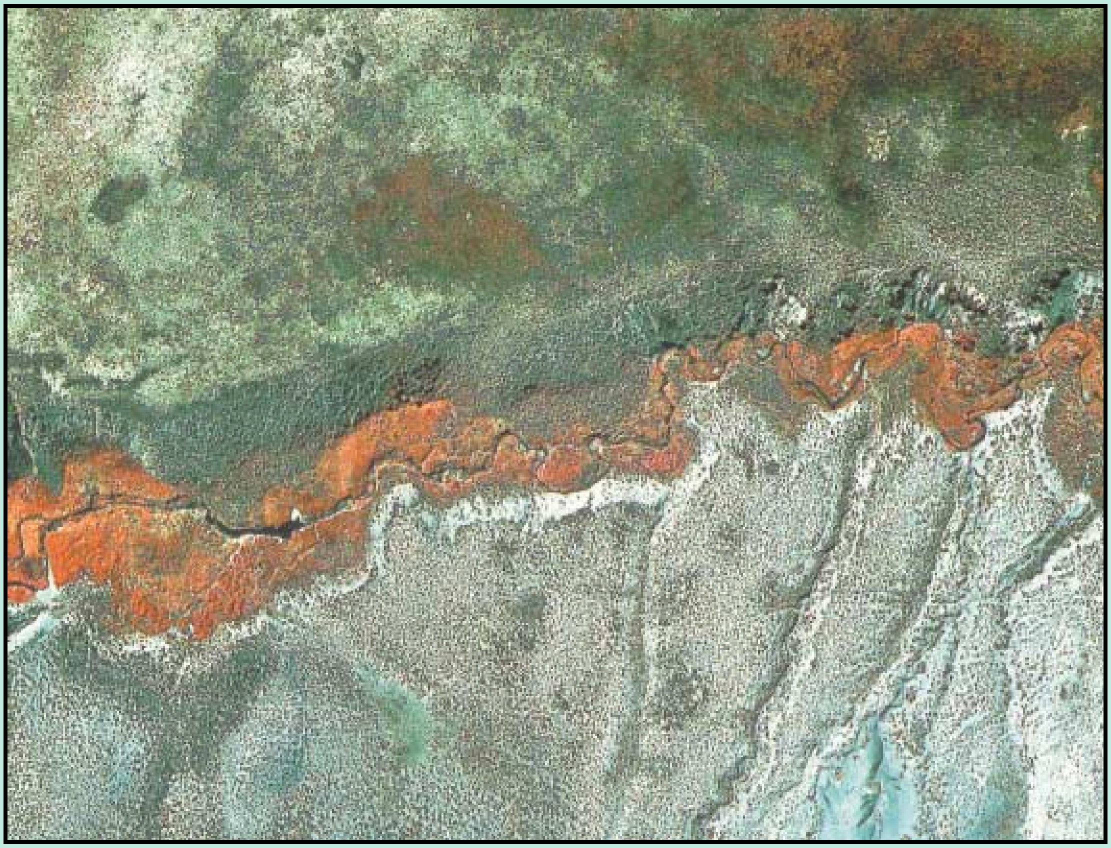
RIPARIAN AREA MANAGEMENT

TR 1737-12 1996 (Revised 1999)

Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas



U.S. Department of the Interior
Bureau of Land Management

U.S. Department of Agriculture
Natural Resources Conservation Service

Copies available from:

Bureau of Land Management
National Business Center
BC-650B
P.O. Box 25047
Denver, Colorado 80225-0047

BLM/RS/ST-96/007+1737+REV99

RIPARIAN AREA MANAGEMENT

Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas

by

U.S. Department of the Interior
Bureau of Land Management
PFC Aerial Photo Interpretation Team

Don Prichard - Team Leader
Fishery Biologist/Riparian-Wetland Coordinator
BLM—National Applied Resource Sciences Center
Denver, CO

Team

Pam Clemmer
Cartographer/Remote Sensing
BLM—National Applied Resource Sciences Center
Denver, CO

Mark Gorges
Fishery Biologist/Riparian-Wetland Coordinator
BLM—Wyoming State Office
Cheyenne, Wyoming

Gretchen Meyer
Natural Resource Specialist/Remote Sensing
BLM—Wyoming State Office
Cheyenne, Wyoming

Karen Shumac
Cartographer/Geologist/Remote Sensing
BLM—Wyoming State Office
Cheyenne, Wyoming

Sandy Wyman
Rangeland Management Specialist
NRCS—Riparian/Wetland Technical Team
Bozeman, Montana

Marcus Miller
Rangeland Management Specialist
NRCS—Riparian/Wetland Technical Team
Bozeman, Montana

Technical Reference 1737-12
1996 (Revised 1999)
U.S. Department of the Interior
Bureau of Land Management
National Applied Resource Sciences Center
P.O. Box 25047
Denver, CO 80225-0047

Acknowledgments

To compile a document about such a valuable resource requires the assistance and support of BLM field offices and individuals. The PFC Aerial Photo Interpretation Team wishes to acknowledge Larry Gerard, Jerry Jech, and Cheryl Hicks of BLM; BLM's Great Divide and Buffalo Resource Areas; Forrest Berg, Terry Costner, Bob Leinard, Larry Murphy, Joe Carlton, and Chris Noble of NRCS; and the University of Wyoming for assisting in the development of this document.

The work group also extends a special thank you to Linda Hill and Janine Koselak of the National Applied Resource Sciences Center and to the National Business Center for doing a fine job in editing, layout, design, and production of the final document.

Table of Contents

Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas

I. Introduction

Riparian-wetland areas comprise a small portion of the total land base, yet they are some of the most productive and important ecosystems found in the United States. Riparian-wetland areas have vegetative or physical attributes reflective of water influence. Marshes, wet meadows, shallow swamps, estuaries, and lands adjacent to rivers, streams, and lakes are typical riparian-wetland areas. Characteristically, riparian-wetland areas have a greater diversity of plant and wildlife species and vegetation structure than adjoining ecosystems. Wildlife use riparian-wetland areas disproportionately more than any other type of habitat. Riparian-wetland areas are also important for their economic values and for diverse uses such as livestock production and recreation.

Healthy riparian-wetland areas are noted for having adequate vegetation, landform, or large woody debris to dissipate energy during high-flow events, limit erosion, and bolster water quality. Sound riparian-wetland areas also filter sediment and capture bedload, which aids floodplain development and enhances flood-water retention and ground-water recharge. In addition, healthy riparian-wetland areas produce diverse ponding and channel characteristics that provide habitat necessary for fish production, waterbird breeding, and other uses.

Knowing the condition of a watershed is an important component of assessing whether a riparian-wetland area is functioning properly. Assessing the condition of riparian-wetland areas is an initial step toward effective management of these resources. Many tools have been developed for managing riparian-wetland areas. For example, aerial photography, along with other remote sensing techniques, provides useful data to make ecosystem-based and site-specific riparian-wetland management decisions. This baseline data, when carefully selected prior to a project, allows analysis of a larger area of interest, at a minimum cost, in less time per hectare than conventional on-the-ground methods (Clemmer, 1994).

II. Purpose

Two standard checklists have been developed to assess condition of riparian-wetland areas. One checklist is designed for lotic riparian-wetland areas, and can be found in Technical Reference (TR) 1737-9, *Process for Assessing Proper Functioning Condition* (Prichard et al., 1993). The other checklist is designed for lentic riparian-wetland areas, and can be found in TR 1737-11, *Process for Assessing Proper Functioning Condition for Lentic Riparian-Wetland Areas* (Prichard et al., 1994). The use of aerial photos and other remote sensing techniques can assist in this process by establishing baseline data and saving time and money.

The purpose of this document is to provide a procedure for using aerial photography to answer PFC checklist items. This document supplements the above technical references, as well as TR 1737-10, *The Use of Aerial Photography to Manage Riparian-Wetland Areas* (Clemmer, 1994); TR 1737-15, *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas* (Prichard et al., 1998); and TR 1737-16, *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas* (Prichard et al., to be published in 1999).

III. Background

During fiscal year 1994, discussions were conducted among BLM's Great Divide Resource Area (now the Rawlins Field Office), Service Center (now the National Applied Resource Sciences Center), Wyoming State Office, and the University of Wyoming regarding the usefulness of aerial photography for assessing functioning condition of riparian-wetland areas. As a result of the discussions, a Photo Interpretation Team was formed to evaluate the feasibility of this type of assessment.

The Photo Interpretation Team's first task was to identify field sites where assessments using aerial photography could be tested. Field sites were identified in Colorado, Idaho, New Mexico, and Wyoming. Because only a limited number of sites could be visited, the initial field sites were narrowed down by applying the following criteria, in priority order:

1) A variety of film types and film scales were available for the site;

2) A variation of riparian-wetland area conditions relative to functionality were near the site;

3) A variety of riparian-wetland types were near the site; and

4) The site could be visited within travel and time constraints (for those potential sites rated equally on criteria one, two, and three).

The Team's final site selections included nine lotic sites and two lentic sites in Wyoming. Six lotic sites and two lentic sites were located in south-central Wyoming bordering Muddy Creek, Littlefield Creek, and McKinney Creek, and three lotic sites were located in north-central Wyoming bordering the Middle Fork Powder River and Buffalo Creek.

The Photo Interpretation Team's second task was to assess functioning condition of each field site from available aerial photos, including those recently obtained by the Rawlins District Office of the Muddy Creek drainage. The interpretation was done stereoscopically using optics with 4X magnification. A checklist was completed for each field site and an overall rating selected (PFC, functional—at risk, or nonfunctional).

A third task for the Photo Interpretation Team was to visit field sites to validate the completed checklists following the procedures identified in TR 1737-9 and TR 1737-11. Field validations were completed during the summer of 1995.

The Team's final task was to compare the results of the photo interpretations against the field validations. This analysis resulted in the development of a procedure to assess functionality of riparian-wetland areas using aerial photography.

IV. Photo Interpretation Procedure

The following procedure is intended to speed the process defined in TR 1737-9, TR 1737-11, TR 1737-15, and TR 1736-16. It involves having an interdisciplinary (ID) team preassess large areas by interpreting aerial photography, completing a PFC checklist, and, when necessary, visiting the field site. An ID team ideally consists of specialists in the areas of hydrology, geology/geomorphology, remote sensing, photo interpretation, biology, and vegetation. The considerable prework involved cuts down on field time and allows work to be accomplished during those times when field sites are not accessible.

