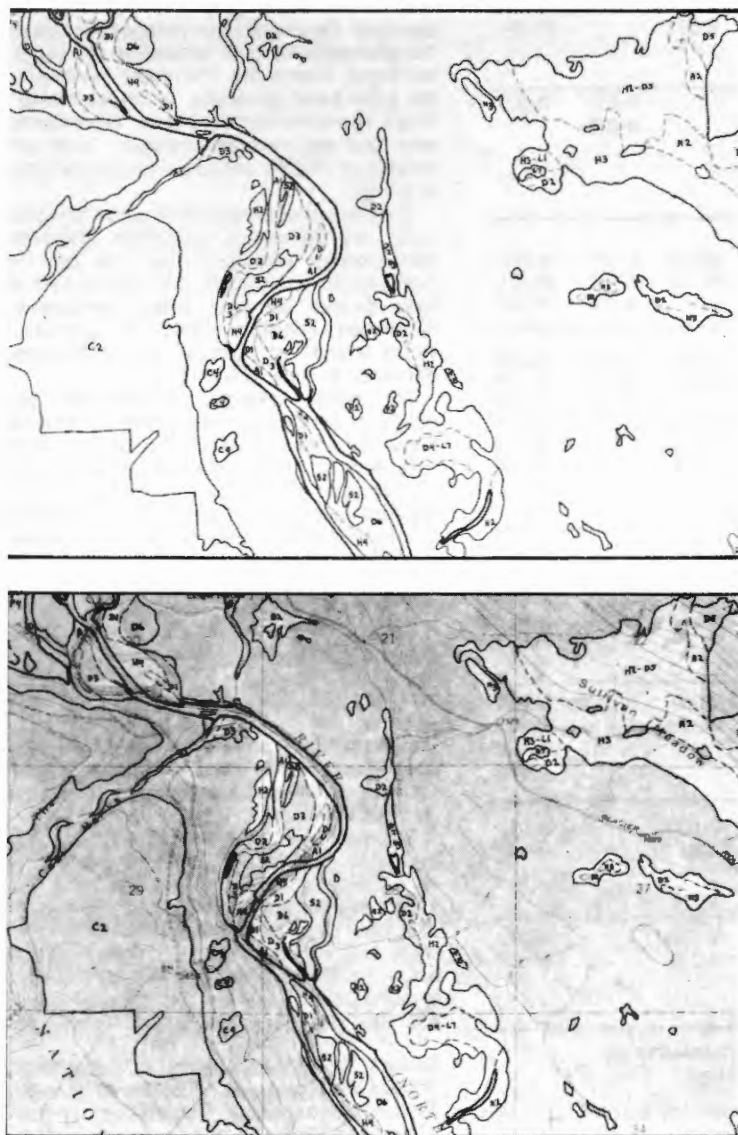
By Carl H. Key

The proliferation of remote sensing technology and digital cartography has produced a multitude of useful and exciting tools for resource management. The need persists, however, to apply what some might view as "archaic methodology" to synthesize resource information in low-budget, short-term situations. Managers of small parks, researchers studying a relatively small area, and managers confronting an immediate problem need to gather and manipulate resource information without investing large sums of money, time, and expertise. The resource mapping alternative described below, minimizes the latter quantities while developing a useful product. It applies a simple projection/tracing method to map directly from aerial photographs and achieves proper scale with minimum distortion.

