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Anchorage, Alaska 99513

Aerial Photography Assessment of Riparian Areas in the Unalakleet Drainage, Alaska

Michael Scott

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Cover Photos

Various views, Unalakleet drainage

Author

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In the early 1990's the Bureau of Land Management (BLM) provided a blueprint of management and restoration of riparian-wetland areas. The initiative recognized Alaska as a "special situation" in that only a small proportion has been disturbed. Most riparian documents about Alaska emphasize inventorying and maintaining these habitats. However, little emphasis has been given to inventorying Alaska riparian-wetland areas primarily due to the assumed condition of riparian habitat, limited funding, the remoteness of the water bodies, and the sheer magnitude of the number of miles of riverine habitat in the state. In 1998, BLM's Washington Office directed BLM-Alaska to inventory 500 miles of riparian habitat. To meet this goal, BLM-Alaska first assessed areas that were readily accessible but it became evident that to assess the large number of more remote areas in a cost efficient and reasonable time frame would require a different approach. Advances in Geographic Information Systems (GIS) and techniques developed at BLM's National Applied Resource Sciences Center (employing small-scale aerial photography to assess Proper Functioning Condition) combined with a statistical procedure were applied to document the condition of vast amounts of remote and primarily pristine riverine riparian areas in Alaska.

Introduction

The BLM Manual 1737 Riparian-Wetland Area Management (USDI, 1992), the BLM Riparian-Wetland Initiative for the 1990s (USDI, 1991), and 43 CFR 4, 1780, and 4100 provides policy, regulations and guidance for the identification, protection, restoration and maintenance of riparian-wetland areas for BLM lands. While these documents emphasize grazing management, they include language that pertains to "other uses" which are pertinent to Alaska.

The 1990s initiative document suggested that Alaska concentrate on completing initial inventories and evaluations and maintaining these areas in their natural state. In 1990, Alaska estimated that 99 percent of their lotic riparian areas were functioning properly, but classified 90 percent as "unknown" since no inventories had been conducted. These figures were based on estimates by resource specialists familiar with these areas and submitted to the BLM Alaska State Office (ASO). This information was incorporated into the *Alaska Riparian Area Management Plan*.

Fiscal Year 1999 Annual Work Plan directives emphasized the importance of implementing an inventory following the procedures outlined in technical reference TR 1737-9, Process for Assessing Proper Functioning Condition (Prichard et al., 1993), and technical reference TR 1737-15, *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas* (Prichard et al., 1998). The Alaska statewide assessment goal for FY99 was more than 400 miles of which the Anchorage Field Office (AFO) was to complete approximately 80 miles. To complete our assessment goal, Alaska requested proper functioning condition (PFC) training. This training was held in Fairbanks, Alaska, on May 4-6, 1999.

During the training, participants discussed differences between Alaska and contiguous states riparian-wetland situations. Most participants felt the contiguous states situation is complicated because many areas are classified as nonfunctioning or functional at risk; Alaska has a larger proportion of riparian-wetland areas, but if inventoried, these would be classified as functioning properly.