A. Gather Existing Source Material

Any existing source material should be gathered prior to beginning the interpretive process. The knowledge of individual team members about an area under investigation is a valuable component of the assessment. Existing inventory data aids in the interpretation and adds another dimension to the interpreters' abilities to accurately assess an area's condition. Previous data collected may also provide indications of prebaseline condition and subsequent trend. Ancillary source material may take several forms.

1. Tabular and Other Hard-Copy Data

Inventory data collected in the past is a great asset to any photo interpreter. Field files and databases containing information pertaining to the sites are important sources of input. They provide a way to obtain field verification without actually visiting a site. Photos keyed to data provide a valuable source for building a photo interpretation key, such as the example in Appendix A.

Topographic map coverage of a study area should be acquired from the U.S. Geological Survey (USGS) by the ID team. The 7.5 minute, 1:24,000-scale series is recommended for this application. These maps are used for creating a photo index of coverage for ease in locating position on photos, for delineating reaches to be assessed, and for frequent reference during the interpretation process.

Orthophotography is a valuable tool to use in conjunction with a topographic map. Orthophotos are available in a 7.5-minute, 1:24,000-scale matching the topographic maps, but have a differentially rectified black-and-white image rather than the standard topographic contours. Orthophotos for most of the U.S. are available in hard copy and digital formats from the Earth Science Information Center (ESIC) at USGS in Denver, Colorado. Reaches can be digitized on-screen directly onto digital orthophotos.

Additional information can be obtained from soils survey maps, which are usually available at the local conservation district or NRCS office. National Wetland Inventory (NWI) maps that describe existing wetlands are also helpful and are available for most areas from the U.S. Fish and Wildlife Service. Land ownership maps can aid in defining ownership boundaries and access points for assessments and are available from various agencies.

2. Photos

The ID team should conduct a search to determine the best available photos for a project. Many field offices already have photos available, but these photos may not be the best selections for conducting the assessment.

Aerial photo searches can be conducted by remote sensing specialists within BLM, NRCS, or ESIC. Searches are usually conducted by 7.5-minute topographic quadrangle and result in a list of available photos from various government agencies and private companies. The list includes scale, film type, and date of acquisition. When ordering photos, adequate time for delivery, which can take 6 to 8 weeks, should be allowed.

Appropriate photos should be selected according to the following guidelines:

- For this application, the most current photos generally yield the most accurate results. However, older photos should not be ignored, as they can provide clues to prior condition and trend. Other factors may influence the date of photography selected (e.g., film type, scale). For example, color infrared (CIR) film dated July 1993 would probably be a better choice than black and white film dated September 1995.

  NOTE: Contracts for flights to obtain aerial photos specifically for PFC assessment should not be considered due to cost and time restrictions. If contracts are being considered for other purposes, the PFC application requirements could be included in those contracts (i.e., film type, scale).

- CIR photos are preferable because they allow interpreters to detect subtle differences in vegetation due to the spectral reflectance of the film. Natural color (NC) photography can be used, but spectral reflectance is less than that for CIR. TR 1737-10 provides examples of natural color and CIR photos.

- A photo scale should be selected that is small enough to expedite the interpretation task, but large enough to interpret the detail needed. In most cases, a scale of 1:40,000 is adequate for this type of interpretation. This scale provides a synoptic view of the area and gives a better perspective of general landform characteristics. Using a smaller scale is also the most efficient way to assess large areas in a cost-effective manner. Smaller problem areas should be approached using larger scale imagery when needed (e.g., 1:3,000- to 1:24,000-scale). TR 1737-10 provides examples of different photo scales of the same area. In addition, larger scale photography can always be acquired as an enlargement if desired.

  NOTE: The scale selected is directly influenced by the type of optical equipment that is available for use in interpretation (see Section B).

- Film transparencies are more easily interpreted than paper prints. Transparencies are more expensive, but worth the cost for the added sharpness and clarity that they provide. Detail at smaller scales is easily interpreted when viewed on a film transparency. However, one drawback to film transparencies is that they must be used on a light table and cannot be used easily in the field.

- Farm Services Agency (FSA) aerial photos and compliance aerial photos may provide the latest available photos of riparian-wetland areas. These may be most useful when assessing lentic riparian-wetland areas.

Once photos have been received, team members should compile a photo index. A photo index simply shows the approximate location of each frame of photography on a topographic map. Indices are usually compiled on overlay material registered to a 7.5-minute map (Figure 1). Although this process is somewhat time-consuming, a photo index assists the interpreters in locating position on the photo and helps keep track of project photography. Clear mylar material should also be used to protect the original photos.

B. Analyze Equipment Needs

Many different types of optical equipment, with a wide range of prices, are used in photo interpretation. For this application, a mirror type stereoscope with at least 4X magnification capability is recommended. Magnifications of 10X-20X offer more magnification, but with a smaller field of view. The Photo Interpretation Team found 4X-10X magnifications adequate for this application. Viewing is enhanced by placing the photos on a light table. When paper prints are used, the light table provides backlighting and sharpens an image. A light table is mandatory when using film transparencies.

A single hand lens or magnifier is a convenient way of viewing a site-specific area monoscopically on an aerial photo. These are inexpensive and available through most office supply or camera stores. Drafting pens for making annotations on the clear mylar material used to protect original photos are also available from office supply stores. Various tools are available for measuring such things as reaches and channel/valley lengths from photos.

C. Define Reach/Area

Prior to photo interpretation, the ID team should define lotic reaches and lentic areas using aerial photography, orthophotos, and 7.5-minute topographic maps. Climatic data, historical information, and other ancillary sources are used to make this determination. Reaches/areas should be delineated on overlay material registered to a topographic map and labeled with the reach or area identification number. Team members should keep in mind that the intent of a study is to achieve an immediate assessment of overall riparian condition. There will be times that reaches need to be further defined due to changes in management or changes in land use (e.g., rangeland to cropland).

Reach delineation is discussed at length in TR 1737-3 (Meyers, 1989) and TR 1737-7 (Leonard et al., 1992). A defined stream reach needs to be a manageable unit that, as a general rule, is at least 1/4 mile in length (slightly longer than 1/2 inch at 1:24,000-scale). Using this guideline prevents reach length from becoming too segmented. It is best to begin with longer reaches that can be subdivided further during the interpretation process.

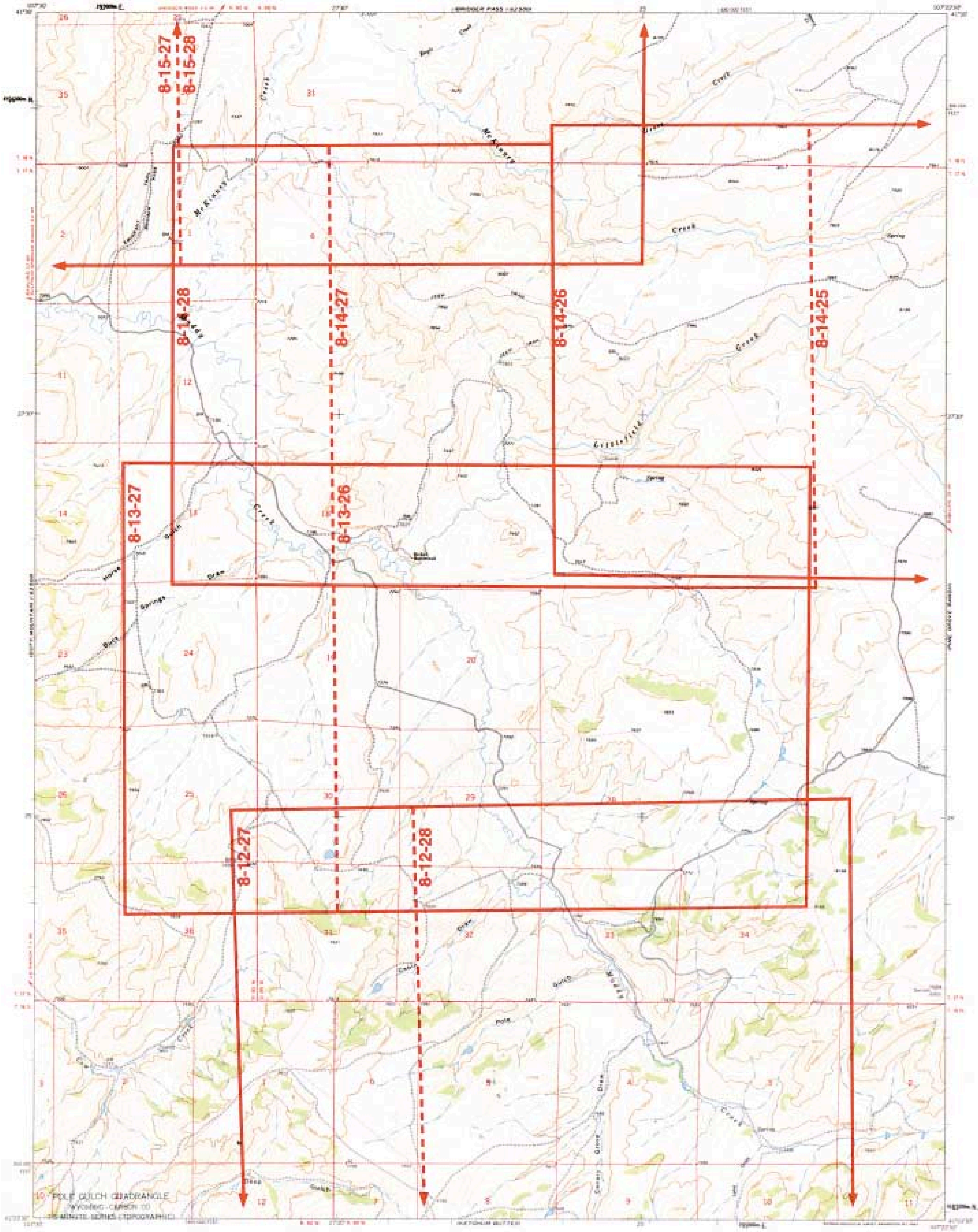


Figure 1.

Suggestions:

1. The roll-flight-exposure number should be annotated on each frame.
2. Annotations should be on the same side as the film (west edge in this example) so that north can easily be determined.
3. Overlap between photos should be shown with a dashed line.
4. Corner ticks and the quad name should always be included on each overlay.
5. If more than one project or scale of photography was used, the index should be drafted in separate colors for easy differentiation.