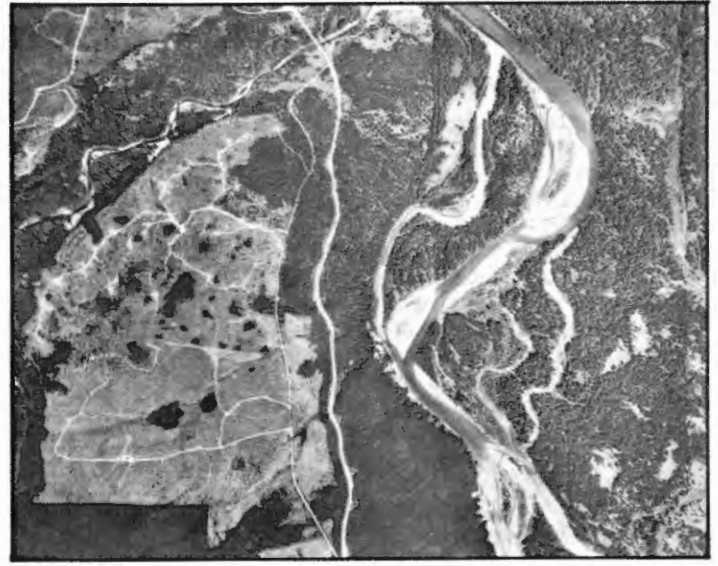
Limitations, Results and Applications

As with all mapping techniques, limitations exist. Some of the method's timeliness is lost if the analyst must undertake extensive ground surveys to become familiar with the environment. Appropriate photography also must be available. The method works best when applied to high altitude and medium to small scale imagery. Large scales are acceptable, however, where typography varies less than 305m (1000 ft) elevationally. No limit to map scale appears to exist as long as image features are adequately resolved and the map draft is sufficiently controlled. The technique should be tested beforehand by mapping a small area and verifying the results against a USGS topographic map. A measurement of map accuracy can then be made. My experience has shown that 1:24,000 scale maps produced from 1:30,000 scale high-altitude imagery are geometrically accurate to 0.5 mm (map distance) when carefully drafted.

Overshadowing these limitations is the fact that resource maps produced by this method are easy to draft, inexpensive and versatile. The Flathead River Basin Riparian Study Team invested less than 60 man days and \$200 in materials to produce land cover maps for portions of the Flathead River corridor (figure 1). Six map series at 1:24,000 depicting five unique environmental components (a total of 30 overlays) were completed for the 690 sq. km study area. The image source was a set of U2 color infrared transparencies at a nominal scale of 1:30,000. Twenty five polyester and 60 ozalid reproductions



Transparent overlays such as the two shown here can be registered on a USGS topographic map to display the relationship of such information as is desired. The upper overlay identifies natural non-forest communities (labeled A, D, and H) and logged areas (C and P). The lower overlay incorporates the relationship of land type to geographic relief and information that allows monitoring of changes in the river channel. A forest types overlay has been prepared, and a final overlay of tributary streams and roads has been drafted and could be added, to document drainage patterns and access.



Two aerial photographs of the identical site within the North Fork study area. The left photo was made August 2, 1965; the right photo, June 30, 1977. Taken about a decade apart, they illustrate measurable impacts to vegetation, as indicated by the recent clear cuts in the photo on the right. Increased road access, changes in the river channel, and vegetative

succession on the floodplain are also detectable. Resource map overlays help quantify such changes and provide the manager with an effective monitoring capability. In the photos, Glacier National Park lies to the right of the River.

were made at low cost. Overlays were produced singly and in combination to evaluate relationships between two or more environmental components (i.e. legend hierarchies). Ozalids were used as base maps for transparent overlays, and were colored, written on, and taken in the field without the risk of irretrievable loss or damage.

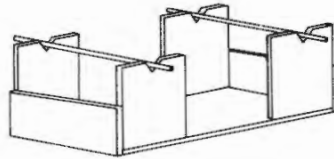


Figure 2. A simple adaptor, constructed from 1 x 12 inch lumber, sits under the projector and dispenses film rolls of large-format transparencies. Overall dimensions may vary depending on projector and film size.

mapping objective (See Baily, R.G., R.D. Pfister, and J.A. Henderson. 1978. Nature of Land and Resource Classification — A Review. *J. of Forestry* 76 (10):650-655.) When the legend has several hierarchies (a complex environment), for example, a system of overlays, one for each major hierarchy group, should be planned to simplify map interpretation and provide a means for evaluating related components. Only with an appropriate legend and a concept of the map's purpose and structure can the analyst proceed confidently to the mechanics of map drafting.



Figure 1. A map of the study area along the west boundary of Glacier National Park and above Flathead Lake, Montana.