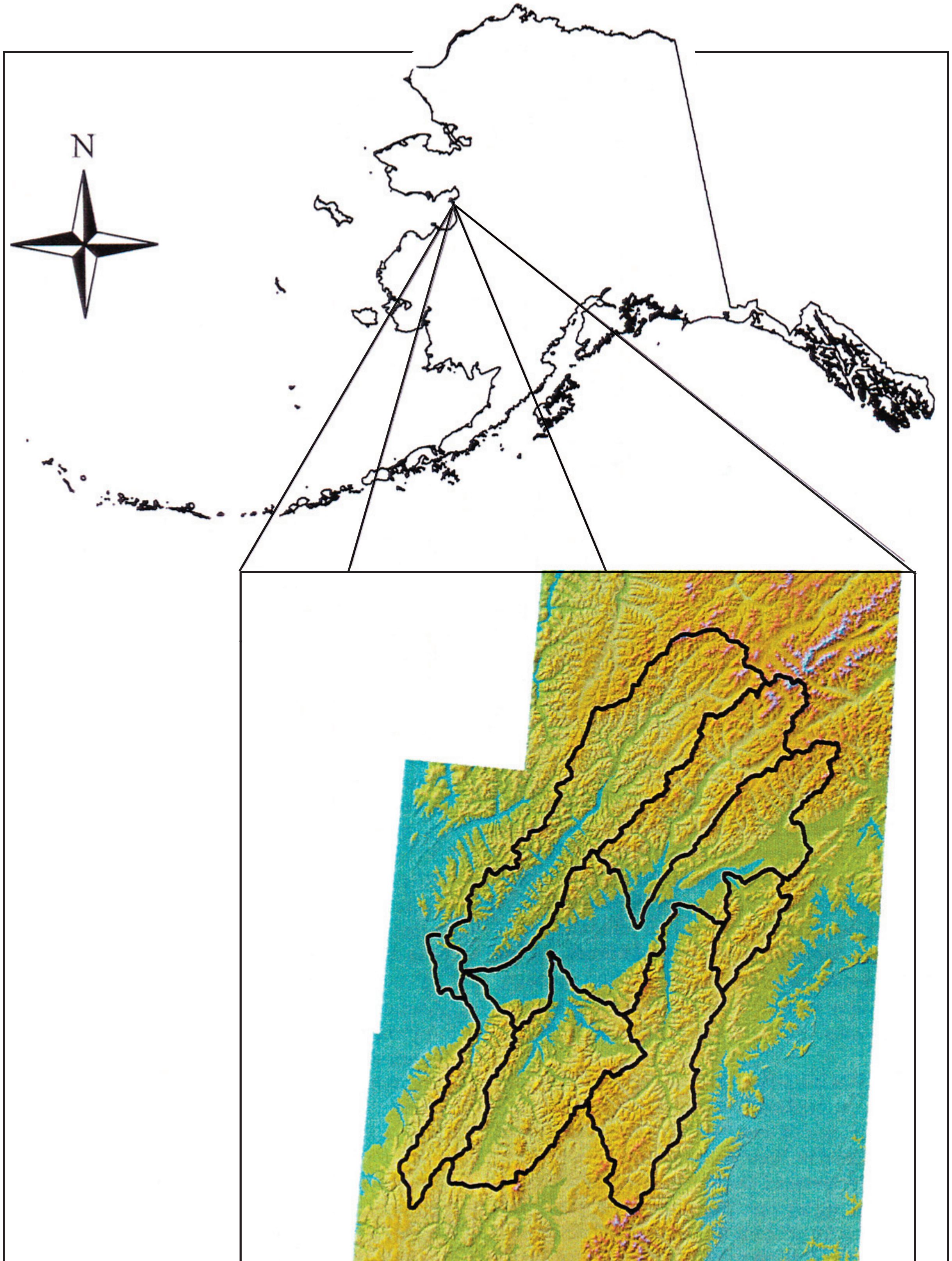

Figure 1.
Location of Unalakleet drainage area, Alaska.

The discussion then addressed ways Alaska could assess the vast amounts of riparian-wetland areas in the state. The approaches ranged from (1) assessing only those areas known to be impacted by various activities, assuming that non-impacted areas are properly functioning to (2) assessing all areas on a basin-wide basis, a monumental task because of the number of miles of lotic riparian habitat.

Because of the magnitude and remoteness of riverine riparian areas managed by the Anchorage Field Office, a landscape-scale approach using aerial photography was considered the most viable option to evaluate Proper Functioning Condition (PFC).

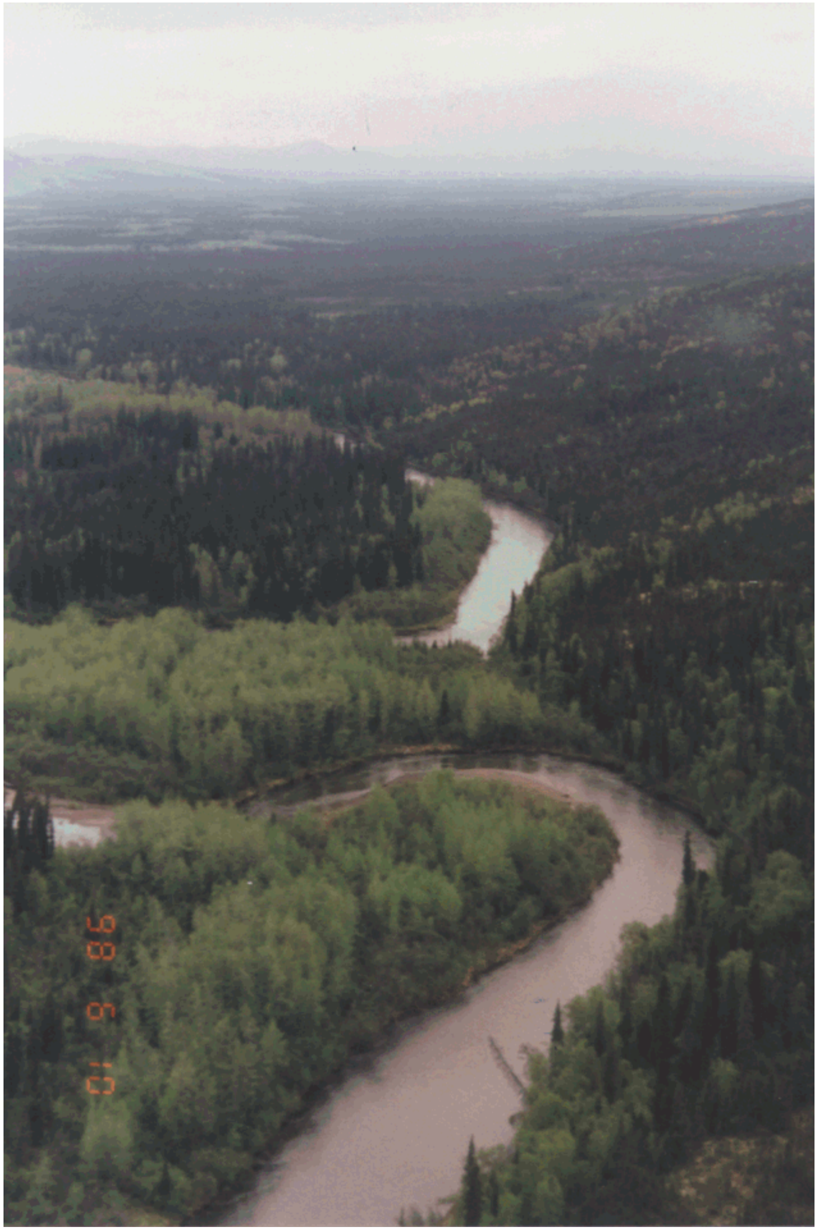

Photo 1.
An overview of the Unalakleet River valley. Note the diverse age classes and vigor of the willow. The younger-age classes of willow on the point bars are revegetating.

Description of the Study Area

The Unalakleet River drainage is located in the northwestern part of Alaska on the Seward Peninsula (*Figure 1*). The drainage encompasses about 2,082 square miles and has 3,246 miles of streams as depicted on 1:63,360 USGS quadrangle maps. The mountains rise from sea level to elevations up to 2,000 feet. The headwaters of the main stem originate in a section of the Nulato Hills called the Kaltag Mountains. Approximately 81 miles of the Unalakleet River, from its headwaters to the confluence with the Chiroskey River, is designated as part of the National Wild and Scenic River System. (*Photo 1*)

Winter temperatures average -5°F to -12°F. Average summer temperatures range from 42°F to 61°F. Prevailing winds are generally easterly (Unalakleet means “place where the east wind blows”) and average 10 mph. During fall storms, wind speeds can exceed 50 mph. Average annual precipitation is 14.2 inches, including 37 inches of snowfall.