Scale	1:24,000	Pole Gulch, WY
Project	WY82A1	41107-D4
Film	color infrared	
Date	7/16/82	

Stream reaches should be identified relative to confinement, gradient, and sinuosity. The contour information on a 7.5-minute map can provide general indications of landform and valley slope. Photography should be used in conjunction with the map to define channel confinement, sinuosity, and gradient. Small-scale photography (1:40,000) provides a synoptic view of an area, gives a better perspective of the general landform characteristics, and provides a practical way of viewing the entire reach.

Reaches should be defined and annotated on overlay material using standard naming conventions throughout the project. Figure 2 provides an example of reach definition for one quad. Forethought should be given to naming conventions that allow subsequent input to a Geographic Information System (GIS) for graphic query capabilities based on functionality.

D. Interpret Aerial Photos

Clear overlay material should be attached to each photo for protection, and fiducials, identification format, and beginning and endpoints of each reach or area should be clearly marked on the overlay material. Fiducials are the camera registration marks found on each side of the photo and in the corners. The identification format is the textual information along one side of the photo. This information usually gives the date of photography, project code, nominal scale, and roll-flight-exposure number (see TR 1737-10). Marking the fiducials and identification format onto overlays allows them to be removed and reregistered later without damaging the original photo.

A PFC checklist should be prepared for each reach/area, with the photo number, reach delineation number, and date recorded on each checklist. A general photo interpretation key, such as the example in Appendix A, should be developed for the assessment. Using a key during photo interpretation ensures that team members are answering checklist items using the same set of criteria. A key also assists in feature identification so that the interpreters are confident in the decisions made. Various elements listed in the key are intended to be generic and may need to be expanded upon based on a specific ecoregion. Appendix B provides photo samples with explanations of elements from the key. Prior to beginning the assessment, all team members should familiarize themselves with the key and discuss any changes or alterations that may need to be made for a specific area. The key should be revisited frequently during interpretation to maintain consistent interpretations.

Organizing the stereo photo pairs will facilitate the interpretation process. A stereo pair for a reach/area should be set up under a mirror stereoscope. Team members should study the reach/area and consider how to answer a PFC checklist item. Each item should be discussed individually and rated based on the interpretation key. When there is disagreement on an item, a "?" should be written in both columns of the checklist (Figure 3). Notes should be made regarding issues in question; larger scale photos may help answer these checklist items, or team members may need to visit a field site for verification. If the condition appears to change midway on a reach, interpreters should state why they feel the condition changed (e.g., active headcut). Change in condition may require that a new reach needs to be started at this

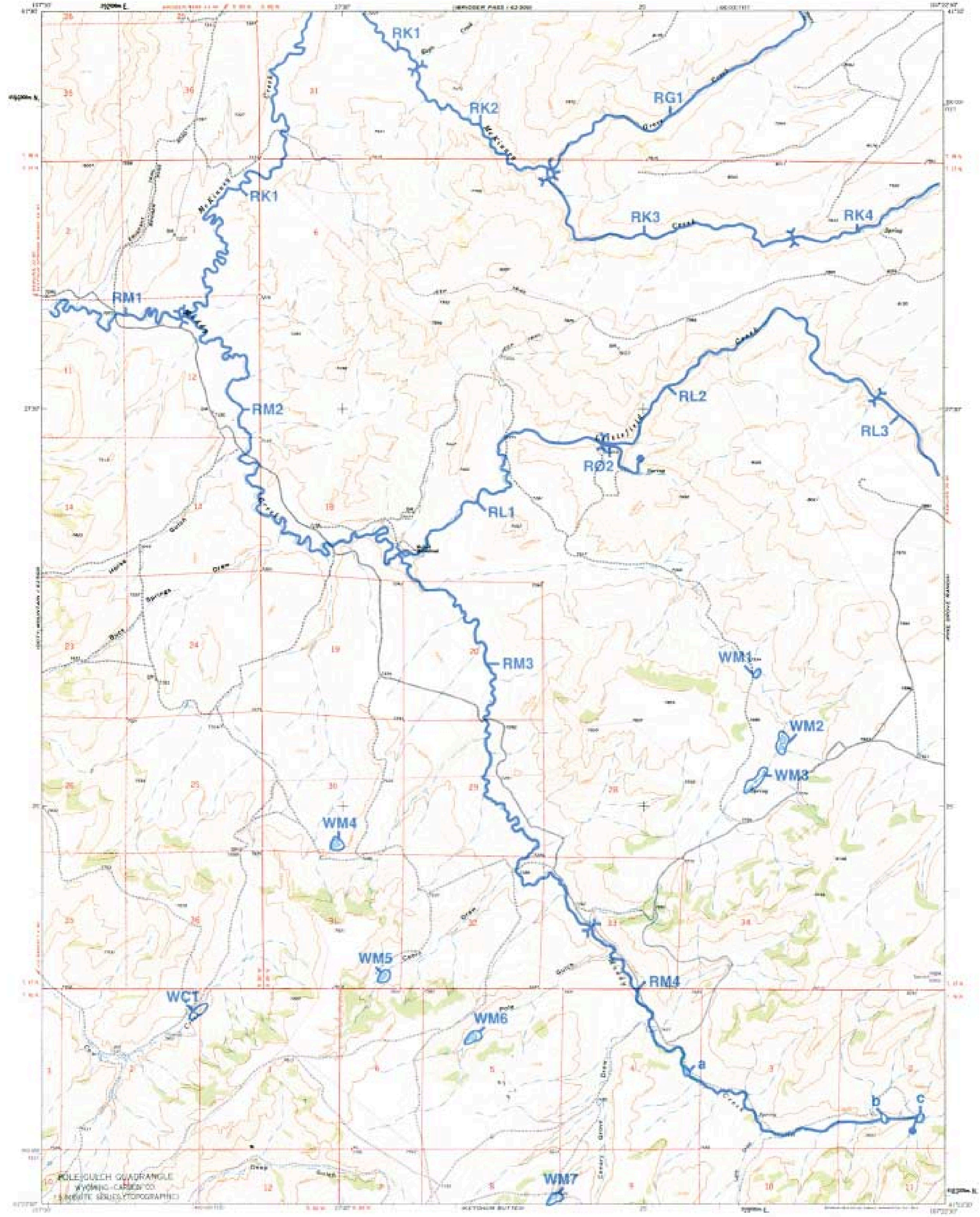


Figure 2.

Suggestions:

1. Beaver ponds are treated as part of the lotic system (see a, b, and c).
2. Reach definition is standardized working from the bottom of the reach to the top.
3. Reach numbers should be annotated on each checklist along with the 7.5-minute map name and photo number (roll-flight-exposure).

W = Wetland (lentic)
R = Riparian (lotic)
M = Muddy Creek
K = McKinney Creek
G = Grove Creek
L = Littlefield Creek
Ø = No name
Number = Number of reach or site on quadrangle

Pole Gulch, WY
41107-D4

Standard Checklist*

Name of Riparian-Wetland Area: Muddy Creek - Site 1

Date: March 6, 1995   Segment/Reach ID: Pole Gulch, Wyoming/41107D4

Miles: 1.5   Acres: ______

ID Team Observers: Mark Gorges, Don Prichard, Gretchen Meyer, Karen Shumac, Pam Clemmer

Photo Number: NAPP 1735-13   Date: 7/2/89   Film Type: CIR   Scale: 1:40,000

Topo Map Name: Pole Gulch

Yes	No	N/A	Hydrology
x			1) Floodplain above bankfull is inundated in "relatively frequent" events
	x		2) Where beaver dams are present they are active and stable
?	?		3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
	x		4) Riparian-wetland area is widening or has achieved potential extent
x			5) Upland watershed is not contributing to riparian-wetland degradation

Yes	No	N/A	Vegetation
	x		6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)
	x		7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)
	x		8) Species present indicate maintenance of riparian-wetland soil moisture characteristics
	x		9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events
?	?		10) Riparian-wetland plants exhibit high vigor
	x		11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows
		x	12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)

Yes	No	N/A	Erosion/Deposition
?	?		13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
x			14) Point bars are revegetating with riparian-wetland vegetation
x			15) Lateral stream movement is associated with natural sinuosity
x			16) System is vertically stable
	x		17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

* This example is for a lotic site (TR 1737-9 and TR 1737-15). (Revised 1998)
The checklist that appears in TR 1737-11 and TR 1737-16 should be used for lentic sites.

Figure 3.

point. After all items are discussed and a PFC checklist completed, team members should determine an overall rating for a site.

Team members' field knowledge is important in answering some checklist items when using aerial photography. A combination of field experience and training in photo interpretation is critical to the success of this endeavor.

E. Verify Interpretations in the Field

As a general rule, an ID team should conduct random field verifications of 25 percent of the reaches assessed for a lotic system. This percent can be reduced if the area being assessed is large. There has not been a minimum established for lentic riparian-wetland areas. Field visits to all lentic areas are recommended until the ID team is satisfied that their interpretations are accurate.

If a field visit to a lotic riparian-wetland reach supports the interpretations and conclusions recorded on the checklist, no further verification of that reach is needed. It can be noted on the checklist that the reach was field checked and no changes are necessary. The date of the field visit and the names of the ID team making the verification should be documented.

There may be situations where some of the answers on the checklist will be changed based on the field visit. If these changes do not result in a change of the summary determination, the changes should be noted on the checklist, along with the other suggested information, before proceeding to the next site.

If there are discrepancies that lead to a significantly different determination, additional locations within the same reach must be assessed until the team reaches agreement. The new rating should be documented. Field observations should be recorded on the checklist for that reach. The correct determination needs to be properly identified to avoid future confusion. The ID team should initial the revised/corrected information and determinations. Trend may be confirmed or determined during field verification.

V. Recommendations

Aerial photography can be used to assess PFC, but there are limitations. The following recommendations can help ensure success in applying this technique:

- When possible, CIR film should be used rather than natural color or black and white film. CIR film allows the ID team to more accurately make stream channel and vegetation interpretations at a smaller scale.

- A mylar overlay should be used to protect USGS topographic maps and photos.

- A cost/time analysis should be done when selecting a photo scale (see Appendix C). Though larger scale (1:3,000) photos are easier to interpret, more photos are required to cover the same area as that covered by one small-scale (e.g., 1:40,000) photo. The PFC checklist items can be answered using small-scale, CIR photos.