Prior Considerations

A major objective of resource mapping is to maximize relevance, accuracy, and practicality. The following relate directly to that objective and must be determined before initiating any mapping project: 1) the map's purpose; 2) the environmental components that are both identifiable and relevant to that purpose; 3) the scale and type of imagery that most faithfully resolve the relevant components; and 4) the map structure or organization that leads to easiest interpretation.

To facilitate map planning, a basic legend should be constructed beforehand; preferably one that fits a hierarchical design. In that form, it groups components in a manner that displays relationships, indicates environmental complexity, and enables the analyst to efficiently determine the requirements of the

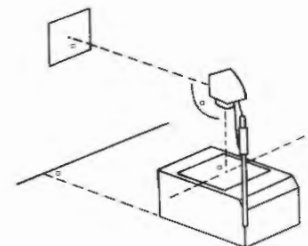


Figure 3. To minimize distortion, the straight edges of a small square wall target should parallel the edges of a projected image. An accurate bubble level can be used initially to orient wall target and projector so angles (a) are 90 degrees. Move the projector away from or toward wall to adjust scale.

Materials and Methods

The materials needed to complete this technique include standard drafting instruments, velum, matte-polyester drafting film, USGS topographic maps, aerial imagery, and a quality projector capable of projecting the imagery. Any or all components can be adapted to suit a particular situation, while making maximum use of available or inexpensive hardware and supplies. If aerial photos do not fit conveniently onto the projector's platen, for example, construct an adaptor (fig. 2) but take care to adequately vent the platen so images remain cool during long periods of projection.

The mapping procedure involves projecting a land image without distortion at a desired scale onto matte polyester or velum and simply outlining the features of interest. First, the projector is oriented correctly relative to a wall or other projection surface, and the image is approximately scaled (fig. 3). Next, a matrix of control points is traced onto velum from appropriate topographic maps and placed on the projection surface. The image is then adjusted precisely to the control sheet so that controls on the imagery match or overlay their conjugate points on the control sheet. In that state, the image is at the desired scale with minimum distortion.

Control points must be readily identifiable on both maps and imagery, evenly distributed throughout the map area, and sufficiently numerous to represent the true plan position of vertically displaced points in the scene. Since the method's accuracy depends on adequate geometric control and correct projector orientation, careful attention to the above is a necessary prerequisite to drafting.

A sheet of matte polyester film is then placed over the control sheet and appropriate features are drafted in blue pencil from the projected image. Generally, all areas of the image can be mapped within the bounds of matching control points, increasing in size with higher photo altitudes and smaller scales.

To proceed to the next photo, realign points on the control sheet with controls on the imagery, reposition the map draft, and continue drafting. Partially overlap a new image with a region that was drafted previously to insure uniformity between images and consistency throughout the map. The process is reiterated until all areas are mapped.

Overlays should be drafted in sequence using the same image position to insure that lines on sequential overlays begin and end at correct points. Accuracy should be checked periodically by placing the drafts over the appropriate topographic map.

When completed, map drafts are placed on a horizontal surface, retraced in ink, labeled, and geographically referenced to matching topographic maps. Either the first draft, or a clean sheet of polyester can be used for the final product. Various colors or line types can be applied to highlight certain features. Again, overlays should be finished in sequence, stacking one on the other while maintaining their correct relative position.

Currently, the study team is using the maps to locate transects to proportionately census available habitat for animal abundance, distribution and movement. In the future, the team plans to quantify, with a digital planimeter, the amount of available habitat for selected animal species, describe the relationship between the available habitat and animal

distribution, and define the effect of human disturbance on habitat availability.

The overlay system produced by this method is easy to amend and add to for future reference. All features can be digitized and contribute to a computerized information system (in fact, manually produced resource maps are usually the necessary source of digital cartographic information). When superimposed on topographic maps, these overlays provide an understanding of natural plant community distribution as it relates to terrain and hydrology. When compared to older photography or previous resource maps, these can be used to estimate changes in landuse and monitor vegetative succession, thus establishing a baseline for multiple environmental components.