Plant species common to riverine riparian areas in the drainage are listed in *Table 1* (Reed, 1988).

Riparian-Wetland Vegetation	Region A Indicator	Habitat
1. *Salix subsp. (willow)*	FACU to OBL 31 species	Native shrub
2. *Alnus subsp (alder)*	FAC 6 species	Native shrub
3. *Calamagrostis canadensis* (bluejoint)	FAC	Perennial native grass
4. *Potentilla palustris* (marsh five finger)	OBL	Perennial native forb emergent grasslike
5 *Carex aquatilis* (water sedge)	OBL	Perennial native emergent grasslike
6. *Picea glauca* (white spruce)	FACU	Native tree
7. *Picea mariana* (black spruce)	FACW	Native tree
8. *Populus balsamifera*	FACW	Native tree
9. *Populus tremuloides* (quaking aspen)	FAC	Native tree

Table 1.
Common plant species that occur in Alaska wetlands.

Study Design

Objectives for this assessment included:

1. developing cost and time efficient procedures to assess riparian habitat in Alaska.

2. estimating the number of reaches that are in Proper Functioning Condition within the drainage such that the estimated river miles are within 5 percent of the true proportions 95 percent of the time.

3. estimating the proportion of riverine habitat that is PFC such that the proportion is within 5 percent of the true proportion 95 percent of the time.

4. determining if these procedures are applicable to assess PFC in other major basins administered by the BLM Alaska.

The Unalakleet River riparian area assessment involved the following tasks:

- using a Geographic Information System (GIS) to analyze and document results of this assessment.

- identifying riparian areas/reaches within the Unalakleet River drainage using GIS.

- developing a photo index for the Unalakleet River drainage.

- applying a statistical procedure to determine the number of aerial photos that needed to be assessed to provide a 95 percent accuracy for the entire drainage.

- using photo interpretation procedures outlined in Prichard et al., 1999 to assess PFC.

- visiting field sites in the Unalakleet River drainage to validate photo interpretations.

- determining reportable units using land status and the routed Digital Line Graph (DLG) coverage in GIS.

This assessment incorporated GIS to help analyze and document the results. Four base layers were used in the assessment including two U.S. Geological Survey (USGS) digital elevation models (DEM) which were hillshaded and a DLG hydrography dataset which was routed by BLM Alaska State Office personnel. The two other layers (a Unalakleet River drainage boundary and a point coverage of the centroid of the aerial photography) were produced at the BLM Anchorage Field Office. Many of the themes and coverages used in this project are shown in *Figure 2*.

The coverage of the centroid of the small scale aerial photographs was generated from an ascii text file containing the latitudes and longitudes downloaded from BLM's Alaska State Office Alaska Lands Information System web site. The coverage was overlaid on the drainage boundary to determine the extent and distribution of areal coverage in the drainage.

Statistical Sampling

A single-stage cluster sampling technique was employed for this analysis (Cochran, 1980). The primary sampling unit (psu) was the effective area of the individual aerial photographs. Stream reaches were the elementary units whose characteristics were assessed. In single-stage sampling all streams in the psu were sampled.

A 60 percent buffer theme was created around the centroid of 91 aerial photos. The buffer had an area that approximated the stereo coverage of the aerial photos and was used to estimate the number of reaches in the effective area of the aerial photographs. The statistical simulation was based on pilot data consisting of the number of reaches within the 91 buffered plots.

For each combination of sample size and assumed PFC, 10,000 percentages were run to determine the chances of a sample percentage being different from the assumed PFC. This test only determined if a given reach was or was not PFC. The statistical design did not consider whether a reach was Functional-At Risk.