- Positive transparencies used on a light table are superior to paper prints. Many features not discernible on prints are easily detected on transparencies. However, transparencies are more costly than prints (Appendix C).

- Photos should be taken at the appropriate time of the year to assure accurate signatures of vegetation, width/depth ratios, and erosion/deposition. Photos showing low water may affect channel interpretations. Shadows may be misleading because they can make the streambanks appear to have a vertical cut. For most areas, the appropriate time to take photos is mid- to late summer.

- Photos that are as current as possible and that meet the above criteria should be selected if possible. Photos taken over a series of years will help determine trend.

- PFC assessments must be conducted by an ID team. ID team members should be experienced with PFC and should have reviewed TRs 1737- 9, -11, -15, and -16 before using the remote sensing method.

- Field experience and training in photo interpretation and PFC, as well as practice on some sites before starting the process, are mandatory for ID team members.

- This process should be used as an initial cut at assessing PFC. It is a tool that assists in focusing on problem areas that should be visited on the ground to verify interpretations.

- Explanatory notes should be included on the PFC assessment checklist so that the ID team or others have a better understanding of why a question is answered no and why a reach/area is given a particular rating.

- Large-scale assessments can result in large volumes of data. The PFC process delineates reaches/areas into three major categories. Reaches/areas that are functioning at-risk are further stratified by trend. It may be necessary to further stratify the data to increase its usefulness for setting priorities, etc. (See Appendix D, Crow Reservation Case Study).

- Depending on the size of the assessment area, field verifications should be completed on at least 25 percent of the lotic reaches.

- A Global Positioning System (GPS) unit may facilitate locating reach breaks, areas of concern, and structures during the field verification process.

- PFC assessment results can be incorporated into a Geographic Information System (GIS) so that map overlays can be developed by watershed for planning purposes. Final PFC findings should be incorporated into a database and linked by reach number to a vectorized hydrography layer to enable ongoing analysis and monitoring in a GIS.

- On-site visits should be conducted for all reaches that are rated as unknown.

VI. Summary

The Photo Interpretation Team found that aerial photos can be used to assess functioning condition of riparian-wetland areas. Success in applying this procedure is related to the recommendations listed in this document. Training in photo interpretation, field experience, and knowledge of field sites assessed are also very important.

This procedure should be used as an initial cut at assessing PFC. Like any tool, the application of photo interpretation has its advantages and limitations. Some of the advantages are:

- An ID team can cover a large area in a short period of time.
- Upland impacts are easier to detect on aerial and CIR photos.
- Aerial photos can make detecting trend easier through the use of multiyear photos.
- Assessments can be done year round, without having to wait for field season.

Some of the limitations of this tool are:

- Age, quality, and scale requirements may limit the availability of usable aerial photos.
- Some channel characteristics may be difficult to interpret.
- Photos may not be sensitive enough to detect minor changes.
- Maps, aerial photos, and/or equipment can be potentially costly or unavailable.

The Photo Interpretation Team also found that lentic riparian-wetland areas are easier to assess than lotic riparian-wetland areas. Most lentic areas are confined to a smaller area, which allows team members to examine and interpret the entire site. Many lotic riparian-wetland areas are narrow and set in landforms (e.g., canyons) that make photo interpretation more difficult.

Photos from the National Aerial Photography Program (NAPP), when taken with CIR film, were found to be the most cost-effective to use for answering PFC checklist items. Even though individual features are not as obvious at the 1:40,000 scale, most checklist items could be interpreted. NAPP photos are usually taken on a 7-year cycle and can be used to establish baseline data. Photos from subsequent flights can be compared for trend and monitoring purposes.

Aerial photography may not be the only other possible means by which to assess PFC. Videography is an up-and-coming technology that may be used for this application. Videography may provide a cost-effective, timely means of acquiring assessment imagery. The BLM's Prineville District Office is exploring the efficiency of videography for this purpose. Similar efforts are being explored on the Virgin River in Arizona, Nevada, and Utah; on the Arkansas River in Colorado; and on a number of streams in Arizona.

Results gathered from any riparian-wetland PFC assessment should be put into a database for followup. Case studies (Appendix D) provide examples of how the interpretation results can be put into a database for future planning or studies.

Literature Cited

Clemmer, P. 1994. Riparian Area Management: The Use of Aerial Photography to Manage Riparian-Wetland Areas. TR 1737-10. Bureau of Land Management, BLM/SC/ST-94/005+1737, Service Center, CO. 64 pp.

Leonard, S., G. Staidl, J. Fogg, K. Gebhardt, W. Hagenbuck, and D. Prichard. 1992. Riparian Area Management: Procedures for Ecological Site Inventory - with Special Reference to Riparian-Wetland Sites. TR 1737-7. Bureau of Land Management, BLM/SC/PT-92/004+1737, Service Center, CO. 135 pp.

Meyers, L. 1989. Riparian Area Management: Inventory and Monitoring of Riparian Areas. TR 1737-3. Bureau of Land Management, BLM/YA/PT-87/022+1737, Service Center, CO. 89 pp.

Prichard, D., H. Barrett, J. Cagney, R. Clark, J. Fogg, K. Gebhardt, P. Hansen, B. Mitchell, and D. Tippy. 1993. Riparian Area Management: Process for Assessing Proper Functioning Condition. TR 1737-9. Bureau of Land Management, BLM/SC/ST-93/003+1737, Service Center, CO. 60 pp.

Prichard, D., C. Bridges, S. Leonard, R. Krapf, W. Hagenbuck. 1994. Riparian Area Management: Process for Assessing Proper Functioning Condition for Lentic Riparian-Wetland Areas. TR 1737-11. Bureau of Land Management, BLM/SC/ST-94/008+1737, Service Center, CO. 46 pp.

Prichard, D., J. Anderson, C. Correll, J. Fogg, K. Gebhardt, R. Krapf, S. Leonard, B. Mitchell, and J. Staats. 1998. Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas. TR 1737-15. Bureau of Land Management, BLM/RS/ST-98/001+1737, National Applied Resource Sciences Center, Denver, CO. 136 pp.

Prichard, D., W. Hagenbuck, R. Krapf, S. Leonard, M. Manning, C. Nobel, and J. Staats. To be published in 1999. Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lentic Areas. TR 1737-16. Bureau of Land Management, National Applied Resource Sciences Center, Denver, CO.

Glossary of Terms

Color Infrared Film - A three-layer color film sensitized to green, red, and near-infrared. Conventional natural color film is sensitive to blue, green, and red.

Fiducial Marks - Index marks, rigidly connected with the camera lens through the camera body, which form images on the film. Usually there are eight, with one in each corner and one on each side of the image frame.

Functional—At Risk - Riparian-wetland areas that are in functional condition, but an existing soil, water, or vegetation attribute makes them susceptible to degradation.

Nonfunctional - Riparian-wetland areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows and thus are not reducing erosion, improving water quality, etc. The absence of certain physical attributes, such as a floodplain where one should be, are indicators of nonfunctioning conditions.

Proper Functioning Condition (PFC) - Riparian-wetland areas are functioning properly when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize streambanks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity.

Spectral Reflectance - Electromagnetic radiation at specified wavelength intervals.

Signature - Any characteristic or series of characteristics by which a material may be recognized. Used in the sense of spectral signature (i.e., differences in electromagnetic wavelength).

Appendix A

Photo Interpretation Key

NOTE: This key was developed based on the use of CIR film. The spectral characteristics inherent in CIR photos are a critical part of some interpretation keys. This key is an example and should not be considered complete. A similar key can be developed for black and white film. Various color tones of black and white can be used to distinguish condition.

HYDROLOGY

1. Floodplain above bankfull is inundated in "relatively frequent" events.

   - Evidence of matted vegetation and debris on the active floodplain.
   - Active floodplain (first terrace) is close to the same level as the stream.
   - Absence of steep vertical banks adjacent to the active channel.
   - Bright red spectral response of vegetation next to the water in CIR photos.

2. Where beaver dams are present they are active and stable.

   - Ponding or widening of stream with associated dams across channel.
   - Abandoned dams are vegetated, evidenced by reddish signature.
   - Signs of building, ponding, silting in, with evidence of grasses, sedges, or rushes.

3. Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting, (i.e., landform, geology, and bioclimatic region).

   - Stream meanders across full width of valley floor.
   - Good sinuosity in relation to valley width and slope.
   - Active channel is narrow and deep (black reflectance) rather than wide and shallow (blue-green reflectance).

4. Riparian-wetland area is widening or has achieved potential extent (reference historical photography for comparison).

   - Riparian vegetation (bright red in CIR) is replacing upland vegetation (greenish to bluish).
   - Young riparian vegetation is capturing streambanks.
   - Fullest width has been achieved.

5. Upland watershed is not contributing to riparian-wetland degradation (look at area from a small-scale perspective).

   - Alluvial fans from side drainages excessive (gray or white signature on CIR).
   - Excessive deposition from uplands.

VEGETATION

6. There is diverse age-class distribution of riparian-wetland vegetation.

   - Variation in spectral signatures of vegetation.
   - Variation in textural pattern for new to old growth (2-3 age classes).
   - Variation in height.

7. There is diverse composition of riparian-wetland vegetation.

   - Variation in spectral signatures of vegetation.
   - Variation in textural pattern.
   - Variation in height.

8. Species present indicate maintenance of riparian-wetland soil moisture characteristics.

   - High spectral reflectance in infrared bands (bright red color late in the growing season).
   - Presence of high moisture communities, e.g., sedges, rushes, willows, cattails (OBL or FACW species - TR 1737-11).

9. Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events.

   - Presence of stabilizing, woody species, e.g., willows and cottonwoods.
   - High spectral reflectance in infrared bands (bright red color late in the growing season).

10. Riparian-wetland plants exhibit high vigor.

    - Deep red spectral signature in infrared bands.
    - High soil reflectance indicating drying conditions not evident in infrared bands.
    - White to yellow signature indicating unhealthy vegetation not evident in infrared bands.

11. Adequate riparian-wetland vegetative cover present to protect banks and dissipate energy during high flows.

    - Streambanks are well-vegetated with riparian species (bright red color in CIR along most of streambank late in the growing season).
    - Soil disturbances (e.g., slumping) not evident.
    - Excessive bare soil on streambanks (white to grayish reflection) not present.

12. Plant communities are an adequate source of coarse and/or large woody material (trees, conifers, etc., along forest streams in the Northwestern U.S.).