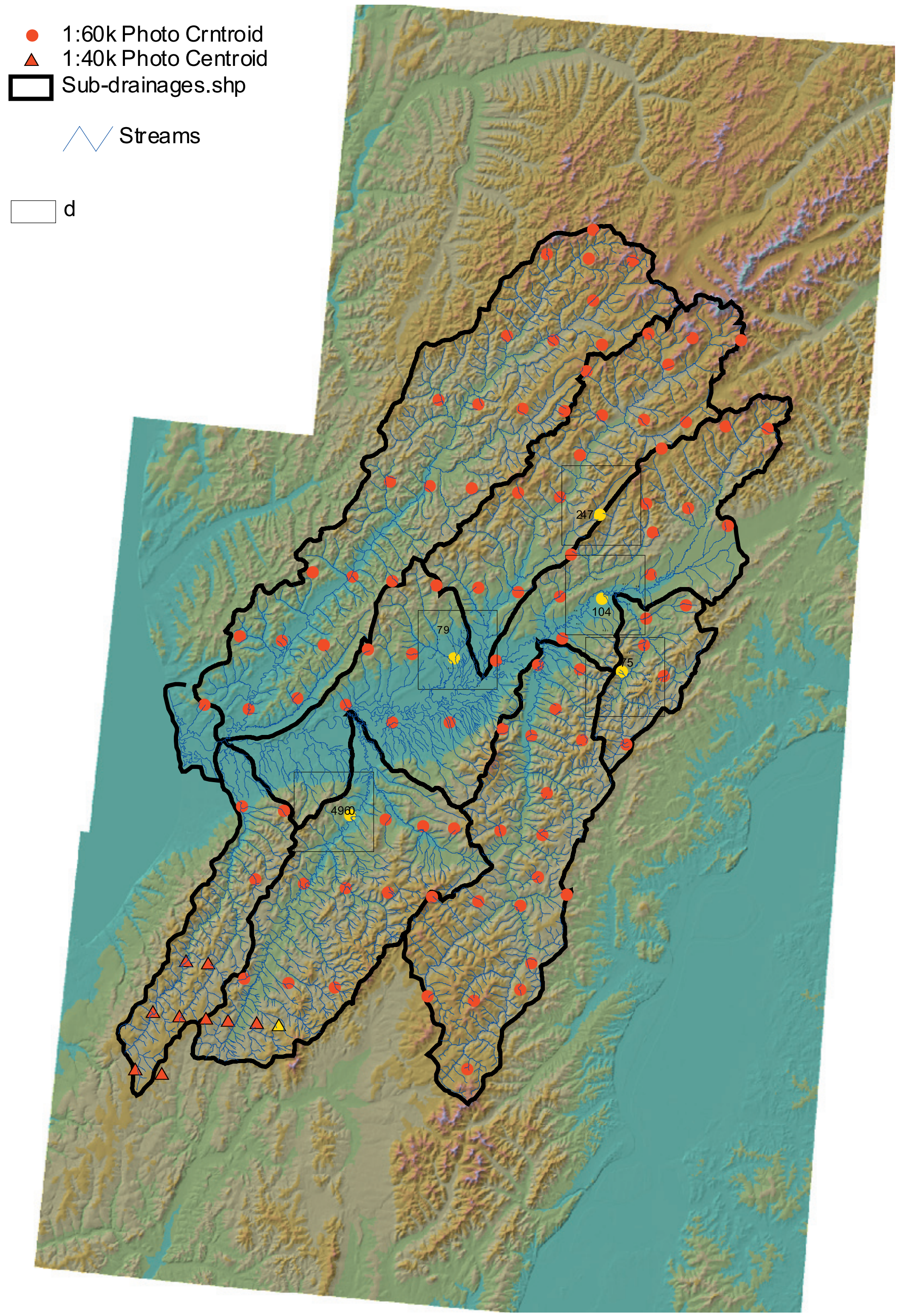

Figure 2.
Unalakleet drainage, subdrainages and photo points.

The simulation used realistic parameters and data ranges to determine the approximate sample size that would result in a sample that would be above a specific PFC level x, y percent of the time if the true percentage is z. The PFC level x was determined by setting y at 90 or 95 percent and the assumed true percentage z took on the values of 95, 97 and 99 percent. The estimate of the PFC reaches was calculated as:

$$\textbf{Percent PFC} = 100\,\frac{\sum_{j=1}^{p}\sum_{k=1}^{r} I_{jk}}{\sum_{j=1}^{p} r_j}$$

where: I = 1 if the reach is PFC and
0 if not PFC, and
r = the number of reaches in photo plot p

Appendix A contains the SAS code used in the simulation.

Based on the summary of the statistical simulation, 10 photos were randomly selected by their frame number using a spreadsheet. The photo frame numbers were exported from the attribute table of the centroid theme of the aerial photo distribution. Using ArcView's query capabilities, the centroids of the selected photos were identified and highlighted.

PFC Assessment

Available photography was used in this assessment to avoid the increased cost of obtaining current photography. The most current color infrared (CIR) photography available was flown in the 1980s at 1:60,000 and 1:40,000 scale. Transparencies of the 10 randomly-selected photo pairs (for stereo coverage) were requested through the BLM Alaska State Office Branch of Mapping Sciences. Five of the transparencies had to be ordered and did not

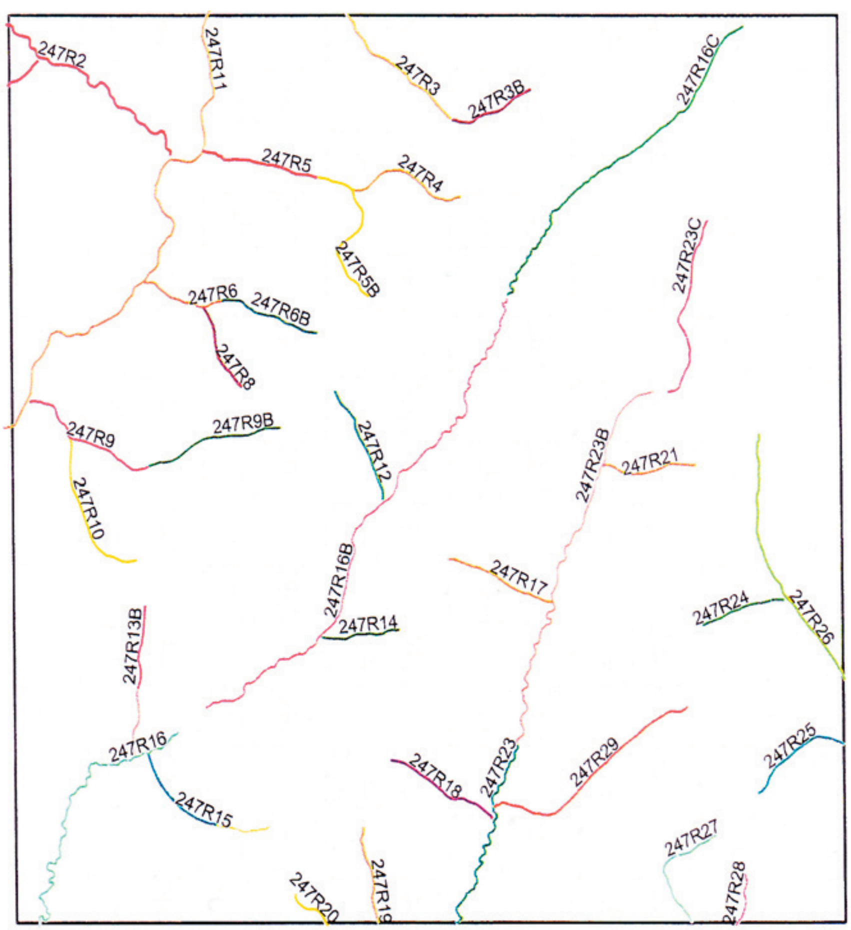

Figure 3.
Identificaton of reaches.

arrive in time to be included in the assessment. All photographs were taken during July except those for photo plot 4960 which were taken in August.

A 6x6-square-mile theme representing the effective area of each of the randomly-selected photos was created in ArcView. Reaches were then defined within the effective area of the photographs (*Figure 3*). The theme was centered on the centroid of the respective photo. All streams within the effective area were stratified into reaches. Reaches were delineated primarily on gradient but confinement and sinuosity were also used as criteria in the process. Data layers used to define the reaches included hillshaded relief of the DEM and the routed DLG data. An ArcView Avenue script utilized the event tables up and down indices in the Aquatic Resource Information Management System (ARIMS) database to define reaches on the routed DLG coverage.

After the reaches were defined, they were numbered consecutively. The number consisted of a numeric code which was formatted as the frame number of the selected photo followed by an alpha code (R) to indicate that the reach was a lotic water body, followed by a numerical identifier for each reach in the effective area of the photo. If two or more reaches were identified on the same stream, the unique number used to identify the reach was followed by an alpha character to distinguish them.

A map of each photo plot with the hillshaded relief of DEM and DLG coverages was created using ArcView layout. The stream reaches were labeled with their respective reach numbers on each of the maps. The maps were provided to all interpreters involved with the project to help them identify reaches on the aerial photographs. (*Photo 2.*)

Attributes and process identified in TR1737-9 (Prichard, 1993) and the photo interpretation key in TR 1737-12, *Using Aerial Photographs to Assess Proper Functioning Condition of Riparian-Wetland Areas* (Prichard et al., 1999) were used as guidelines for this assessment. The photo interpretation key (based on hydrology, vegetation, and erosion/deposition char-

Photo 2
Light table, aerial photos and printout of the effective area of the aerial photo (far right). The print out with reaches and reach numbers created in ArcView layouts was useful in identifying reaches on the aerial photo.

Assumed PFC	5-Plot Sample 5% Quantile	 10% Quantile	10-Plot Sample 5% Quantile	 10% Quantile
95	91.35	92.23	92.42	93.07
97	94.08	94.89	94.97	95.47
99	97.22	97.69	97.79	98.09

Table 2.
Summary of simulations for 5- and 10-plot samples.

acteristics) was modified to meet conditions common to Alaska (Appendix B). Stream flow characteristics, developed from a regional model for an instream flow study on the Unalakleet River, were used to evaluate the questions related to hydrology on the checklist (Klein et al., 2000). Interpretations were recorded on a hard copy of the PFC checklist to be entered into the PFC module of the ARIMS database upon completion of field verification.
Results of the photo interpretation were verified during a three-day field survey of selected reaches. Some reaches were randomly selected while others were identified during the photo interpretation process as sites that needed to be visited. The random selection of reaches to be included in the field verification phase was based on the proportion of the number of reaches in each of the five plots. Twenty randomly-selected reaches and 18 questioned reaches from the photo interpretation effort were visited on site.

Coordinates were derived from the GIS to facilitate locating the reaches in the field. A lat/long converter in ArcView determined geographic coordinates of those reaches to be evaluated. The coordinates were entered into the helicopter GPS and used by the pilot as waypoints to efficiently locate the reaches.

Interpreters used a portable light table and a stereoscope in the field to help them review reaches before and after field verification. By using these tools in the field, the team members could match their field observations to the photos more precisely.

Results

The statistical simulation used to determine the number of photo plots indicated that very few photos were required to assess PFC for this drainage. Results ranged from 91.35 percent compliant with an assumed PFC of 95 percent using five sample plots at a 5 percent quantile to 98.09 percent compliant with an assumed PFC of 99 percent using 10 sample plots at a 10 percent quantile (Table 2).

Two hundred and sixty-one reaches were delineated within the effective area of the five photographs. Photo plots 4960, 75, 79, 247, and 104 had 47, 96, 45, 36, and 37 reaches respectively.

The initial attempt by the members of the team from Alaska to assess PFC from the photos was not encouraging. Less than 10 percent of the total number of reaches were interpreted, all of which were PFC. The results of these interpretations along with the aerial photos were sent to BLM's National Applied Resource Sciences Center (NARSC) for review and further evaluation. (*Photo 3.*)

Photo interpretation by the NARSC Team proved much better. This team was able to assess all reaches on photo plots 79 and 104,

all but two reaches on photo plot 247, all but three reaches on photo plot 4906, and all but 11 reaches on photo plot 75. The NARSC Team found all remotely assessed non-questioned reaches were PFC. NARSC could not assess 18 reaches on the edge of the photography because these reaches were outside the stereo coverage.

These reaches could have been interpreted if the proper adjacent photography was available. Other reasons reaches were not interpreted included time of photography and darkness at the edge of some photos.

Members of the Alaska team, personnel from NARSC and the National Riparian Service Team conducted field validations in June.

Geographic coordinates derived from GIS proved to be very accurate in locating the reaches selected for field verification. All but four coordinates were within a few hundred feet of the selected reach. Three of those four were about 11 nautical miles off, probably due to transcription error.

Photo 3.
A typical small drainage that presented problems to the members of the team from Alaska. Open water and the channel were not readily visible from the small scale aerial photos. Meander patterns and spectral response were important attributes in assessing these streams.