    - Evidence of woody debris on floodplain and/or channel that can act as a hydrologic modifier.

EROSION/DEPOSITION

13. Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy (relative to potential).

    - Presence of rock and/or large woody debris in channel and floodplain.
    - Presence of active overflow channels, back-water areas, oxbows.

14. Point bars are revegetating with riparian-wetland vegetation.
    - Red spectral reflectance in infrared bands on point bars.
    - Presence of young riparian vegetation on point bars.

15. Lateral stream movement is associated with natural sinuosity.
    - Natural channel migration is evident.
    - Point bars are revegetating with lateral movement.
    - Single channel systems should not show braiding.

16. System is vertically stable.
    - Headward erosion (headcuts) not evident.
    - Presence of healthy, vigorous riparian vegetation exhibiting a reddish signature.
    - Presence of geologic controls (i.e., bedrock).

17. Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition).
    - Water appears black in infrared band, indicating little sediment.
    - Excessive erosion or deposition (gray to white reflectance) not evident (i.e., blowouts and midchannel bars).

Appendix B provides examples for some of these interpretation keys. For example, in photo 2b, the red signature of vegetation above arrow 1 is different than below arrow 1. The bright red signatures are reflective of healthy riparian-wetland vegetation. The mixed red, white, and blue-green signatures are indicators of upland species invading the site. When observing these signatures, an ID team would answer “Yes” to item 4 on the checklist above arrow 1 and “No” to item 4 below arrow 1.

Appendix B

Photo Interpretation Examples

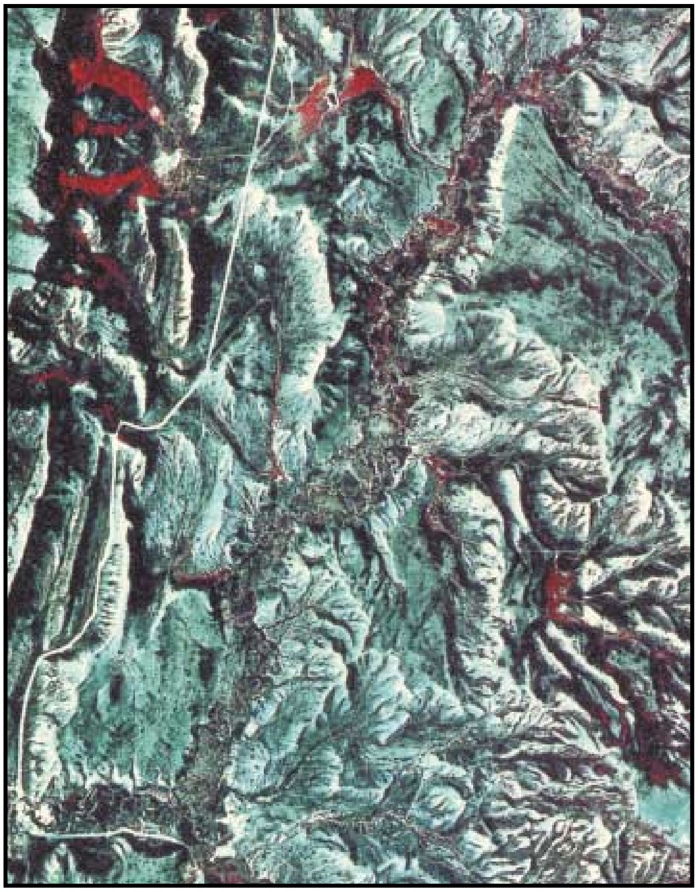


Photo 1a — July 1989

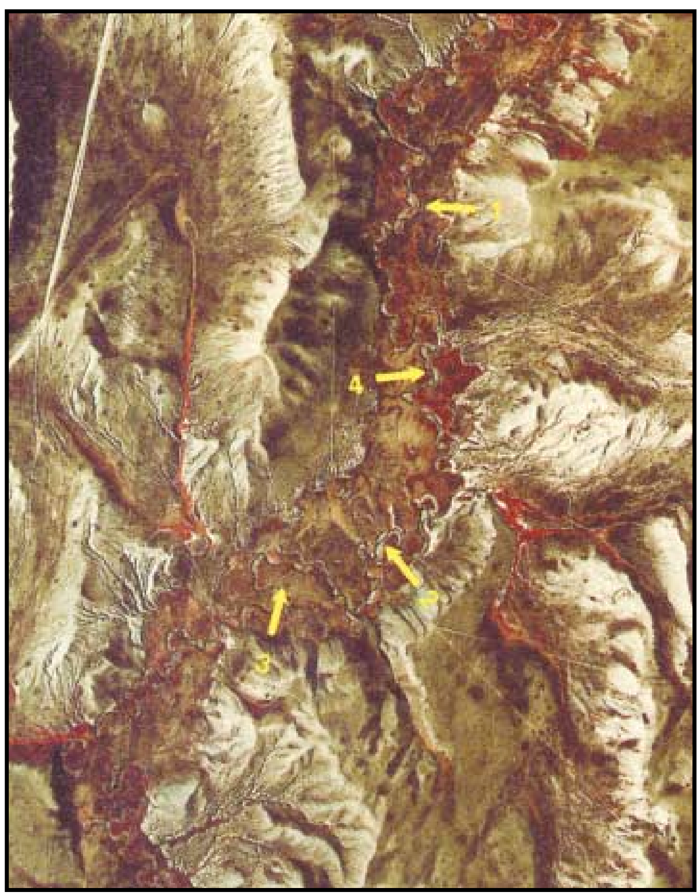


Photo 1b — July 1989

McKinney Creek - Wyoming

Photo 1a is a CIR photo of McKinney Creek at a nominal scale of 1:40,000. Photo 1b is a 2X enlargement of photo 1a (approximately 1:20,000). In photo 1b, the stream is wide and shallow, indicating that its width/depth ratio is not in balance with its landscape setting (arrow 1).

The white reflectance (arrow 2) identifies lateral and point bars that are not vegetated. If lateral and point bars were vegetated, they would exhibit a bright red signature indicating healthy riparian-wetland vegetation. A light pink to gray signature (arrow 3) indicates primarily upland vegetation. All vegetation items on a PFC checklist would receive a "No" response.

The presence of midchannel bars (arrow 4) suggests that the floodplain and channel characteristics are not adequate to dissipate energy. Deposition of materials also indicates the system is not in balance with its sediment load.

The color balance difference in the two photos should be noted. Color balance in CIR photography is difficult to control.

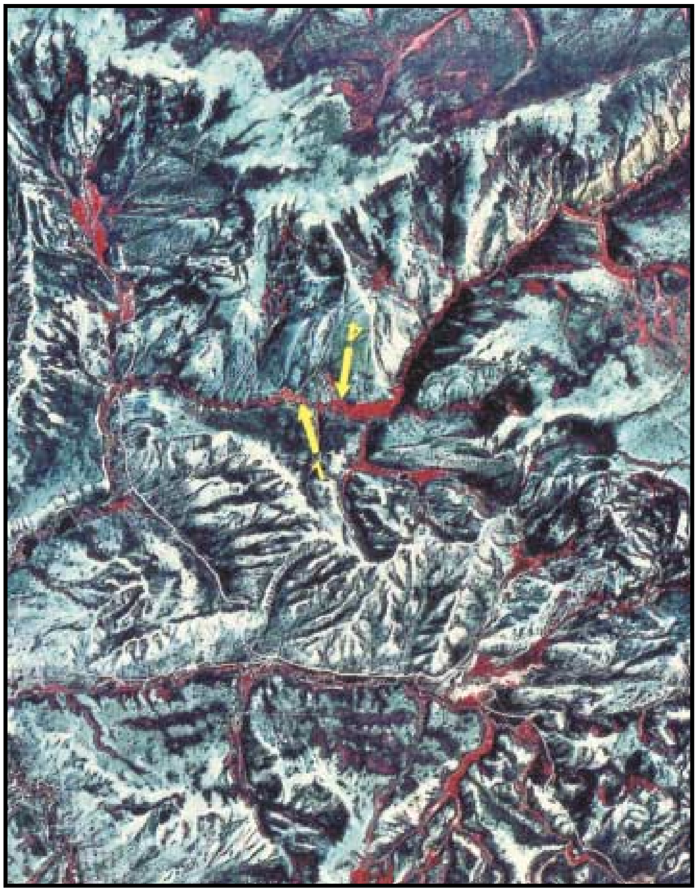
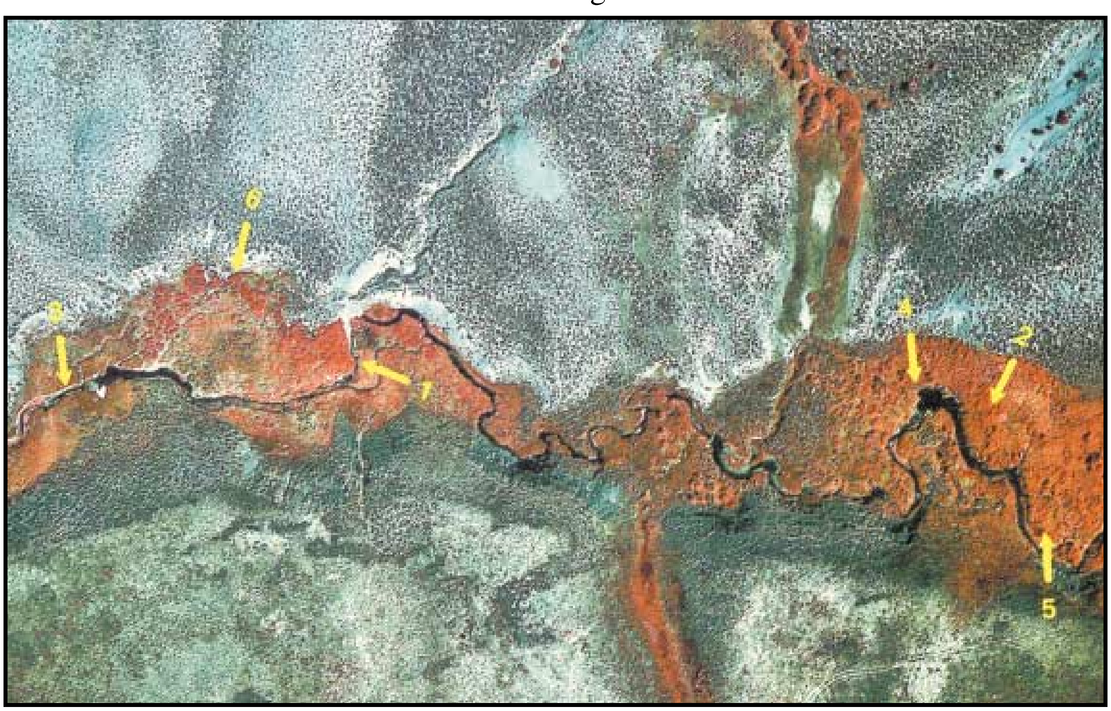


Photo 2a — July 1989

Photo 2b — August 1993



Littlefield Creek - Wyoming

Photo 2a is a CIR photo of Littlefield Creek at a nominal scale of 1:40,000, photo 2b is a CIR photo at a nominal scale of 1:3,000, and photo 2c is a ground photo. All three photos focus on a headcut (arrow 1) that is slowly progressing upstream through a beaver complex.