With few exceptions, all the reaches proved to be lotic habitats and PFC. Exceptions included reach number 75 R16 (interpreted from aerial photography as a riparian area). In all probability was not be treated as a riparian area. Reach 79R12 turned out to be lentic, not lotic.

Reaches 79R34, 35 and 36 were part of a large lentic wetland and would not be assessed as individual lotic systems. Although these sites eventually drained into the Unalakleet River, they should have been assessed as a lentic unit. (*Photo 4.*)

Other reaches questioned from the original interpretations 247R12 and 14, and 4960R25,

Photo 4.
Reach 79 R34, one of the 18 questioned reaches that drained an area of low relief and was depicted on the DLG as terminating on the tundra.

26 and 27. Photo interpretations for 247R12 and 14 indicated drier sites. These sites were probably ephemeral and would not be considered riparian areas. Concerns for 4960R25, 26 and 27 related to date of the photography (August). Results from field investigations indicated that there were lotic riparian areas that should have been assessed because they had a riparian-wetland community. The early fall (August) photography revealed the spectral response of the understory vegetation instead of alders and willows. Local field knowledge about these sites would have reminded the interpreters to adjust the interpretation key and identify them as riparian areas rated as PFC. (*Photo 5.*)

The team observed other reaches in the drainage on a random fly-through on the last day. This fly-through validated that the randomly-selected photo plots and their reaches provided reliable information related to PFC for the entire watershed.

For the most part, reaches defined using hillshaded relief of DEM were found to be adequate. Reaches, such as short first order streams that have no side drainages, probably should not have been included in this assessment. Reach breaks on some Rosgen's C type streams evaluated were not correct and required some adjustments.

All lotic reaches verified in the field were found in PFC. The use of small-scale aerial photography and GIS allowed us to efficiently assess 2,964 miles of riverine riparian on BLM land in the drainage. The results suggest more than 97 percent of the reaches were compliant, using an assumed PFC of 99 percent with five sample plots at a .05 level of significance.

Discussion

While it is generally accepted that the most current photos will yield the most accurate results, much of the high altitude photo base for Alaska is old. However, field verification of a remote riparian assessment in the eastern part of the Crow Indian Reservation using 16 to 17-year-old photographs was found to be 95 percent accurate by the Natural Resource Conservation Service (USDI, 1999). Despite the age of the Unalakleet photography, characteristics between reaches interpreted from the photographs were very similar to those observed on the ground. Field validation indicated the remote assessment to be very accurate.

The use of statistical evaluation to determine a sample size resulted in an assessment that was not only repeatable, but it also permitted us to place a high degree of confidence in the assess-

Photo 5.
A Rosgen E type channel about one foot wide and 1.5- to 2 feet deep that is preamial. Dense willow and alder makes seeing open channels on small-scale photos difficult.

ment. The advantage of estimating the number of reaches for the statistical simulation was not having to define them in all of the photos (using the "up and down" indices in ARIMS). It is estimated that there would have been more than 5,000 reaches to delineate in the drainage.

The buffers and criteria used to estimate the number of reaches for the statistical simulation resulted in an underestimate of the number of reaches that were identified later to interpret the photos. It is unlikely that the underestimate affected the results of the assessment because the chance of a sample percentage being much different from the assumed PFC is directly related to the total number of reaches in the sample. Because the number of reaches in the assessments increased as a result of using the effective area of the photo rather than the buffer, the likelihood that the sample percentage was closer to the assumed PFC also increased. Consideration should be given to more accurately estimating the number of reaches in the simulation.

Primary consideration was given to the breaks in the hill-shaded relief coverage to define reaches. The use of this data proved adequate particularly on the medium-to-large drainages within the photo plots. Several adjustments should be made in the way reaches are defined on the sample plots. Accretion of flow should be one of the criteria used to define reaches. However, the upper reaches of many small, moderate-to-steep gradient, notable first-order systems with no side drainages should have been truncated approximately midway up the drainages because it was determined that these reaches were not riparian areas. (*Photo 6.*)

More accurate reach definitions could have been made on moderate-to-steep gradient streams by using the aerial photography in conjunction with GIS to determine whether small side drainages would contribute enough flow to

Photo 6.
An example of a first-order stream in the basin that is represented on the digital line graph. Typically, the upper portions (above treeline) of these systems have few, if any, side drainages and should not have been included in the assessment. The lower portion (having channel or vegetaion attributes characteristic of lotic systems) should be assessed.

create riparian habitat. A logical break should have been made on several of the reaches due to their size. On the larger drainages, more consideration should have been given to using sinuosity and confinement to define reaches. A tool available through ArcView that generates contour intervals from DEM data was not used and could have helped define the reaches.

The Alaska team was not comfortable interpreting the aerial photos. The team attempted to strongly adhere to some of the guidelines used to assess riparian areas. Specifically, if they could not see the channel, they felt they could not assess the stream reach. This presented a problem with small drainages, particularly first and second order streams. Their results, when compared to those made by NARSC, clearly showed that experience is an important aspect in assessing riparian areas. In addition to reviewing our interpretation, NARSC also provided suggestions and adjustments to the interpretation key before and after the assessments were verified in the field. NARSC efforts will be of assistance in future efforts. The adjusted interpretation key can be found in Appendix B .

GIS greatly reduced the time required to create and analyze all related aspects of this project. Much more time would have been required to manually create and track the many overlays that this effort demanded, including the aerial photo distribution coverage, photo index and reach indices. Some query capabilities of GIS used to great advantage included determining the number and lengths of reaches and extracting geographic coordinates that were used to locate selected reaches in the field.

Several attempts were made to obtain reportable units based on land status. ArcView clipped the stream coverage to BLM, state and native-selected lands. It was soon apparent that ArcView's subroutine would not work with the events tables in the routed hydrography coverage. The length header was in the table of the clipped coverage, but records did not contain the information necessary to obtain the total miles in the clipped coverage. However, the table of an un-routed DLG contained the necessary information.

BLM's ESRI support person in NARSC, Mike Badar, suggested using an ArcView script named calcapl.ave on the clipped version of the routed DLG coverage. This script calculates area and for polygon themes and length for line themes However, there was a two percent difference in the number of stream miles when we compared the results of a clipped coverage of unrouted data to the routed coverage on which the script was used.

Overall, this approach appears to be an efficient and cost-effective means to document PFC in remote areas landscape basis where most streams are expected to be properly functioning. An estimated 65 staff days were required to complete the assessment, including travel time. Helicopter costs for three days to validate the photo interpretation cost approximately $10,500. There was an average of 50 reaches per photo.

One hundred and four photos were used to cover the drainage with some overlap. Assuming an assessment could be accomplished with 75 photos that averaged 50 reaches per photo, assessing the entire drainage using either aerial photography and field validation or site-based assessment would have required significantly more time and money.

Acknowledgements

This project was the result of efforts of many people. Tim King, presently the only GIS support staff at the BLM Anchorage Field Office, provided invaluable GIS support and encouragement. Andy Hall and Paul Bartschi from the BLM Alaska State Office provided timely fixes to the ARIMS data base and ArcView interface which facilitated the uses of GIS for this effort. Jim Alegria from the BLM Oregon/Washington State Office and probably the only biometrician with the BLM graciously donated his valuable time to provide statistical input and the programming code used for the statistical analysis. Scott Guyer, the BLM Alaska State Office vegetation expert who along with myself learned much about the assessment process, was of great assistance in our initial attempt to interpret photography; his expertise with vegetation proved invaluable during the field evaluation. Janis Staats, a US Forest Service hydrologist on the National Riparian Service Team, was an excellent note taker. Her knowledge of geomorphology and stream systems during the field evaluation provided consistency in evaluating the hydrography questions in the key. Finally, the assistance of Pam Clemmer and Don Prichard from the BLM Center National Applied Resource Sciences Center was of great benefit; their intimate knowledge and experience with the PFC assessment processes and interpretation of aerial photography were much needed during the initial phases of the project. They were able to make timely adjustments to the key which will assist us in the future. During the field evaluation, they were able to demonstrate key features on the ground and relate them to the aerial photography which will be of benefit with future efforts.

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Appendices

Appendix A
SAS Code

```
/* This is a simulation for unequal cluster sizes
for proportion with the number of subunits
within each PSU following a lognormal distri-
bution.

*/
options ls=80;
%global loop size;
%let pfc=99;
%LET LL=5;
%let mean=3.; /* the mean of the lognormal
distribution.  This is approximately the mode
of the pilot data. */
%let sigma=.5; /* the standard deviation of the
lognormal distribution.  This was estimated
using SAS Insight and the pilot data and later
verified within the Excel spreadsheet. */

%let range=.55;

/* This macro has two primary functions 1)
reduces a lognormal variate with mean and
sigma defined that represents the number of
reaches within a photo. 2) Repeats #1 'size'
times which represents the number of photos
drawn from the population. 3) Repeats #2 'loop'
times which represents the number of samples.

*/
%macro psu(loop,size);
Data file1;
seed=7519;
do k=1 to &&loop;
bi=0;
do i=1 to &&size;
LL=5;
call ranuni(seed,x); /* draws a uniform random
variate */
rnum=log(&range*x*100+&LL+.5); /* takes the
natural log of the uniform random variate */
miln=rannor(seed)*&sigma+&mean; /*
creates a lognormal random variate with
mean=&mean and sigma=&sigma */
mi=round(exp(miln)); /* rounds to the nearest
whole number.  This represent the number of
reaches per photo */
bi=
o j=1 to mi; /* The probability that a reach
fails to be PFC is simply the probability that a
uniform random variate exceeds the targeted
PFC */
call ranuni(seed,x1);
intx3=x1*100;
if intx3 ge &pfc then bi=bi+1; /* accumulates
the number of reaches that fail to be PFC */
end;
output file1;
 end;
end;
%mend psu;

%MACRO ALL(LOOP, SIZE); /* A convenient
loop that processes the macro PSU, summariz-
es the data by sample, calculates the estimated
PFC or the non-PFC percentages and creates a
historgram of the frequency of PFC or non-PFC
compliant samples.  */

%PSU(&LOOP, &SIZE);

proc summary data=file1 (where=(mi ge 6));
by k;
var bi mi;
output out=file2 sum(bi mi)=;

ata file3;
set file2;
pi=(1-bi/mi)*100;
fake=1;
run;
title1 "The distribution of &&loop samples,
each drawing
proc gchart data=file3;
vbar pi;
run;
quit;
%MEND ALL;

%ALL(10000,5); /* the first argument is the
number of samples and the second is the num-
ber of 'photos' to randomly draw within each
sample. */
```

Appendix B

Alaska Interpretation Key

CIR

Aerial photos are an excellent tool for defining reaches because they provide a view of a large area that defines changes in landforms and other variables. However, pay close attention to headwater streams (stream order 1/no tributaries), moderate-to-steep gradients, and less than mile long as these may not be riparian areas.

Before assessing a particular reach look at the entire photo for similarities and differences. Try to note size differences, landform (confined/unconfined), and vegetation types (herbaceous, shrubs, or trees) for areas being assessed. Note the time of year of the photos relative to the growing season; this is important for determining spectral responses. Look for introduced elements (roads, power lines, gas lines, etc.) so you have an idea of what disturbances might look like. Overall try to set in your mind what might be natural and what might be altered. Key in on areas that you have knowledge about to help define what you are seeing elsewhere.