This stream would be divided into two reaches, one above the headcut and one below, based on evidence in these photos. The disturbance caused by the headcut can be seen in all three photos.

Bright red signatures (arrow 2) reflect healthy riparian-wetland vegetation. Below the headcut, the white signature (arrow 3) indicates bare streambanks. With a stereoscope, the incision of the channel can be seen.

Photos 2a and 2b show a series of beaver ponds (arrow 4). Ponding in photo 2a, a broader riparian zone associated with ponding, and structure of woody vegetation are clues that tell an interpreter that beaver are present. Careful examination with stereo magnification of 1:40,000 photos will show dams stretching across Littlefield Creek.

Under stereo magnification, diverse age structure of vegetation (arrow 5) can be seen around the beaver ponds in aerial photos 2a and 2b. Variations in texture, height, and spectral reflectance are indicators of a diverse composition and age structure of vegetation. Some diversity can still be seen below the headcut (arrow 6). However, the mixed red, white, and blue-green signatures are indicators of upland species that have invaded the site due to lowering of its water table.

On a standard PFC checklist, items addressing vegetation above the headcut would be answered "Yes;" items addressing vegetation below the headcut would be answered "No."

Photo 2c — June 1995

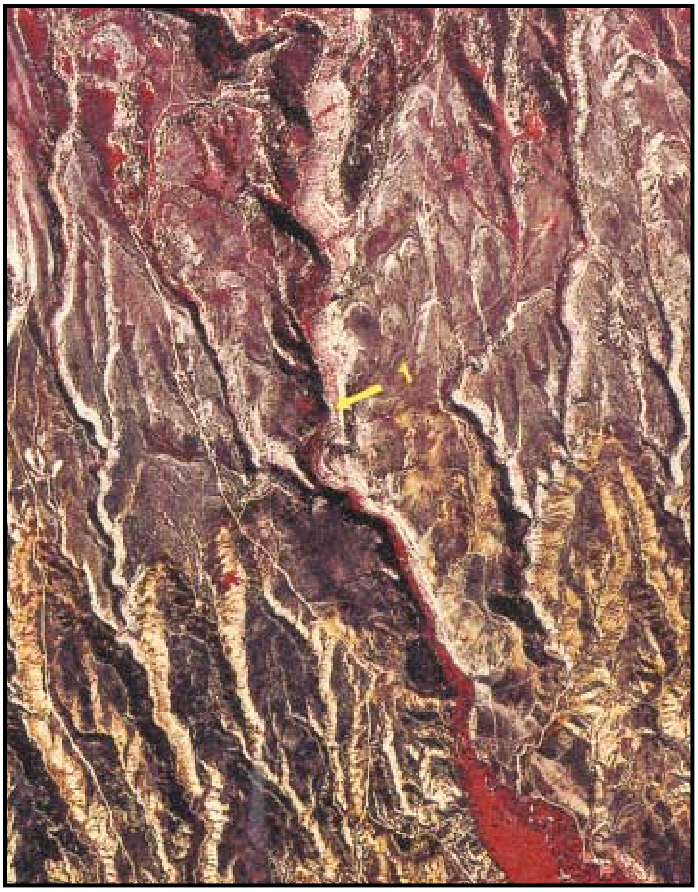


Photo 3a — July 1989

Photo 3b — August 1991

Middle Fork Powder River - Wyoming

Photo 3a is a CIR photo of the Middle Fork Powder River at a nominal scale of 1:40,000. Photo 3b is a natural color photo of the same area at a nominal scale of 1:3,000. Photo 3c is a field photo taken from a ledge approximately 200 feet above the valley floor. This series of pictures shows how landform is important in determining the condition of a riparian-wetland area.

Under stereo magnification, unvegetated spots (arrow 1) can be seen in the channel in photo 3a. The slope of the valley bottom and the gradient of the stream suggest that these could be rock rather than sand, gravel, or soil bars; the other two photos confirm the presence of large rocks and possible bedrock in the channel.

Vegetation items on a PFC checklist could be answered "N/A" or "Yes" because vegetation plays a limited role in dissipating stream energy.

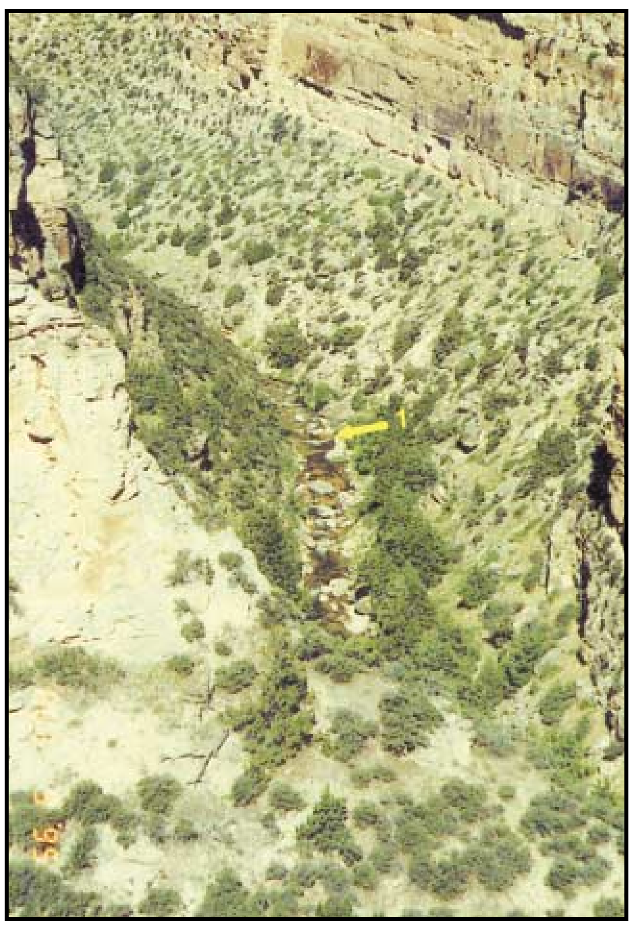


Photo 3c — June 1995

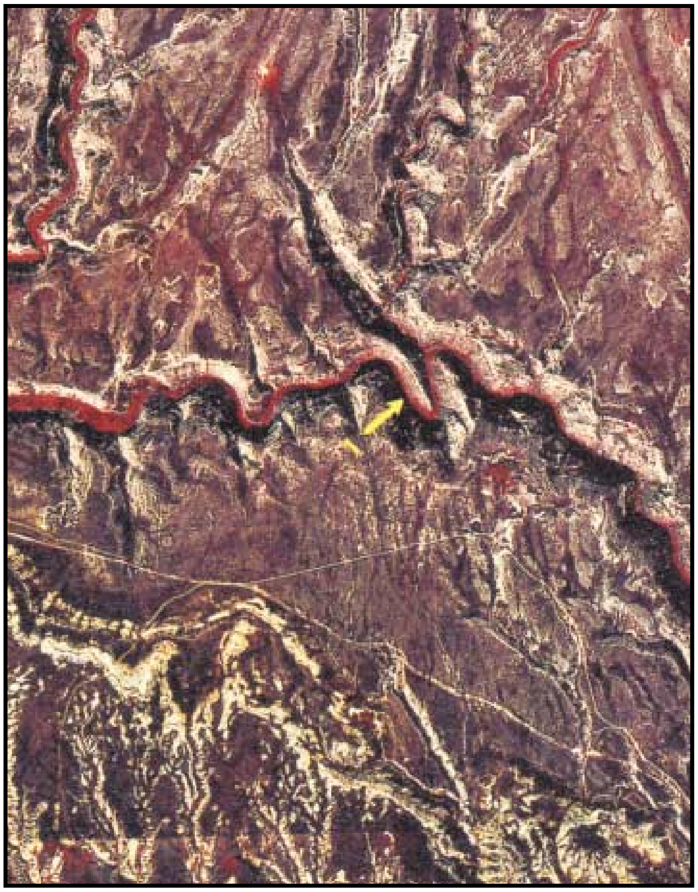


Photo 4a — June 1989

Photo 4b — August 1991

Buffalo Creek - Wyoming

Photo 4a is a CIR photo of Buffalo Creek at a nominal scale of 1:40,000. Photo 4b is a natural color photo of the same area at a nominal scale of 1:3,000. Photo 4c is a ground photo.

Photo 4a shows a bright red signature throughout the valley floor due to a wet year (arrow 1). This would be interpreted as excellent riparian-wetland vegetation condition throughout the reach. However, an interpreter must compensate for photos that were taken while upland species are still actively growing. Photos 4b and 4c show that there is a high percentage of upland vegetation, especially grasses, growing on the streambanks (arrow 2). Upland plants do not count when deciding if there is adequate vegetation to protect streambanks. Vegetation items on a PFC checklist would be answered "No."

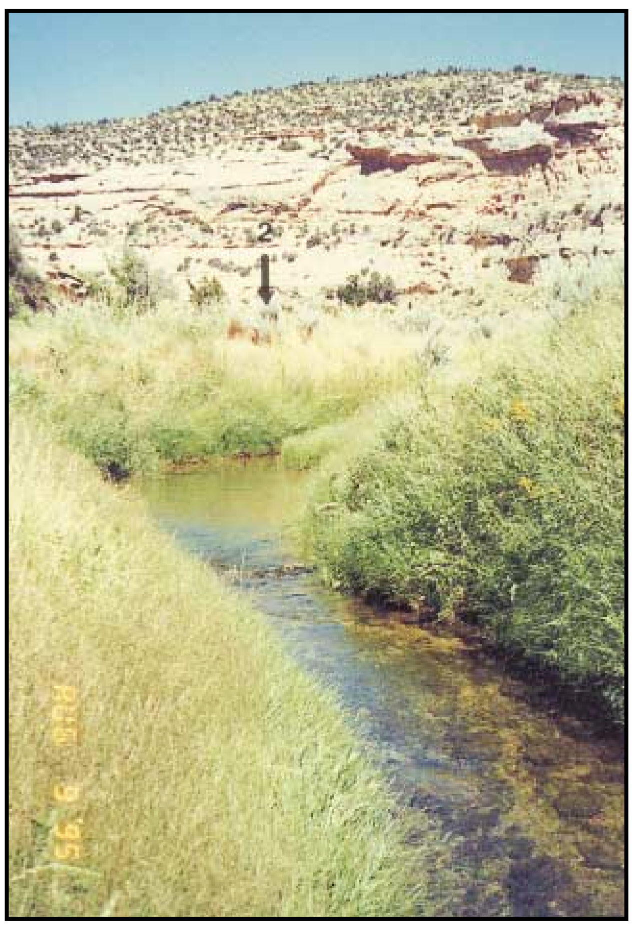


Photo 4c — August 1995

Appendix C

Imagery Comparisons

Below are comparisons among the types of imagery used in this project. There are other types of film and many different scales of aerial photography available for the Western United States.

	1:40,000	**1:31,680**	**1:24,000**	**1:15,840**	**1:6,000**	**1:3,000**	**Comments on media characteristics**
Linear coverage per photo (miles)	5.7	4.5	3.4	2.25	0.85	0.43	9- x 9-inch photos with 60% overlap for stereo
Area coverage per photo (sq. miles)	32.5	20	11.5	5	.72	.18	
Cyclic coverage	Yes (5-7 yrs. NAPP)	no	no	no	no	no	Cyclic provides historical coverage
General use	resource	resource	resource	resource	site-specific	site-specific	
Resolution (feet)	8-10	6-7	5-6	2-3	0.75-0.85	0.25	Positive transparencies provide sharper image
Film type: natural color **(NC),** color infrared(**CIR**), or black and white (**BW**)	BW, CIR	CIR	NC, CIR	NC	NC, CIR	NC, CIR	CIR best for vegetation interpretation
Cost per photo*	$3/print-BW $8/print-CIR	$8/print $12/film	$1/print-NC $8/print-CIR	$1/print	$1/print-NC $8/print-CIR	$1/print-NC $8/print-CIR	$25 per roll color balance charge
Comments on imagery	National program	2 inches = 1 mile	same scale as 7.5-minute map	4 inches = 1 mile	good detail and resolution w/limited ground coverage		

* All costs stated are approximate.

Appendix D

Case Studies

Case Study 1: Crow Indian Reservation Riparian Assessment

Introduction

In 1997, the Crow Indian Tribe and Crow Conservation District in south-central Montana requested a natural resource assessment of their reservation, which was to include an assessment of riparian areas. The reservation encompasses 2.2 million acres in 6 major watersheds containing over 1,000 miles of perennial streams. The riparian assessment was assigned to the NRCS Intermountain Riparian/Wetland Team in Bozeman, Montana.

This request for assistance was given top priority by the NRCS in Montana. The goal for completing the assessment was September 30, 1997. Due to the magnitude of the job, the time constraints (less than a year), and the lack of existing data on the riparian areas, remote sensing was considered the only viable option for completing the assessment on time. The team members had experience using PFC assessment methodology on the ground, which was an important factor in the decision to do the assessment using aerial photography. The assessment would be the first large-scale application of this methodology by NRCS. The assessment would provide information to aid in prioritizing reaches needing improvement or further inventory.

Color infrared transparencies at a scale of 1:63,000 from flights in 1980 and 1981 were used for this assessment.

Results

Riparian assessments were conducted on six watersheds of the Crow Reservation. Overall, 208 stream reaches, covering 1,000 miles of perennial streams, were evaluated (Figure 1). Of the 208 reaches assessed:

- 95 reaches (375 miles) were rated PFC (proper functioning condition)
- 109 reaches (614 miles) were rated FAR (functional—at risk)
- 4 reaches (11 miles) were rated NF (nonfunctional)

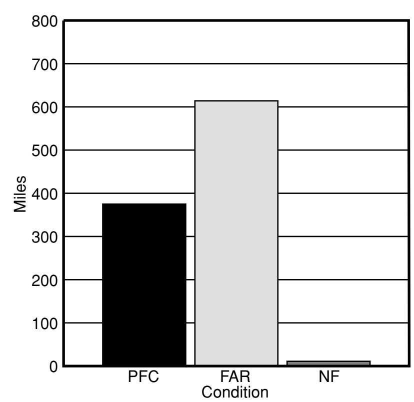


Figure 1. Functioning condition of reaches assessed.

Trend was determined for reaches rated FAR (Figure 2). Trend is only determined on FAR reaches because all NF reaches need improvement and PFC is considered a stable situation. Trend can be upward, downward, or not apparent. An upward trend indicates that physical recovery is occurring and the functional condition of the reach is moving toward PFC. A downward trend indicates that conditions in the reach are continuing to deteriorate, and if left unchecked, could result in a reach that is nonfunctional.

These deteriorating conditions can be transmitted both upstream and downstream, affecting a reach that is PFC or FAR. When a trend is not apparent, further study is needed. Of the 109 reaches rated FAR:

- 44 reaches (215 miles) had an upward trend
- 8 reaches (61 miles) had a downward trend
- 7 reaches (338 miles) had no apparent trend

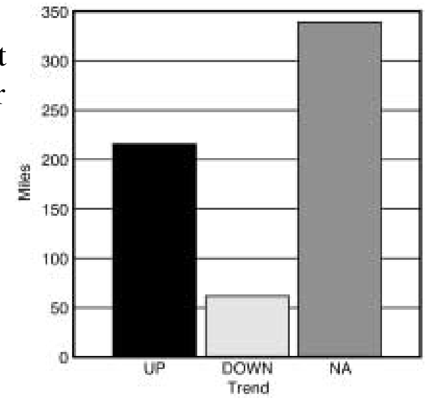


Figure 2. Trend ratings for reaches that are functional—at risk.

Because of the large volume of data from the reaches rated FAR, four categories were established to segregate data by potential causes for riparian-wetland deterioration (Figure 3):

- FAR1 included reaches affected by grazing management
- FAR2 included reaches affected by cropland encroachment
- FAR3 included reaches affected by both grazing management and cropland encroachment
- FAR4 included reaches affected by channel straightening, structures, and road encroachment, and reaches where the cause of deterioration was not readily apparent

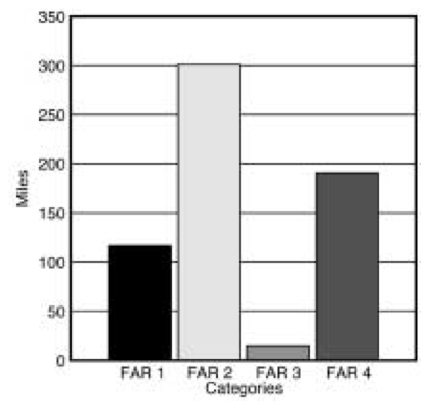


Figure 3. Categories for reaches that are functional—at risk.

Since only a small number were found, nonfunctional reaches were not delineated in this manner.

Results of the remote riparian assessment were verified in the field on 40 percent of the reaches. Field verification was limited to locations with reasonable access. Further investigations were conducted if observations conflicted with the findings of the remote assessment. Field verification indicated 95 percent accuracy for the remote assessment on the Crow Reservation. After reaches were assessed and rated, the results were displayed using a Geographic Information System (GIS) for planning purposes.

Discussion

Because this was the first large-scale application of this technology and the ID team's first experience with remote sensing of riparian conditions, a number of issues had to be addressed during the assessment.

After delays in obtaining the needed materials, the team began remote assessments in the Rosebud and Upper Tongue Watersheds on the east side of the reservation. In May 1997, the team began field verification of the remote assessments of these watersheds, which revealed serious problems with the photo interpretations. The team corrected the assessment on as many reaches as possible while in the field. The remainder of these reaches had to be reassessed remotely to correct the interpretations. The age of the photographs was a contributing factor to these early problems. The photos used were 16-17 years old and were used only because they were the only CIR photos available. However, most of these problems could have been avoided by making a reconnaissance trip and customizing the photo interpretation key (see Appendix A) prior to conducting the remote assessment. After adjusting the photo interpretation key, the assessment moved along more smoothly. Field verification in the Little Big Horn Watershed indicated that the remote assessment was 98 percent accurate.

In most cases, ratings could be assigned by using the standard checklist without collecting additional data; however, for Owl Creek and other streams in the southeast portion of the Little Big Horn River Watershed, further investigation was required before a rating could be assigned. These streams had become incised in the past, yet appeared to have stabilized without developing significant floodplains. The team could not assign ratings on these reaches based on the standard PFC checklist alone. Data on channel geometry and hydrology was collected to determine if these reaches had been subjected to a 25-year frequency flow. Data analysis indicated that since the downcutting had occurred, these stream reaches had not experienced any flows of that magnitude. These reaches were assigned a rating of FAR since the floodplain characteristics appeared inadequate to provide stability through a 25-year flow event. For the reaches that exhibited these unique characteristics, the additional data would have been required whether the assessment was conducted remotely or on-site.

The PFC method does not provide for separation of reaches with the same rating except for those reaches rated FAR, which are given a trend rating. Over 60 percent of the stream miles in this assessment fell into the FAR category, which normally receives priority for planning and application to improve function. Because of the large volume of data on the FAR reaches, there was a need to further stratify the data to make it more useful for the tribe and conservation district. Additional FAR categories were defined as an objective way to further stratify the data.

The PFC process is a valuable tool for prioritizing and concentrating resources on areas that may be improved with a change in management. The process also helps determine where further inventory is needed to determine the actual problem. Based on this riparian assessment, priorities for planning and application on the Crow Indian Reservation were:

1. Reaches rated FAR with a downward trend
2. Reaches rated FAR with an upward trend
3. Reaches rated NF
4. Reaches rated PFC where the landowner is trying to improve to a desired future condition

Nonfunctional reaches often require structural measures, have greater restoration costs, and respond more slowly to treatment. It is generally more cost-effective to treat FAR reaches. However, nonfunctional reaches can threaten the stability of other reaches, both upstream and downstream. Actions to stabilize a nonfunctional reach may then be justified and warrant a higher priority.