Hydrology

1. Is the floodplain above bankfull inundated in "relatively frequent" events?

> Look for bright red spectral response of vegetation
>
> Look for dark spectral response of water
>
> Look for changes of elevation (out of the norm) with landform remaining constant.

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

> Look for ponding or enlargement of a stream as indicated by dark spectral response of water. Then look for a dam, usually indicated by a pattern (lines/grid) that contains a white/gray spectral response.
>
> Look for bright red spectral response of vegetation on a dam to indicate stability. If you see no indication of vegetation capturing the dam then look for erosion (white/gray spectral response) around the dam or below the dam that might indicate instability.

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

> First define the surrounding landform. Should the riparian-wetland area be narrow, straight, and steep or should it be wide, sinuous, and flat?
>
> Next, review the entire reach for any indication of a meander pattern. For large systems this is usually easy to see as the spectral response of water is dark.
>
> Where open water is not visible, look for vegetation patterns. Assess the type of vegetation and look for any red spectral response indicating it is riparian-wetland vegetation.
>
> When there is no indication of a meander pattern (channel or vegetation) and there is a red spectral response indication riparian-wetland vegetation, think about the area being lentic instead of lotic.

4. Is riparian-wetland area widening or has it achieved potential extent?

> Again define the surrounding landform. Should you have a broad riparian-wetland area or a narrow riparian-wetland area? Assume a reach has achieved potential extent.
>
> Look for factors that tell you it has not. These factors usually have a white/gray spectral response indicating areas with little or no vegetation.

5. Is upland watershed contributing to riparian-wetland degradation?

Start by looking for any mass wasting within the watershed of a particular reach. This is usually indicated by a white/gray spectral response. If you notice any, then look to see if it has entered the riparian-wetland area and resulted in degradation.

Look for introduced elements such as roads and pipelines that might result in degradation of a riparian-wetland area. These would include features such as mid-channel bars and recent alluvial fans.

Vegetation

If CIR photography is done at the right time of year, it allows for an easier separation of riparian-wetland vegetation from upland vegetation. If you do not have this clarity, then you need to separate the different colors of red. Select a known area and review what that vegetation looks like. Then apply this knowledge to the reaches you are assessing and apply that color difference to each question (6-11).

Be aware that at times some vegetation that is normal for specific streambanks will not give off a clear red reflectance (such as evergreens). Also, be aware that if the photography is late in the year and vegetation has started to turn, your spectral response might vary from the understory vegetation.

6. Is there diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)?

For shrubs and trees look for height differences which indicate young, middle, and old age. Also analyze the red spectral responses,

For herbaceous species, look for a dense matting which indicates age-class.

7. Is there diverse composition of riparian-wetland vegetation (for maintenance/recovery)?

Differences in red spectral response indicates different species. Also analyze textural patterns.

8. Do the species present indicate maintenance of riparian-wetland soil moisture characteristics?

Use red spectral responses to determine this.

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

Again, use red spectral response to find whether the right plants are in place. Also analyze textural patterns.

10. Do the riparian-wetland plants exhibit high vigor?

A deep red spectral response for any vegetation is saying that plant exhibits high vigor. If you start to see a more yellow signature, assume you are dealing with stressed and/or unhealthy plants.

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

Look for a continuous band of red spectral response.

When you observe a lot of white/gray spectral responses, it usually is indicative of little or no vegetation. However, be aware that it could also be a rock outcrop or in the case of large systems a normal nonvegetated point bar.

12. Are plant communities an adequate source of coarse and/or large woody material (for maintenance/recovery)?

For the Unalakleet watershed we felt this process was an N/A. Yes, there is wood in places but we felt that it was not mandatory for large wood to be in place to help dissipate energy.

Erosion / Deposition

13. Are floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) adequate to dissipate energy?

Review the existing landform to give you an idea of the channel characteristics that should be in place. For example, do not expect oxbows to be in a small headwater stream that is in a confined landform. Then look for these features.

For items such as rocks you will see a white/gray spectral response. For oxbows and overflow channels you should see a dark spectral response if water is present. You should also see the vegetation that characteristically lines these channels exhibit a red spectral response. For areas where water is not visible, there still should be the vegetation response.

14. Are point bars revegetating with riparian-wetland vegetation?

Determine if the system you are looking at should have point bars. For example, this item would be N/A for most systems that are confined by landform (steep and straight).

If it is a system that has point bars, look for red spectral responses that indicate riparian-wetland vegetation is present on the point bars. Look for variation in heights as you move away from the water's edge. A variation in heights indicates that the point bar is revegetating over time. Be sure to separate what is a normally-scoured point bar from where vegetation should start on the larger river systems.

15. Lateral stream movement is associated with natural sinuosity.

Be sure to define if you are looking at a single channel system or a multiple channel system. For any single channel system you should see a well-defined line of open water (dark spectral response) and/or vegetation (red spectral response) that would indicate its lateral movement is natural. If there are problems and lateral movement is not natural it will trend toward being multiple channels and have a strong white/gray spectral response in the channel.

If you are looking at a multiple channel system you must determine if you are dealing with a vegetated system or a braided system as the spectral response will be different. A healthy vegetated system will have black spectral responses for water and red spectral responses for vegetation on islands and streambanks. A braided system will have a lot of white/gray spectral responses along with some black and red spectral responses.

16. Is the system vertically stable?

Look for a negative change in extent of riparian-wetland area within same landform. Most of the time this will be reflected in a change of spectral response due to loss of vegetation or change in composition.

17. Is the stream in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)?

Where open water is visible, look for black spectral response as this indicates there is little sediment. For any single channel system the evidence of any mid-channel bars (white/gray spectral response) is a strong indication of a system being out of balance.