For this study, the reaches having top priority for further study were those rated FAR with no apparent trend in the FAR4 category. In these reaches, neither the trend or the impacts resulting in the FAR rating are known. The next priority for further study would be any other categories of FAR reaches with no apparent trend.

The assessment of 1,000 miles of streams on the Crow Indian Reservation was accomplished with 180 staff days. An ID team, including a hydrologist, soil scientist, and vegetative specialist, completed the remote assessment in 41 days (123 staff days). Field verification of the interpretations was completed in 17 days (51 staff days), and the report was prepared in 6 staff days. It is estimated that if this assessment had been done in the conventional way, it would have required over 600 staff days. The interdisciplinary team would have needed 200 days in the field (600 staff days), which because of Montana's latitude, would have required two field seasons.

The Crow Reservation and Conservation District have used the PFC assessment information to assist in setting priorities for watershed treatment. The Pryor Creek Watershed was identified as a high-priority watershed for further inventory and planning efforts. This assessment is one example of how PFC may be used in assessing watershed conditions and planning improvements.

Case Study 2: Cut Bank Creek Watershed

Introduction

The Blackfeet Tribe and Glacier County Conservation District requested an assessment of the riparian areas of the Cut Bank Creek Watershed in north-central Montana in September 1997. The tribe and conservation district were involved in the development of a local watershed group, and the group needed background information on riparian conditions and causes of riparian degradation in the watershed to develop a framework for riparian improvement. Information from the assessment was also to be used for developing grant applications.

The study area encompassed the perennial streams of the Cut Bank Creek Watershed within the Blackfeet Indian Reservation in Montana. The study area began at the Glacier National Park boundary at an elevation of 5,080 feet and continued eastward to the confluence of Cut Bank Creek and Two Medicine River at an elevation of 3,300 feet.

The assessment request was received by the NRCS Intermountain Riparian/Wetland Team in Bozeman, Montana, late in the annual work plan development process. Because of the late date, the team had two options for conducting the assessment:

- Train the local NRCS field office and tribal personnel to use the on-site PFC approach, which would require 120-140 staff days to complete, including a 2-day training course and 6 days of assistance in the field to get the local team started.

- Have an experienced ID team complete the assessment using the remote PFC approach, which would require 45-60 staff days to complete the entire assessment, including field verification.

Under option 1, only an estimated 15 percent of the assessment could be completed during the first field season. The local team, which was already fully committed to other projects, would be left to complete the remainder of the assessment. Option 2 was chosen because the assessment could be accomplished in one field season without impacting the workload of the local team. In addition, the experience gained during the riparian assessment of the Crow Indian Reservation indicated that the quality of data would not differ significantly between an on-site assessment and a remote assessment.

Color infrared transparencies at a scale of 1:33,000 from a September 1989 flight were used for the assessment. The resolution of these photographs was outstanding, making signatures of riparian vegetation and stream channel characteristics easily discernible. The transparencies were only 2.25 inches by 2.25 inches, and more photos had to be used because of the limited coverage of each stereo pair of photos.

Results

Fifty-five reaches, covering 209 miles of perennial streams, were evaluated in the Cut Bank Creek Watershed (Figure 1). Of the reaches assessed:

- 12 reaches (31 miles) were rated PFC (proper functioning condition)
- 31 reaches (124 miles) were rated FAR (functional—at risk)
- 12 reaches (54 miles) were rated NF (nonfunctional)

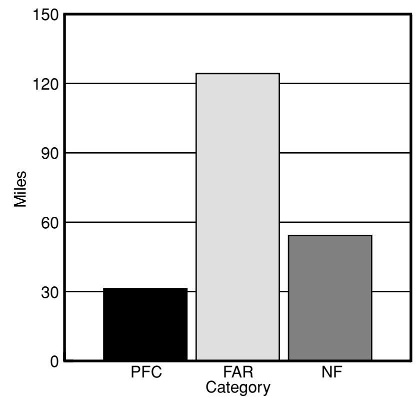


Figure 1. Functioning condition of reaches assessed.

The assessment of riparian conditions resulted in 56 percent of the reaches, or 124 miles, receiving FAR ratings (Figure 2). Of the 31 reaches rated FAR:

- 5 reaches (10 miles) had a upward trend
- 11 reaches (48 miles) had a downward trend
- 15 reaches (65 miles) had no apparent trend

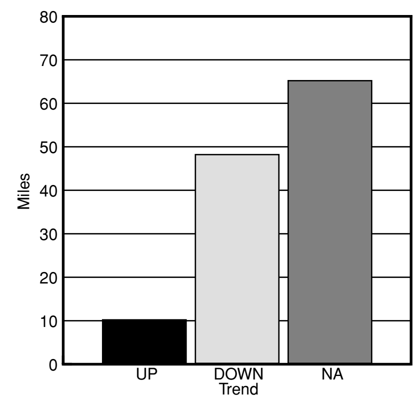


Figure 2. Trend ratings for reaches that are functional—at risk.

Discussion

Twenty-seven percent of the stream reaches assessed were verified in the field. Field verification was generally limited to a few points along a stream reach with reasonable access. Further investigations were conducted if field observations conflicted with the results of the remote assessment. Field verification indicated the remote assessment was 98 percent accurate.

The streams of the Cut Bank Creek Watershed had a significant degree of natural instability due to the geomorphology and soils. It was not within the scope of this study to isolate and quantify natural instability and human-caused or accelerated instability. However, evidence of accelerated instability, such as excess sediment and bank erosion, began in the upper reaches of the study area and continued to accumulate downstream.

In general, the excessive sediment load within the tributaries of the Cut Bank Creek Watershed had resulted in stream channels that were overly wide and shallow. The stream's capacity for sediment transport was exceeded, resulting in lateral instability (bank erosion), deposition of central bars, and stream meander cutoffs. The cumulative effects of the excess sediment load were reflected in the ratings for the lower reaches of Cut Bank Creek. These reaches were all rated NF or FAR with a downward trend. One exception was reach seven of Cut Bank Creek, which flows through a canyon where stability is provided by large rock.

Accelerated erosion and sedimentation in areas such as the North Fork of Cut Bank Creek appeared to be caused by uncontrolled livestock access to the creek during times of streambank saturation. The vegetation in this area was not overgrazed and appeared to be adequate to provide bank stability if off-site water developments for livestock were provided.

Grazing management and cropland encroachment in the riparian area appeared to be the most common practices causing accelerated erosion and sedimentation in the Cut Bank Creek Watershed. Grazing management currently involves winter-long grazing with free access to streams and riparian areas, which has severely reduced the quantity and quality of stabilizing vegetation. Woody species in particular have been severely impacted. Prescribed grazing management plans, including the facilities to implement those plans, should be developed for all livestock producers bordering streams in the watershed.

Encroachment in the riparian area is due to crops being planted to the stream's edge. Annual crops and hay do not have the rooting depth and strength to protect the streambanks from erosion. Riparian buffers, as part of an overall conservation plan, would help to alleviate this source of instability. In many situations in the Cut Bank Creek Watershed, some form of bank stabilization will be required before buffers can be successfully applied.

The data from this assessment was helpful for establishing priorities within the watershed. Based strictly on the riparian assessment, priorities for planning and application were:

1. Reaches rated FAR with a downward trend
2. Reaches rated FAR with an upward trend
3. Reaches rated NF
4. Reaches rated PFC where the landowner is trying to improve to a desired future condition

Reaches rated NF normally receive the lowest priority for planning because expensive structural measures combined with changes in land management are often required to effect a change in function. In the case of the Cut Bank Creek Watershed, the main problem in the watershed is excess sediment. Any change in land management that reduces erosion or sediment delivery will benefit the stream system. Any producer who is ready, willing, and able to implement management changes that will reduce erosion or sediment delivery should receive assistance when resources are available. Additionally, reaches that are rated NF can threaten the stability of other reaches, both upstream and downstream. Actions to stabilize a nonfunctional reach may be justified when the conditions of that reach threaten the stability of other reaches. Reaches rated FAR with no apparent trend are top candidates for further study.

The assessment of 209 miles of perennial streams within the Cut Bank Creek Watershed was accomplished with 45 staff days. The ID team, including a hydrologist, soil scientist, and biologist, completed the photo interpretations in 9 days (27 staff days). Field verification was completed in 5 days (15 staff days), and the report was prepared in 3 staff days. Assuming an assessment rate of 5 miles per day, an on-site PFC assessment of the same 209 miles of stream would have required the ID team to spend 42 days (126 staff days) in the field. The local field office would have spent a minimum of 5 staff days obtaining permission from landowners to access reaches on their lands. No field verification would have been required, and report preparation would have taken 3 staff days as it did for the remote assessment. Thus, an on-site PFC assessment would have taken approximately 134 staff days.

The assessment of the perennial streams within the Cut Bank Creek Watershed provided excellent background resource information. The major sources of stream degradation and land management practices contributing to stream degradation were identified. The assessment results also indicated appropriate practices and management changes to improve stream function. The assessment data can be used to build consensus within the local watershed group, for grant applications, and to set priorities for the allocation of staff and financial resources. These benefits are all derived from an assessment that was completed with one-third of the staff time required to complete a conventional assessment.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
April 1999

3. REPORT TYPE AND DATES COVERED
Final

4. TITLE AND SUBTITLE
RIPARIAN AREA MANAGEMENT TR 1737-12
Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas

5. FUNDING NUMBERS

6. AUTHOR(S)
Pam Clemmer, Mark Gorges, Gretchen Meyer, Don Prichard, and Karen Shumac

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Department of the Interior
Bureau of Land Management - National Applied Resource Sciences Center
P.O. Box 25047
Denver, CO 80225-0047

8. PERFORMING ORGANIZATION REPORT NUMBER
BLM/RS/ST-96/007+1737+
REV99

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
This is a revision to the original technical reference published in September 1996.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This technical reference provides a process for using aerial photos to assess functioning condition of riparian-wetland areas, thereby reducing field time and costs.

14. SUBJECT TERMS
- Wetlands
- Riparian areas
- Vegetation
- Aerial photography

15. NUMBER OF PAGES
64 including covers

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL